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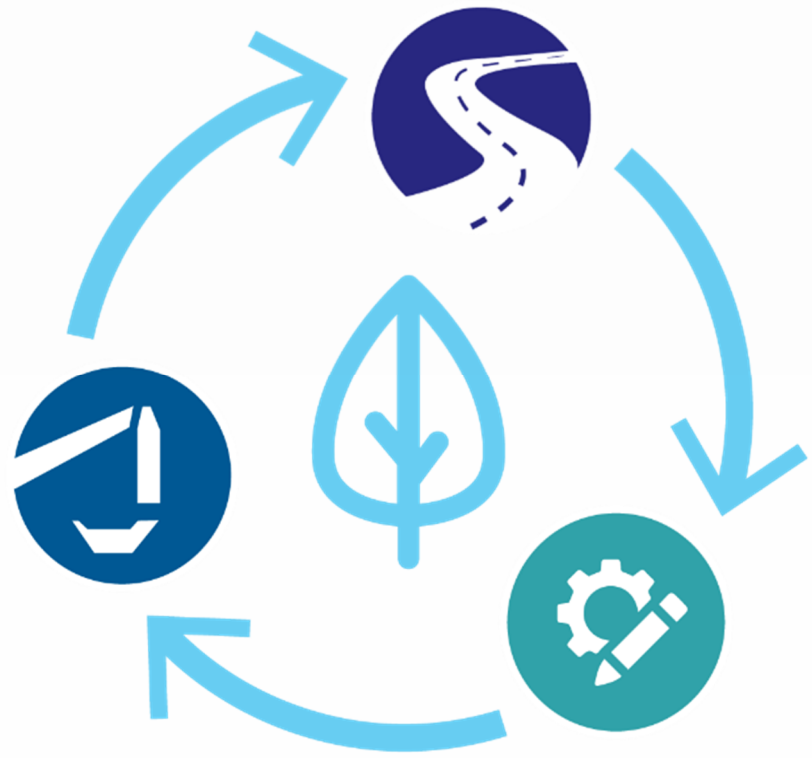

Earthworks Analysis and Mass Haul Tool - User Guide

Version 2.01 | September 2023

UPDATE LOG

USER GUIDE

Tool Ref	User Guide Ref	Update	Description
2.01	2.01	Phase 2 Marginal Classification	Previously (applies to the Phase 2 Tool only) material classified as marginal was automatically assumed as unacceptable. A new setting has been added to allow the user to toggle allocation of marginal material as either acceptable or unacceptable. Guidance has been provided in the User Guide (Section 8.1).

EXCEL-BASED TOOLS

Tool Ref	Category	Update	Description
2.01	Functionality	Phase 2 Marginal Classification	Previously (applies to the Phase 2 Tool only) material classified as marginal was automatically assumed as unacceptable. A new setting has been added to allow the user to toggle allocation of marginal material as either acceptable or unacceptable.
	Visual	Conditional Formatting for Inputs	Update to the conditional formatting to (1) hide legacy data (which the user may forget to remove) following changes to the settings; and (2) refine the number of cells where yellow fill appears to make the input process more efficient for the user. This applies to the following tabs: *Unbulked Cut Volumes; Bulked Cut Volumes; Fill Volumes; Cut Reusability; Cut Classification; Fill Classification.*
		Clarification to Overburden Reusability Subheading	(Applies to the Phase 3 Tool only) In order to clarify where the tool will assign certain classifications in accordance with TII SRW Series 600, additional text has been added to the 'Fine-Grained' and 'Coarse-Grained' subheadings, in terms of 'Class 2' and 'Class 1' respectively.
		Plotting Extents for Diagrams	Previously the x-axis bound was limited to 2000. This has been updated to automatically alter depending on the project-specific chainages.
		Conditional Formatting for Outputs	Update to the conditional formatting in the *Haulage Analysis Summary* tab to (1) represent zero percentage outputs as green as opposed to red; and (2) slight alteration to how the percentages of uphill movement is represented.

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TABLES

1 Introduction

Appropriate consideration of earthworks is necessary at the early stage of design and planning, particularly at Phase 2 (Option Selection) and Phase 3 (Design and Environmental Evaluation), to achieve objectives such as waste minimisation, optimal material re-use and a well-informed and sustainable design.

Mass Haul involves the assessment of the allocation and haulage of material across a scheme. However, an effective Mass Haul assessment should consider factors such as topography, proposed road alignment, earthworks volume, ground conditions, material sources and destinations, and haulage constraints, with a level of detail appropriate for the Project Phase and project-specific objectives. The level of detail must also be balanced with what is reasonable with respect to the Project Phase and the level of information which can be practicably obtained.

To assist with this process, two Excel-based tools has been developed which undertakes material analysis, produces summary Mass Haul diagrams, conducts further haulage analysis, and highlights opportunities for more sustainable design through earthworks and haulage optimisation.

1.1 Purpose of the Earthworks Analysis Tools

The purpose of the Excel-based tools is to provide a semi-automated and structured process for the user to undertake Mass-Haul analysis. The tools are intended to achieve the following based on available information:

- Incorporation of the acceptability and reusability of the excavated material, based on inputs and analysis by the user
- Assess the allocation of material on localised scales
- Allow the consideration of the source and destination of all material required for the scheme
- Identify where the proposed alignment design would result in unsustainable and/or uneconomical earthworks practices

In addition, the following should be noted with regard to the purpose of the Excel-based tools:

- The tools are intended to support the project team in making decisions regarding the design with respect to sustainability in earthworks. However, the assessment and selection of option(s) must also take into account other factors (*e.g.* biodiversity, human health). Therefore, the optimisations identified using the tool should be considered in a holistic manner with all other relevant aspects. This may result in the inability to apply all the potential optimisations identified with respect to sustainability in earthworks.
- The objective of the tools are to support the Phase 2 and Phase 3 assessment and design process rather than to achieve the level of detail typically associated with a complete Mass-Haul analysis at Phase 6 construction. The tools are intended to aid the designer to consider the constructability of the option or route using geotechnical information which can be practically obtained at the relevant Project Phase.

1.2 Considerations of the Earthworks Analysis Tools

The Earthworks Analysis Tools gives particular attention to the following factors:

- material classification
- material bulking
- material acceptability
- source and destination of material
- haulage constraints
- alternative sources and destination sites (*e.g.* material deposition areas and borrow areas)

- haulage considerations (*e.g.* freehaul, overhaul, gradient)

Earthworks Analysis and Mass Haul provides the opportunity to consider the source, destination and movement of material for a project. Figure 1.1 provides a summary of the value that can be achieved throughout the Project with the introduction of Mass Haul within both Phase 2 and Phase 3.

