

Dam Volume Calculation

Version 8.095



Dam – Dam Volume Calculation – Version 8.095
User Guide

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Published by: SOBEK TECHNOLOGIES INC.
4205 Northcliffe
Montreal (Quebec)
H4A 3L2
Phone: 514 285-4873
E-mail: genevieve@sobek-technologies.com

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CHAPTER 1. DAM DESIGN

The **Dam** module is used for the design of earth and rockfill retaining structures. Dam is used to calculate fill and excavation volumes of a dam as well as the surfaces of foundation treatment.

Dam uses a Graphical User Interface (i.e. with windowing) that is compatible with Microsoft Windows 7, 8 and 10. Dam uses the Geo, X3D and SM2 libraries created by Sobek Technologies Inc. for data editing, the definition of the presentation style, and viewing and editing graphic results. Please refer to the guides of Geo, X3D and SM2 (chapter 2 of the Site guide) for all details.

1. LAUNCHING THE DAM MODULE

 D A M

Double-click on this icon to open the **Dam** module.

The connection to the database can be done directly when calling Dam by entering the following string as target. The string will be:

C:\Geotec80\Bin\Dam.exe username/password@odbc:connection_alias

See paragraph 1 of chapter 2 of the X3D guide for all the details about the connection to a database. Once the connection to a database is done, the user can execute a data query to produce the plan view as well as the cross sections and longitudinal section.

When **Dam** is first launched, the following files are loaded from **C:\Geotec80\Style**:

- the markers file **geotec8.mrk**;
- the patterns file **geotec8.ptn**;
- the style file **Dam_4Graphs.sty** which is a classic presentation model showing a plan view, a longitudinal section and two cross sections.

The user can begin working with this initial presentation, or open another style file included with the software. He can modify the style file and save it in a new presentation. In subsequent loadings, Dam opens the style, markers and patterns files that were in use when Dam was closed.

2. FILE, EDIT, INSERT, WINDOW AND HELP MENUS

None of the options of the **File**, **Edit**, **Insert**, **Window** and **Help** menus is specific to Dam. The detailed description of each option of these menus is done in chapters 2, 3, 4 and 8 of the X3D guide.

3. VIEW MENU



The **2D View** and **3D View** options of the **View** menu and this button are used to change the view of the PLAN_VIEW graph. In the axes editing window, it is possible to change from 2D to 3D view and vice-versa for PLAN_VIEW. For the other graphs, the box cannot be checked.



The **OpenGL mode** can be used to view solids and surfaces with hidden lines and faces and shadows in 3D. The **XVT mode** is the standard display mode.

4. TOOLS MENU

The options of the **Tools** menu are used to define the utilisation parameters of Dam and to edit the graphic components produced by Dam: the characteristics of the graphic page, the graphs and their curves, the axes, the markers used. All these options are described in details in chapter 6 of the X3D guide.

Options is specific to Dam. It is presented in paragraph 4.1.

4.1. Options



The **Options** item of the **Tools** menu or this button opens the window of options for display and calculation, shown in figure 1-1, where the user can define the default values used for the calculation of the cross sections as well as the parameters for the display of the cross and longitudinal sections and the plan view.

4.1.1. Length of the calculated sections

The field **Maximum distance for cross section calculation** is used to define the length (in m) over which the cross sections will be calculated on both sides of the dike's center line. The distance is expressed:

- In the **plan view**, where each cross section is represented by a line more or less long (depending on the scale), when the user starts the calculation of a cross section or a volume.
- In the **two cross sections**, where the X axis's length is the maximum calculation distance on both sides of the origin, i.e. the dike's axis.

The step for the tick marks on the X axis adjusts automatically depending on the length to represent.

If the distortion of the Y axis is imposed at 1, the step on the Y axis is also adjusted according to the calculation distance to keep the good proportions.

- When the calculation distance is modified, the changes to the scale will be visible as soon as other sections are calculated (clicked).