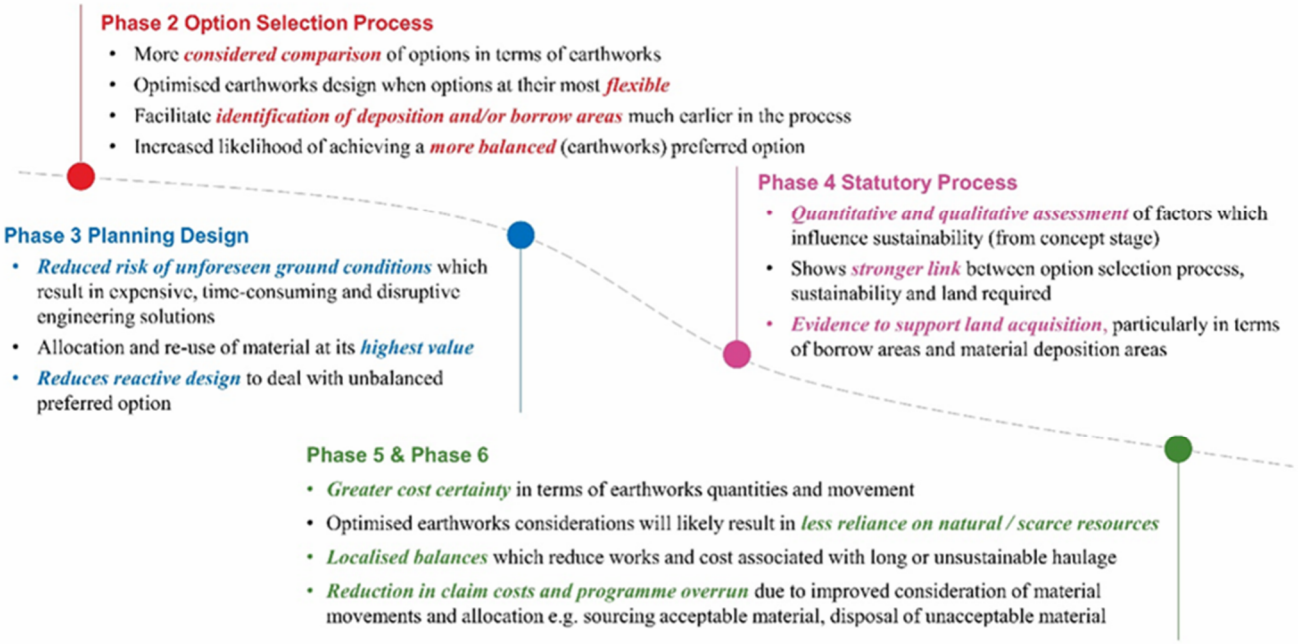

Figure 1.1 Value throughout the project with the introduction of a structured Mass Haul assessment at Phase 2 and Phase 3

1.3 Purpose of This Document

This document is to act as a user guide for the two tools which have been developed for Phase 2 and Phase 3 respectively.

The **Phase 2** tool analyses earthworks in terms of generalised geological descriptions, which are typically collected and appraised from both an engineering and environmental context at Phase 2 (*e.g.* topsoil, overburden, peat, bedrock).

The **Phase 3** tool analyses earthworks in terms of the TII Specification for Roadworks Series 600 classification (*e.g.* Class 1, Class 2, Class 6).

Both tools have been developed with the same structure of 'tabs' in a spreadsheet, where each tab represents a step in the earthworks analysis process. Table 1.1 provides a summary of the different tabs and elements considered in the tools.

Table 1.1 Summary of the Earthworks Analysis (Mass-Haul) Process provided in the excel-based tools

Project Phase	Earthworks Material Units	Geometry & Volumes	Earthworks Analysis	Project Characteristics	Visualisation	Conclusions & Opportunities
Phase 2	Geological Description (e.g. Overburden, Rock)	Geometry: Chainage Alignment Ground Volumes: Cut (Unbulked) Fill (Compacted)	Volumes: Cut (Bulked) Fill (Uncompacted) Reusability Analysis Earthworks Balance Assessment	Constraints Material Deposition Areas Borrow Areas Import Export / Disposal	Overall Mass Haul Diagram Mass Haul Diagram per Material Type (as per Phase & Scope)	Earthworks Balance per material designation Haulage Summary per material designation Haulage Summary per Earthworks Area
Phase 3	TII Earthworks Classification (e.g. Class 1, Class 2)					

The typical structure of each tab is in the form of input, analysis, and output. In some situations, the user is required to provide content for both the input and analysis sections of the tabs, while in other situations the content will be generated automatically based on previous tabs.

Each sub-section of this document relates to a tab within the tool and outlines the following where relevant:

- **Overall Objective** – A brief summary of the overall objective of the tab.
- **Input, Analysis, and Output** – A brief description of the content within each of the associated sections.
- **User Interaction** – The locations in the tab where the user is required to provide content, the format of the content, and any other information relevant to the user.
- **Settings** – Specific inputs which interact with a number of cells.

Note that the tools have been developed where cells with a yellow fill require user input, and all other cells are automatic.

1.4 Applicability & Functionality

The tools are intended for Mass Haul Analysis in Phase 2 and Phase 3 respectively. The user should note the following bespoke functionality:

- **Bulking and Compaction Factors per Earthworks Area** – The user is required to define the bulking factors and compaction factors for the different material designations for either Phase 2 or Phase 3. These factors are then applied scheme-wide to any of the earthworks areas which contain the associated cut or fill material. It is noted that in some situations, the nature of the material or geological setting can change across a scheme, and as such, variations in the bulking and compaction factors can exist in reality. However, this approach is anticipated to be sufficiently accurate for the majority of situations.
- **Haulage Evaluation** – Once each earthworks area is identified, the tool conducts an initial balancing exercise of cut vs fill within each earthworks area. The remaining balance (whether surplus or deficit) is determined for each earthworks area, and this is used as part of the haulage evaluation. Therefore, the outputs related to haulage does not include haulage of material which is both sourced and deposited within the same earthworks area.
- **Two Forward / Backward Movements** – Following an assessment of earthworks balance within each earthworks area, a haulage analysis in conducted of the movement of surplus material between earthwork areas. Surplus material is moved to the next earthworks area in both a forward and backward direction. If surplus material still exists following this first movement, a second movement iteration is conducted to the second nearest earthworks area in both directions. However, in reality, additional or

further movements might be required. The tool highlights the surplus and deficit volumes per earthworks area post these two movements.

- **Gradient** – The haulage evaluation assesses the haulage gradient for each movement between earthworks areas. This is based on the average gradient of the topography and the vertical alignment in both the forward and backward direction. The final output identifies the average gradient and indicates if the associated movement is uphill or downhill. This approach to gradient is anticipated to be appropriate for the majority of situations, with regard to the objective of these tools in Phase 2 and Phase 3.

2 Glossary of Terms

The following provides a description of the terminology used in the Excel-based tools:

- **Long Section** – Profile presentation of the topographical and alignment elevations along the length of the route
- **Fill** – Area which requires placement of material to raise the ground from existing level to the proposed alignment level
- **Cut** – Area which requires excavation of material to lower the existing level to the proposed alignment level
- **Earthworks Area** – A section of road (which accumulates a range of stations) which predominantly matches the same characterisation of the earthworks activity (filling, cutting, or at-grade)
- **Gradient** – Rate (percentage) of change of elevation to the horizontal distance. Positive denotes rise and negative denotes fall.
- **Chainage** – Distance from the start to a particular point along the profile of a road
- **Station** – Particular point along the profile of the route
- **Forward Movement** – Movement of surplus cut material from a cutting in a forward (positive) direction with the chainage (see Figure 2.1)
- **Backward Movement** – Movement of surplus cut material from a cutting in a backward (minus) direction against the chainage (see Figure 2.1)
- **One Movement** – Movement of material from the cutting in question to the next closest earthworks area in the direction specified (see Figure 2.1)
- **Two Movements** – Movement of material from the cutting in question to the second nearest earthworks area in the direction specified. Two movements are only triggered when the surplus material from a cutting cannot be accommodated in the nearest earthworks area in either the forward or backward direction (see Figure 2.1)
- **Bulking** – An increase in volume of material occurs when it is excavated from its in situ location. The change in volume is referred to as bulking and the ratio or percentage of the volume change is referred to as the bulking factor.
- **Compaction** – The volume of material transported to a deposition site reduces or shrinks following compaction activities. A compaction factor represents the ratio or percentage reduction of the volume compacted in situ against the volume of material transported to the deposition site.
- **Freehaul** – Distance with which there is a fixed price for excavating, hauling, and placement regardless of the distance moved. Dependant on the contractor's equipment and methodology.
- **Overhaul** – Distance or volume which needs to travel beyond the freehaul distance.

2.1 Phase 2 Material Designation

The following provides a description of the Earthworks Material Units for Phase 2:

- **Topsoil** – top layer of soil, darker in colour and with more organic matter than the layer below (BS3882:2015)
- **Made Ground** – anthropogenic ground (deposits which have accumulated through human activity) in which the material has been placed without engineering control and/or manufactured by man in some way, such as through crushing or washing, or arising from an industrial process (BS 5930:2015)
- **Peat** – biogenic deposit typically consisting of organic soils derived from partially decomposed plant remains that accumulated under waterlogged conditions.
- **Overburden** – all other naturally occurring soil other than topsoil, peat, made ground and rock

- **Rock** – naturally occurring assemblage of minerals, crystallized, cemented or otherwise bonded together, so as to form material of generally greater strength or stiffness than soils (BS 5930:2015)

2.2 Phase 3 Material Designation

The terminology for the Earthworks Material Units for Phase 3 are derived from TII Specification for Road Works Series 600 (in particular Table 6/1). The following are the general material descriptions for the material classes referenced in the Phase 3 tool:

- **Class 1** – Granular general fill
- **Class 2** – Cohesive general fill
- **Class 4** – Landscaping fill
- **Class 5** – Topsoil
- **Class 6F** – Selected granular fill used for capping
- **Class 6I/6J** – Selected well graded / uniformly graded granular fill used for fill to reinforced earth and anchored earth
- **Class 6N** – Selected granular fill for both to and/or below structures
- **Class U1** – Unacceptable inert or non-hazardous material as defined in Clause 601.2(ii) of TII SRW Series 600.
- **Class U2** – Unacceptable hazardous material as defined in Clause 601.3 of TII SRW Series 600).

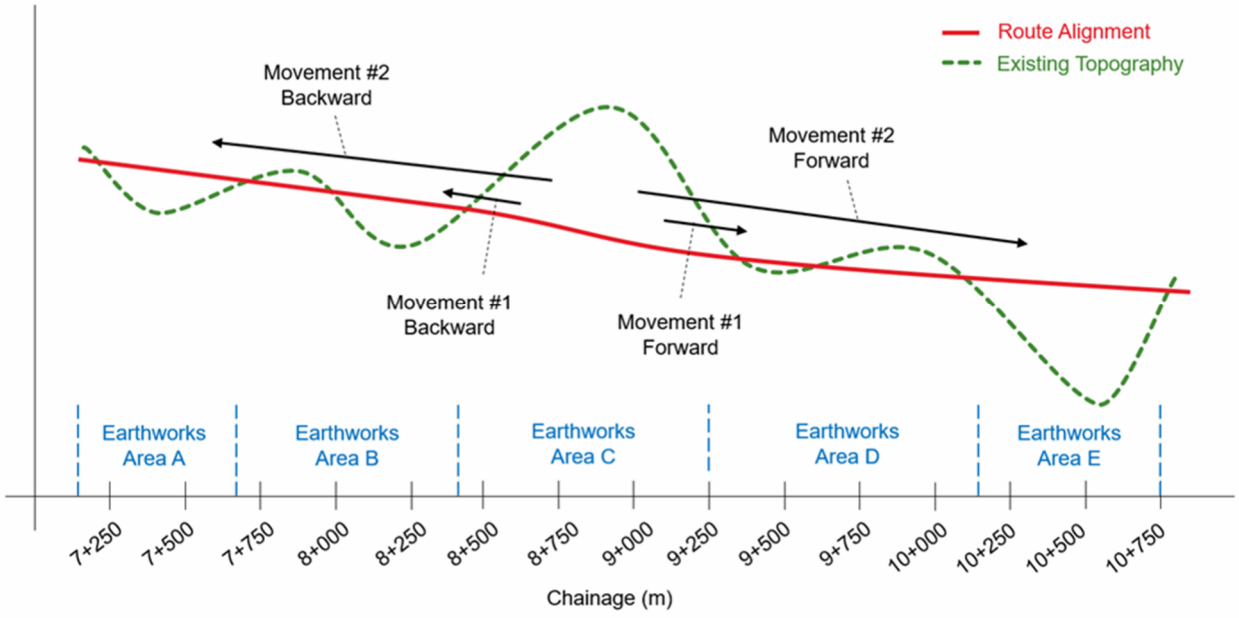

Figure 2.1 Arbitrary example of Forward and Backward Movement

The direction of the movement is associated with the direction of haulage with respect to the chainage sequence (i.e. forward is for movement with increasing chainage, backward is for movement in the opposite direction to increasing chainage). The numerical reference (one and two) denotes the movement to the next nearest earthworks area (i.e. one movement is to the nearest area, two movements is to the second nearest area). The tool works to move material to the nearest earthworks area in both the forward and backward direction. Where surplus remains, it then considers movement to the second nearest earthworks area.

3 Long Section

The Long Section tab analyses the distribution of fill and cut sections throughout the option/route, while also establishing the gradient between stations. Please note that the long section tab has been developed for a continuous centreline alignment and its associated 3D volumes. The designer may decide to incorporate side roads into the volumes of the station where the side road meets the centreline (see Figure 3.1).

It is intended that the user only includes earthworks related materials (*i.e.* omitting typical materials associated with a pavement box). However, an allowance has been made where subbase material can be considered where a breakdown of such material is known and where subbase may be sourced from site-won material. The typical fill materials, as outlined in TII Specification for Roadworks Series 600 (CC-SPW-00600), are permitted.

Table 3.1 Long Section Tab

Process	Description	User Interaction	
Input	Numerical reference for the start and finish of the chainage range for centreline of a scheme (e.g. From 0m To 50m)	✓	Source from output of software used by Designer to model the option alignment (e.g. OpenRoads, MX) It is advised that the chainage spacings are kept low in the initial input (c. 50-100m). This ensures that the gradient analysis is sufficiently detailed. However, larger spacings can be used.
	Topographical elevation or existing ground elevation for each chainage (from and to)	✓	
	Design road alignment elevation for each chainage (from and to)	✓	
	Total cut volume for each chainage	✓	
	Total fill volume for each chainage	✓	
Analysis	Average elevation of topography and road alignment per station	-	Automatic
	Average gradient of topography and road alignment per station	-	
	Earthworks volume balance per chainage range and the predominant earthworks status (cut or fill)	-	
Output	Grouping of predominant earthwork activity into earthworks areas and numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Section chainage midpoint	-	
	Designation of the earthworks areas in terms of cut & fill	-	
	Total cut volume, total fill volume and earthworks balance for each earthworks area	-	
	Section average gradient and elevation	-	
	Average gradient of the topography and road alignment between a specific earthwork area and the next one (one movement) in both a forward and a backward direction	-	
	Average gradient of the topography and road alignment between a specific earthwork area and two movements in both a forward and a backward direction	-	

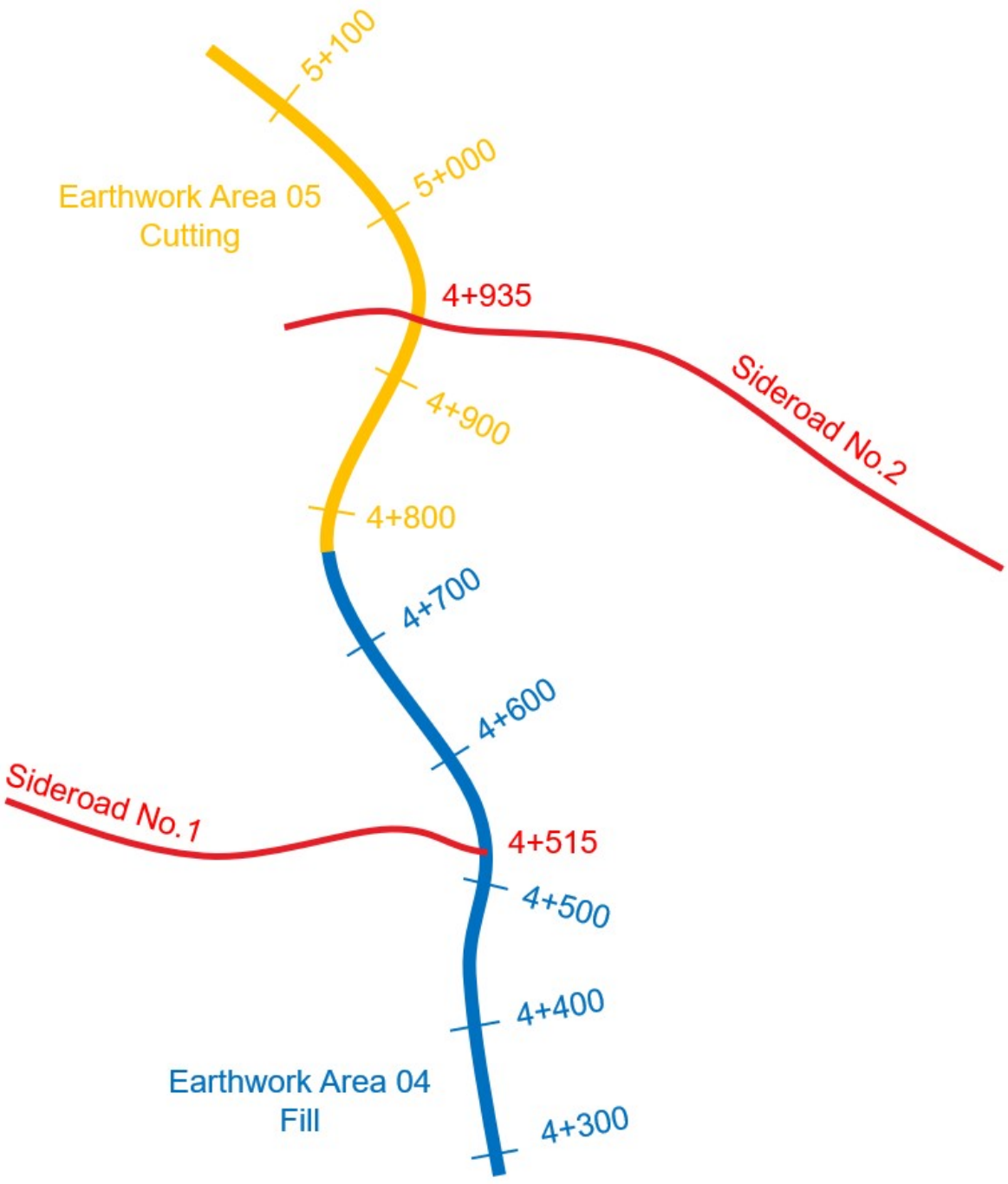

Figure 3.1 Example of possible sideroad allocation

The cut and fill volumes for Sideroad No.1 would be included within the volumes associated with the mainline between Ch. 4+500 to 4+600. The Long Section output would result in the volumes for Sideroad No.1 being included within Earthworks Area 04. Likewise, the total cut and fill volumes for Sideroad No.2 would be included within the volumes associated with the mainline between Ch. 4+900 to 5+000. The Long Section output would result in the volumes for Sideroad No.2 being included within Earthworks Area 05. Haulage distance along the sideroads would not be included in the analysis

4 Unbulked Cut Volumes

The Unbulked Cut Volume tab allows for both input and designation of the cut material according to the scope or project phase, including the ability to provide assumed percentages where an understanding of the volumes is still in development.

Table 4.1 Unbulked Cut Volumes Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Total cut volume for each earthworks area	-	
	Submitted cut volumes (where available) per material designation per earthworks area	✓	Source from output of software used by Designer to model the option/route alignment (e.g. OpenRoads, MX) and earthworks volume (e.g. OpenRoads, AutoCAD Civil 3D)
	Assumed percentage (where applicable) per material designation per earthworks area	✓	
Analysis	N/A	-	N/A
Output	Total unbulked cut volumes per material designation per earthworks area	-	Automatic
	Check box function to indicate if input process matches the original total cut volumes submitted in the earlier tab	-	

4.1 Settings

This tab requires the user to select whether each material designation is to be manually submitted based on an external analysis or is to be assumed using a percentage of another submitted volume (*e.g.* assume a percentage of topsoil from the total overburden volume). The purpose and benefits of providing the ability to include assumed percentages is as follows:

- It allows for the tool to be used, even when a distribution of geological classification is unknown *e.g.* where only the total volume or total overburden/rock is known
- It allows for sensitivity checks to be undertaken for the overall mass haul and balance where particular materials of interest may change with improved ground understanding at later stages (*e.g.* topsoil, rock)

4.1.1 Application of Settings

1. The user determines at the outset which volumes (in terms of material designation associated with the phase) will be submitted based on an external calculation and which volumes will need to be assumed
2. Once these initial settings are assigned, the user must then determine from which submitted volume designation the assumed designation will be based on (*e.g.* assumed topsoil percentage will be based on total volume or overburden volume).
3. The user must then assign the assumed percentage to each earthworks area

5 Bulked Cut Volumes

The Bulked Cut Volume tab takes the outputted unbulked cut volumes, applies a bulking factor based on the material designation (inputted by the user) and outputs bulked volumes.

Table 5.1 Bulked Cut Volumes Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Total unbulked cut volumes per material designation per earthworks area	-	
	Bulking percentages per material designation	✓	Based on technical review, ground investigation information and/or professional experience of Designer
Analysis	Percentage of overburden into fine or coarse grained classification per earthworks area	✓	Based on technical assessment completed by the Designer
	Check box function to highlight if the percentages applied sum to 100%	-	Automatic
Output	Total bulked cut volumes per material designation per earthworks area	-	Automatic

The analysis section of the tab requires the user to assess the percentage breakdown of the overburden in terms of fine grained and coarse grained. The purpose of this is to consider the variation in bulking which would likely exist if the overburden consists of a mix of fine and coarse grained materials. Where the overburden is deemed to be reasonably homogenous, 100% can be applied to one and 0% applied to other.

5.1 Settings

This tab requires the user to input a bulking percentage for each material designation. Bulking reflects the percentage of volume change of excavated material when compared to the original in situ volume before excavation.

6 Fill Volumes

The Fill Volume tab allows for both input and designation of the fill material according to the scope or project phase, including the ability to provide assumed percentages where an understanding of the volumes is still in development. It also requires identification of the compaction factor for the material types.

Table 6.1 Fill Volumes Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Submitted fill volumes (where available) per material designation per earthworks area	✓	Source from output of software used by Designer to model the option/route alignment (e.g. OpenRoads, MX) and earthworks volume (e.g. OpenRoads, AutoCAD Civil 3D)
	Assumed percentage (where applicable) per material designation per earthworks area	✓	
	Compaction Factor percentages per material designation	✓	Based on technical review, ground investigation information and/or professional experience of Designer
Analysis	Total compacted fill volumes are calculated based on assumed and/or submitted compacted fill volumes	-	Automatic
	Check box function to indicate if input process matches the original total cut volumes submitted in the earlier tab	-	
Output	Total uncompacted fill volumes per material designation per earthworks area using compaction factor	-	Automatic

6.1 Settings

This tab requires the user to select whether each material designation is to be manually submitted based on an external analysis or is to be assumed using a percentage of another submitted volume (*e.g.* assume a percentage of topsoil from the total general fill volume).

The purpose and benefits of providing the ability to include assumed percentages is as follows:

- It allows for the tool to be used, even when the fill classification is unknown (*e.g.* where only the total fill volume or total general fill volume is known)
- It allows for sensitivity checks to be undertaken for the overall mass haul and balance where particular materials of interest may change with improved earthworks analysis at later stages (*e.g.* topsoil, select fill)

This tab also requires the user to input a compaction factor percentage for each material designation.

Compaction factor reflects the percentage of volume change of placed material (which is the typical output from a geometrical analysis) when compared to the transported volume before compaction. Typically, due to the compacted effort at deposition, a greater volume of material is required to be transported than the *in situ* placed volume calculation.

6.1.1 Application of Settings

1. The user determines at the outset which volumes (in terms of fill designation associated with the phase) will be submitted based on an external calculation and which volumes will need to be assumed
2. Once these initial settings are assigned, the user must then determine from which submitted volume designation the assumed designation will be based on (*e.g.* assumed selected fill percentage will be based on total volume or general fill volume).
3. The user must then assign the assumed percentage to each earthworks area
4. The user must then apply the compaction factor for each fill designation

7 Cut Reusability

The Cut Reusability tab allows the user to breakdown the reusability per material classification for each earthworks area.

Table 7.1 Cut Reusability Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Total bulked cut volumes per material designation per earthworks area	-	
Analysis	Topsoil – Automatically designated as 100% reusable	-	Automatic
	Made Ground – Percentage of marginal, unacceptable and hazardous with associated volumes automatically generated. Check column also provided to confirm sum of percentage to 100%.	✓	Based on technical review, ground investigation information and/or professional experience of Designer
	Peat – Automatically designated as 100% unacceptable	-	Automatic
	Overburden – Percentage of acceptable, marginal, unacceptable and hazardous with associated volumes automatically generated. Check column provided to confirm sum of percentage to 100%.	✓	Based on technical review, ground investigation information and/or professional experience of Designer
	Rock – Percentage of acceptable and unacceptable with associated volumes automatically generated. Check column also provided to confirm sum of percentage to 100%.	✓	
Output	Total bulked cut volumes per material designation, per reusability classification and per earthworks area	-	Automatic
	Check box function to highlight if the total breakdown following analysis sums to the same as the input total volume	-	

This tab requires the user to provide reusability percentages for made ground, overburden (excluding topsoil and peat which is automatically assessed) and rock. The reusability is assessed under the following headings:

- **Acceptable** – Material deemed to be acceptable in accordance with Cl. 601.1(i) of TII SRW Series 600 Earthworks.
- **Marginal** – Material which may be non-compliant in its natural in situ state but which has the potential to be considered as acceptable with appropriate processing and handling of the material.
- **Unacceptable (U1)** – Material deemed to be unacceptable in accordance with Cl. 601.1(ii) of TII SRW Series 600 Earthworks.
- **Hazardous (U2)** – Material deemed to be unacceptable in accordance with Cl. 601.1(iii) of TII SRW Series 600 Earthworks.

8 Cut Classification

This tab allows the user to breakdown the cut material designation further into the fill material designation for Phase 2, and for Phase 3, into the classes outlined in TII SRW Series 600 Earthworks (*e.g.* Class 1, Class 2 etc).

Table 8.1 Cut Classification Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Total bulked cut volumes per material designation, per reusability classification and per earthworks area	-	
Analysis	Overburden – Of the acceptable volume, General Fill (Phase 2), percentage of Class 1 & 2 (Phase 3).	✓	Based on technical review, ground investigation information and/or professional experience of Designer
	Rock – Percentage of Select Fill, Capping and Subbase and the residual volume for General Fill (Phase 2), percentage of Class 6F, 6I/6J, 6N, other Class 6 not listed, subbase and remaining materials only suitable as Class 1 (Phase 3).	✓	
	Topsoil – Automatically classified as Topsoil (Phase 2) and Class 5 (Phase 3).	-	Automatic
	Marginal Overburden – Automatically classified as Unacceptable (U1) for Phase 2 and automatically classified as Class 4 for Phase 3.	-	
	Unacceptable – All non-hazardous unacceptable volumes (i.e. made ground, peat, overburden, rock) automatically classified as U1.	-	
	Unacceptable – All hazardous unacceptable volumes (i.e. made ground, overburden) automatically classified as U2.	-	
Output	Total bulked cut volumes per earthworks area and per material designation for Phase 2, and per classification for Phase 3, in accordance with TII SRW Series 600	-	Automatic
	Check box function to highlight if the total breakdown following analysis sums to the same as the input total volume	-	

8.1 Settings

For Phase 2, this tab includes the ability for the user to determine whether material, which has been designated as marginal, should be analysed as either acceptable or unacceptable overburden material.

For Phase 3, this tab includes the ability for the user to define the understanding associated with the following materials:

- **Class 6F, 6I, 6J & 6N Status** – The degree of understanding of the breakdown of these material classifications can be selected as ‘Known’ or ‘Unknown’. If Known, the percentages can be provided per material class per earthworks area under the analysis section. If Unknown, the columns will be automatically classified as N/A (not applicable).

Note: Where Unknown is selected, the user is identifying that they are unable to assign a percentage of classification to such material designations (*i.e.* Class 6F, 6I, 6J, 6N). Therefore, the user should ensure that the sum of the percentages applied to the remaining material designations equates to 100% (*i.e.* Class 6 (other), Subbase [see next bullet point] and Class 1)

- **Subbase** – Knowledge of whether there is potential to source subbase material from excavated materials or whether it will require import from an external source. The options available are 'Import Only' and 'Site Won & Import'. The application of these options are as follows:
  - ***Import Only*** – Where none of the site won rock will be processed for use as subbase material. Therefore, no percentage should be included within the associated column.
  - ***Site Won & Import*** – Where it is intended that some or all of the required subbase will be processed from site won rock. This setting allows the user to vary the assumed percentage of classification for subbase per earthworks area (*e.g.* the user may identify one particular rock cut which is likely to yield subbase material, whereas the remaining rock cuts are determined to be less likely – the user can apply an assumed percentage to the earthworks area containing the large rock cutting and use 0% for all other earthworks areas)

9 Fill Classification (Phase 3 tool only)

The Fill Classification tab allows the user to breakdown the fill material designation further into the classes outlined in TII SRW Series 600 Earthworks (*e.g.* Class 1, Class 2 etc).

Table 9.1 Fill Classification Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Total uncompacted fill volumes per material designation and per earthworks area	-	
Analysis	Topsoil – Automatically classified as Class 5	-	Automatic
	General Fill – Percentage of Class 1 & 2	✓	Based on technical review, engagement with design team and/or professional experience of Designer
	Landscaping Fill – Automatically classified as Class 4	-	Automatic
	Select Fill – Percentage of Class 6N, 6i/6j and Others	✓	Based on technical review, engagement with design team and/or professional experience of Designer
	Capping – Automatically classified as Class 6F	-	Automatic
	Subbase – Automatically classified as Subbase	-	
	Check box function to highlight if the percentages applied sum to 100%	-	
Output	Total uncompacted fill volumes per earthworks area and per material classification in accordance with TII SRW Series 600	-	Automatic

10 Material Analysis

The Material Analysis tab undertakes automatic analysis of the bulked cut volumes, per material designation, against the uncompacted fill volumes as per material designation. A cut/fill calculation is then undertaken automatically to ascertain the overall mass haul.

Table 10.1 Material Analysis Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Total bulked cut volumes per material designation, per reusability classification for Phase 2 or per classification in accordance with TII SRW Series 600 for Phase 3 and per earthworks area	-	
	Total uncompacted fill volumes per material designation per earthworks area	-	
Analysis	Automatic analysis of the cut vs fill per material designation / class per earthworks area	-	Automatic
Output	Summary of the cut vs fill calculation per material designation / class per earthworks area	-	Automatic

11 Constraints

The Constraints tab allows the user to record the various different haulage constraints across the option/route. This information is later used to both visually identify constraints on the mass haul diagrams, but also identify issues where haulage of material may traverse a haulage constraint.

Table 11.1 Constraints Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of each constraint	✓	Based on review of aerial photography, road design process, project requirements, site walkovers or any other relevant sources.
	Name of haulage constraint	✓	
	Classification of haulage constraint	✓	
Analysis / Output	Analysis of each earthworks areas and cross referencing with recorded constraints to identify where a constraint exists	-	Automatic

This tab requires the user to identify all the major haulage constraints which intersect with the option/route, and to classify them under available descriptions. Only haulage constraints which are likely to be significant in terms of material movement should be included, as this information is used at a later point in the tool to help the user identify where movement of material will traverse a constraint. The effectiveness of this process is improved where targeted attention is given to major or significant constraints as opposed to all haulage constraints.

12 Material Deposition Areas

The Material Deposition Area tab allows the user to record any available or designated material deposition areas. Where no material deposition areas exist, or have not yet been identified, no input is required.

Note: Volumes should be included as bulked and/or uncompacted.

Table 12.1 Material Deposition Areas Tab

Process	Description		User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area		-	Automatic
	Designation of the earthworks areas in terms of cut & fill		-	
	Numerical reference start / finish of each material deposition area		✓	Based on review of land made available and deposition potential from a beneficial or regenerative perspective (*e.g.* noise bunds). Each areas must then be reviewed and the material type and placement capacity determined.
	Reference to the name and purpose of each material deposition area		✓	
	Phase 2	Unacceptable – Permitted input for both the available capacity and intended placement volumes for peat and/or other unacceptable material, with a check column to ensure that the capacity is not mistakenly exceeded	✓	
		Topsoil – Permitted input for both the available capacity and intended placement volumes for landscaping material, with a check column to ensure that the capacity is not mistakenly exceeded	✓	
		General Fill – Permitted input for both the available capacity and intended placement volumes for landscaping material, with a check column to ensure that the capacity is not mistakenly exceeded	✓	
	Phase 3	Unacceptable – Permitted input for both the available capacity and intended placement volumes for peat and/or other unacceptable material, with a check column to ensure that the capacity is not mistakenly exceeded	✓	
		Class 4 – Permitted input for both the available capacity and intended placement volumes for landscaping material, with a check column to ensure that the capacity is not mistakenly exceeded	✓	
		Class 5 – Permitted input for both the available capacity and intended placement volumes for topsoil material, with a check column to ensure that the capacity is not mistakenly exceeded	✓	
		Class 1 and 2 – Permitted input for both the available capacity and intended placement volumes for general fill material, with a check column to ensure that the capacity is not mistakenly exceeded	✓	

Process	Description	User Interaction	
	Capacity / Placement Check – Check box function to highlight if the placement of materials applied are not greater than the Material Deposition Area's capacity for each material designation	-	Automatic
	Availability Check (Two Movement Haulage Limit) – Check box function to indicate whether the placement volume proposed, per material designation, is available within two earthworks movement in either direction of the earthworks area where the MDA exists	-	Automatic
Analysis	Automatic earthworks balance assessment and update of each material designation accounting for material deposition area placement volume	-	Automatic
Output	Summary of updated earthworks balance across each material designation following allocation to material deposition areas or of the original input volumes where no material deposition areas are identified	-	Automatic

This tab allows the user to identify the location and make up of the potential material deposition areas. The following are the key headings related to the inputs required from the user:

- **Location** – User is required to identify the starting and end chainage for each material deposition areas parallel to the alignment centreline. The purpose here is to identify to haulage point in terms of the alignment chainages to allow the tool to calculate the placement and haulage requirements.
- **Name and Reference** – User is required to assign a name and purpose for the area.
- **Capacity Volume (per Material Type)** – User is required to calculate the capacity available for each area per different material type. For example, it may be intended to deposit peat at a particular area. However, to do so additional material such as Class 1 may be required in order to create the deposition cell or boundaries for the peat. Therefore, this breakdown of capacity should be calculated and identified.
- **Placement Volume (per Material Type)** – While the capacity may exist per area, it is highly likely that material deposition areas will not be fully utilised. The placement volume is the metric used to assess the mass haul as this is the representative volume of material required for haulage and placement.

The inputs associated with the material deposition areas assume the areas are contiguous with the alignment and therefore do not account for the distance the area is from the alignment.

Note: The current version of the tool only accounts for material movements to the material deposition area within **two** earthworks area in either direction from the earthworks area where the material deposition area is located. If it is intended that material is allocated to the material deposition area from an earthworks area at a further distance, this movement will not be accounted for within the haulage analysis. While this is primarily due to the limitations with the current platform, it also ensures that material deposition areas are strategically placed where possible, minimising the haulage movement.

13 Borrow Pits / Areas

The Borrow Pit tab allows the user to record any available or designated borrow pits or borrow areas. Where no borrow areas exist, or have not yet been identified, no input is required.

Note: Volumes should be included as bulked and/or uncompacted.

Table 13.1 Borrow Pits Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Numerical reference for start and finish of each deposition area	✓	Based on review conducted by Designer. Each areas must then be reviewed and the material type, extraction capacity, extraction volume and reinstatement volume identified by the Designer.
	Reference name of each borrow area	✓	
	Potential – Volume of potential extraction capacity per material designation which can be extracted from the identified borrow area	✓	
	Extraction – Volume per material designation which is proposed to be extracted from the identified borrow area	✓	
	Reinstate – Volume per material designation which would be required to reinstate the volume extracted	✓	
	Capacity / Placement Check – Check box function to highlight if the placement of materials applied are not greater than the Borrow Pit's capacity for each material designation	-	Automatic
	Reinstatement Availability Check (Two Movement Haulage Limit) – Check box function to indicate whether the reinstatement volume proposed/required, per material designation, is available within two earthworks movement in either direction of the earthworks area where the Borrow Pit exists	-	Automatic
Analysis	Automatic earthworks balance assessment and update of each material designation accounting for volumes associated with borrow areas	-	Automatic
Output	Summary of updated earthworks balance across each material designation following allocation to and from borrow areas or of the original input volumes where no material deposition areas are identified	-	Automatic

This tab allows the user to identify the location and make-up of the potential borrow areas. The following are the key headings related to the inputs required from the user:

- **Location** – User is required to identify the starting and end chainage for each borrow area parallel to the alignment centreline. The purpose here is to identify the haulage point in terms of the alignment chainages to allow the tool to calculate the placement and haulage requirements.
- **Name and Reference** – User is required to assign a name and purpose for the area.
- **Potential (per Material Type)** – User is required to calculate the potential extraction capacity available for each area per different material type.
- **Extraction (per Material Type)** – While the capacity may exist per area, it is highly likely that the borrow area will not be fully utilised. The extraction volume is the metric used to assess the mass haul as this is the representative volume of material required for extraction and haulage.
- **Reinstate (per Material Type)** – In many situations, the material extracted will need to be replaced with another material. The likely intention is to reinstate with a less valuable material. A source for this volume and material type will need to be identified.

The inputs associated with the borrow areas assume the areas are contiguous with the alignment and therefore do not account for the distance the area is from the alignment.

Note: The current version of the tool only accounts for material movements to (*i.e.* reinstatement) and from (*i.e.* excavation) the borrow area within **two** earthworks area in either direction from the earthworks area where the borrow area is located. If it is intended that material is allocated to/from the borrow area from an earthworks area at a further distance, this movement will not be accounted for within the haulage analysis. While this is primarily due to the limitations with the current platform, it also ensures that borrow areas are strategically selected where possible, minimising the haulage movement.

14 Export / Disposal

The Export / Disposal tab allows the user to include for any necessary export and / or disposal of material. Where disposal / export does not exist for the project, no input is required.

Note: Volumes should be included as bulked and/or uncompacted.

Table 14.1 Export Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Numerical reference for location where the exported material will leave the alignment	✓	Based on review conducted by Designer. Each areas must then be reviewed and the material type and disposal/export volume identified by the Designer.
	Reference name of export / disposal site	✓	
	Distance of Export / Disposal – Distance of haulage from the exit point on the alignment to the export / disposal site	✓	
	Disposal / Export Volume – Volume per material designation which is proposed to be hauled to export / disposal site	✓	
Analysis	Automatic earthworks balance assessment and update of each material designation accounting for volumes associated with export / disposal	-	Automatic
Output	Summary of updated earthworks balance across each material designation following export / disposal or of the original input volumes where no disposal / export is required	-	Automatic

This tab allows the user to identify the location and make-up of the potential disposal or export volumes. The following are the key headings related to the inputs required from the user:

- **Exit Chainage –** User is required to identify the chainage at which the volume of material is proposed to leave the alignment centreline. The purpose here is to identify the haulage point in terms of the alignment chainages to allow the tool to inform the haulage evaluation calculations.
- **Name and Reference –** User is required to assign a name and purpose for the deposition (*e.g.* Quarry, Article 27 Site in Co. Dublin, Landfill Site).
- **Distance of Export / Disposal –** User is required to include the distance for which the disposal volume will need to travel from the alignment centreline to the disposal site location.
- **Disposal / Export Volume (per Material Type) –** Volume per material designation which is intended to be disposed of or export divided into each individual disposal / export site.

15 Import

The Import tab allows the user to identify where import from an off-site source is required and where the source exists relative to the alignment. Where import is not necessary, no input is required.

Note: Volumes should be included as bulked and/or uncompacted.

Table 15.1 Import Tab

Process	Description	User Interaction	
Input	Numerical reference for start and finish of the chainage range of each earthworks area	-	Automatic
	Designation of the earthworks areas in terms of cut & fill	-	
	Numerical reference for location where the imported material will enter along the alignment centreline	✓	Based on review conducted by Designer. Each areas must then be reviewed and the material type and import volume identified by the Designer.
	Reference name for the source of the import	✓	
	Distance from Import Source– Distance of haulage from the source of the imported material to the entry point on the alignment centreline	✓	
	Import Volume – Volume per material designation which is proposed to be imported	✓	
Analysis	Automatic earthworks balance assessment and update of each material designation accounting for volumes associated with import	-	Automatic
Output	Summary of updated earthworks balance across each material designation following import or of the original input volumes where no import is required	-	Automatic

This tab allows the user to identify the location and make-up of the potential import volumes. The following are the key headings related to the inputs required from the user:

- **Entry Chainage –** User is required to identify the chainage at which the volume of material is proposed to enter along the alignment centreline. The purpose here is to identify the haulage point in terms of the alignment chainages to allow the tool to inform the haulage evaluation calculations.
- **Name and Reference –** User is required to assign a reference name for the source of the import (*e.g.* Quarry, Source Site in Co. Dublin).
- **Distance from Import Source –** User is required to include the distance from the source of the import to alignment centreline.
- **Import Volume (per Material Type) –** Volume per material designation which is intended to be imported divided into each individual import source site.

16 Visualisation

Mass-Haul diagrams are provided to display the output of the earthworks analysis. Two charts are provided:

- Overall Mass Haul Diagram for the option / scheme
- Mass Haul Diagram per material designation for the option / scheme

Each of the Mass Haul Diagrams provide the following detail:

- Chainage (x-axis) – Chainage range for the option/route
- Cumulative Volume Balance (y-axis) – Volume in m^3
- Mass Haul Line – Best approximation of the cumulative balance of surplus or deficit material across the option/route
- Constraints, Material Deposition Areas and Borrow Area – Midpoint point location along the option/route

17 Haulage Evaluation

The Haulage Evaluation tab undertakes automatic analysis of iterations of haulage allocation and movements across the scheme. The tab considers backward and forward movements up to a max of two earthworks areas (the nearest and the second nearest earthworks area to a cut) in either direction from the source of material. The output of the analysis is provided in the next tab, Haulage Analysis Summary.

Table 17.1 Haulage Evaluation Tab

Process	Description		User Interaction	
Input	Numerical reference for start and finish of each earthworks area		-	Automatic
	Designation of the earthworks areas in terms of cut & fill		-	
	Average Road gradients between specific earthworks areas		-	
	Updated Earthwork balance per material designation (which includes any additional changes following allocation to/from material deposition areas and/or borrow areas)		-	
Analysis / Output	Fill Required – Total fill required per earthworks area for each material designation		-	Automatic
	Available Cut – Total cut available per earthworks area for each material designation		-	
	FWD / BWD Movement #1 – Half of the available cut volume moved in both directions to the next earthworks area (FWD given priority), with datacells showing volume moved per movement direction and the remaining fill required and cut available after Movement #1		-	
	FWD / BWD Movement #2 – Remaining available cut volume moved in both directions to the next earthworks area (FWD given priority), with datacells showing volume moved per movement direction and the remaining fill required and cut available after Movement #2		-	
	FWD / BWD Movement #3 – Half of the available cut volume moved in both directions to the second nearest earthworks area (FWD given priority), with datacells showing volume moved per movement direction and the remaining fill required and cut available after Movement #3		-	
	FWD / BWD Movement #4 – Remaining available cut volume moved in both directions to the second nearest earthworks area (FWD given priority), with datacells showing volume moved per movement direction and the remaining fill required and cut available after Movement #4			
	FWD / BWD #1 & #2	Gradient – Haulage gradient between cut location and nearest earthworks area in associated direction and per material designation	-	
		Constraint – Identification of where a constraint is present within the movement between the cut and the nearest earthworks area in the associated direction and per material designation	-	

Process	Description		User Interaction	
	FWD / BWD Movement #1 & #2	Volume – Volume of material to be moved between the cut and the nearest earthworks area in the associated direction and per material designation	-	
		Distance – Distance at which the volume of material is to be moved between the cut and the nearest earthworks area in the associated direction and per material designation	-	
		Overhaul Distance – The distance over the freehaul (as identified in the final tab) of which the volume of material is to be moved between the cut and the nearest earthworks area in the associated direction and per material designation	-	
		Overhaul Volume – Associated volume of material which must travel the overhaul distance between the cut and the nearest earthworks area in the associated direction and per material designation	-	
		Uphill Haulage Volume – The volume of material which must travel in an uphill gradient between the cut and the nearest earthworks area in the associated direction and per material designation	-	
		Uphill Haulage Distance – The distance which the volume of material which must travel in an uphill gradient has to travel between the cut and the nearest earthworks area in the associated direction and per material designation	-	
	FWD / BWD Movement #3 & #4	Gradient – Haulage gradient between cut location and second nearest earthworks area in associated direction and per material designation	-	
		Constraint – Identification of where a constraint is present within the movement between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
		Volume – Volume of material to be moved between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
		Distance – Distance at which the volume of material is to be moved between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
		Overhaul Distance – The distance over the freehaul (as identified in the final tab) of which the volume of material is to be moved between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
		Overhaul Volume – Associated volume of material which must travel the overhaul distance between the cut and the second nearest earthworks area in the associated direction and per material designation	-	

Process	Description		User Interaction	
		Uphill Haulage Volume – The volume of material which must travel in an uphill gradient between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
		Uphill Haulage Distance – The distance which the volume of material which must travel in an uphill gradient has to travel between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
	Haulage Summary – Available cut and required fill both before and after all of the movement combinations per earthworks area and per material designation		-	

18 Haulage Analysis Summary

The Haulage Analysis Summary tab is focused on providing the user the output of the haulage evaluation, with the objective of highlighting key metrics and locations where further optimisation could be considered.

As this tab is a summary tab, it is not structured in the form of input, analysis, and output. Rather the tab is structured into the following parts:

- **Earthworks Balance Summary** – Summary of the overall balance for each material designation following allocation
- **Export / Import Summary** – Summary of the export/import volume and haulage requirements for each material designation
- **Earthworks Haulage Balance Summary** – Breakdown of the material deficit, surplus and balance for each material designation following haulage allocation.
- **Haulage Summary** – Breakdown of the volume, distance and gradient of the movement of each material designation and the favourable (freehaul) and unfavourable (overhaul) allocation. Note that this excludes movement within each earthworks area, and only focuses on movements to other earthworks area.
- **Haulage per Earthworks Area** – Detailed breakdown per earthworks area of each material designation of the forward and backward movements and the associated considerations such as gradient, volume, distance and haulage constraints

To assist with identification of optimisation opportunities, formatting has been used to highlight favourable and unfavourable allocation. Favourable conditions (downhill movements, not crossing haulage constraints, haulage within designated freehaul) are shown in green, while unfavourable (uphill movements, crossing haulage constraints, haulage further than designated freehaul) are shown in red [1].

Note: Volumes shown represent bulked and/or uncompacted volumes.

Table 18.1 Haulage Analysis Summary Tab

Process	Description	User Interaction	
Earthworks Balance Summary	Cut – Total overall bulked cut volumes per material designation	-	Automatic
	Fill – Total overall uncompacted fill volumes per material designation	-	
	Material Deposition Areas (MDAs) – Total overall bulked uncompacted volume per material designation for all of the identified MDAs	-	
	Borrow Pits – Cumulative balance of unbulked volume per material designation for all identified borrow pits, when accounting for both extraction and reinstatement	-	
	Export – Total overall bulked volume per material designation which is required for export / disposal	-	

[1] Please note that the conditional formatting has been included as a visual prompt to the user of where favourable and unfavourable mass haul conditions exist for the project. The intention is that the user can use these prompts to assess what optimisation opportunities could be further explored based on these conditions, while balancing this with all other economic, environmental and social objectives and constraints specific to each project. As such, in some situations, it may not be possible to achieve a 'green' status for all cells due to these objectives/constraints.

Process	Description		User Interaction	
	Import – Total overall bulked volume per material designation which is required for import		-	
	Balance – Overall volume balance per material designation which account for all of the aspects previously described (i.e. [Cut] – [Fill] – [MDA] + [Borrow] – [Export] + [Import])		-	
Export / Import Summary	Export	Volume – Total overall bulked volume per material designation which is required for export / disposal	-	Automatic
		Weighted Distance (km) – Weighted total distance for all of the export sites based on volume per material designation	-	
		Haulage (m^3km) – Accumulative export volume times the weighted distance per material designation	-	
	Import	Volume – Total overall bulked volume per material designation which is required for import	-	
		Weighted Distance (km) – Weighted total distance for all of the import sources based on volume per material designation	-	
		Haulage (m^3km) – Accumulative import volume times the weighted distance per material designation	-	
Earthworks Haulage Balance Summary	Haulage Deficit – Volume deficit following application of haulage considerations per material designation		-	Automatic
	Haulage Surplus – Volume surplus following application of haulage considerations per material designation		-	
	Balance – Volume balance per material designation and total for the option / route		-	
Haulage Summary	Haulage Volume NOT Evaluated – Volume per material designation which must travel further than two movements and therefore is not considered further in the analysis presented.			
	Haulage Volume	Overall – Overall volume hauled per material designation	-	Automatic
		Freehaul – Total volume and percentage of hauled material per material designation which is considered as freehaul	-	
		Overhaul – Total volume and percentage of hauled material per material designation which is considered as overhaul	-	
	Haulage Distance	Overall – Overall distance hauled per material designation	-	
		Freehaul – Total distance and percentage of hauled distance per material designation which is considered as freehaul	-	
		Overhaul – Total distance and percentage of hauled distance per material designation which is considered as overhaul	-	

Process	Description		User Interaction	
	Haulage Gradient	Average – Average gradient based on forward and backward movements per material designation	-	
		Uphill Volume – Volume and percentage of hauled material per material designation which is uphill	-	
		Uphill Distance – Distance and percentage of hauled material per material designation which is uphill	-	
Output	Numerical reference for start and finish of each earthworks area		-	Automatic
	Designation of the earthworks areas in terms of cut & fill		-	
	Haulage Summary – Available cut and required fill both before and after all of the movement combinations per earthworks area and per material designation		-	
	FWD / BWD Movement #1 & #2	Gradient – Haulage gradient between cut location and nearest earthworks area in associated direction and per material designation	-	Automatic
		Constraint – Identification of where a constraint is present within the movement between the cut and the nearest earthworks area in the associated direction and per material designation	-	
		Volume – Volume of material to be moved between the cut and the nearest earthworks area in the associated direction and per material designation	-	
		Distance – Distance at which the volume of material is to be moved between the cut and the nearest earthworks area in the associated direction and per material designation	-	
	FWD / BWD Movement #3 & #4	Gradient – Haulage gradient between cut location and second nearest earthworks area in associated direction and per material designation	-	
		Constraint – Identification of where a constraint is present within the movement between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
		Volume – Volume of material to be moved between the cut and the second nearest earthworks area in the associated direction and per material designation	-	
		Distance – Distance at which the volume of material is to be moved between the cut and the second nearest earthworks area in the associated direction and per material designation	-	

18.1 Settings

This tab requires the user to identify the freehaul distance that should be assumed for the project. A value of 1km (1,000m) is the default, however this will vary depending on the Contractor's plant and methodology.