If a **distance** is entered in the **dike definition**, it has precedence over the one specified in the options window.

4.1.2. Minimum spacing between points

The **minimum spacing between points for section calculation** is the minimum interval (in m) at which the elevation of the points is calculated, between the minimum and maximum X. For example, with a value of 2 m, the Z will be calculated every 2 meters.

If a **spacing** is defined in the **dike definition**, it has precedence over the one specified in the options window.

4.1.3. Height of the representation of the cross sections

The **height of cross section in the longitudinal profile** is used to define the percentage of the height of the longitudinal profile that the segments displayed at the chainage of the turning points of the axis, of each typical section and of the two cross-sections, will occupy. The segments are centered vertically in the profile.

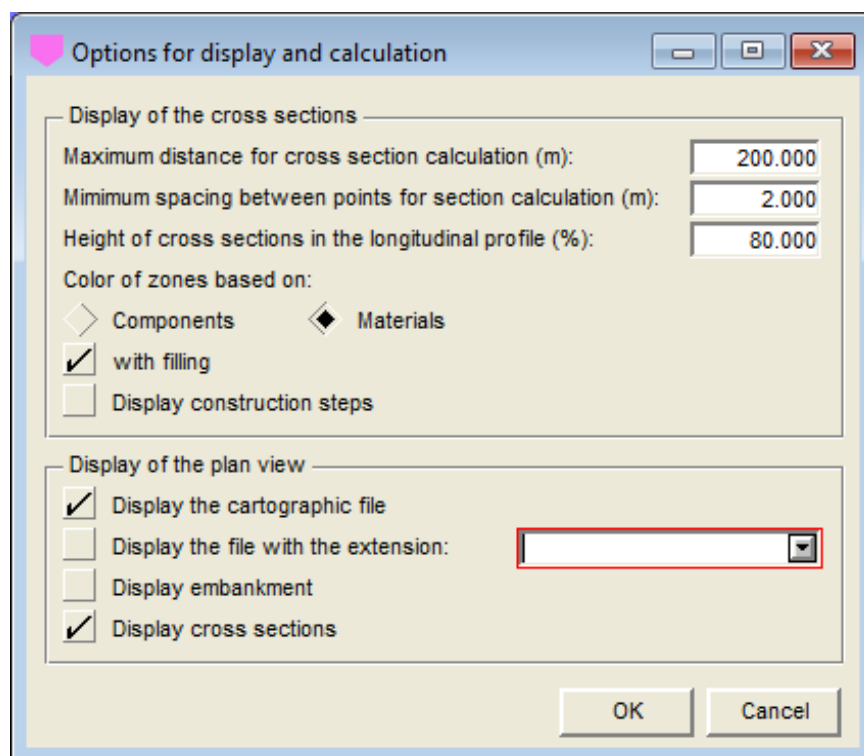


Figure 1-1 - Display and calculation preferences

4.1.4. Color of the dike zones

Depending if the radio button selected is **Components** or **Materials**, the zones of the dike will have as colors the ones defined with the components or with the materials (see descriptions in chapter 2). Please note, the stratigraphic horizons always have as colors the ones defined in the materials.

If the box **with filling** is checked, the zones of the dike, the stratigraphic horizons and the reservoir will be filled with the colors of the components or the materials, in the cross sections and the longitudinal section.

If the box is not checked, only the limits of the zones of the dike, the stratigraphic horizons and the reservoir will be drawn with the colors of the components or materials.

4.1.5. Display of the construction steps

By checking the box **Display construction steps**, the display of the cross sections is done line by line. A message indicates which stratum is drawn at each step, to which the user must click “next” to see the next step. By canceling, the construction is displayed immediately, without showing the following construction steps.

4.1.6. Display of the cartographic file

By checking the box **Display cartographic file**, the site map entered in the **FILE_NAME** field of the **SITE** table will be displayed in the plan view, if a file with this name and of **.sit** extension is found in the input files directory or if the complete path is specified in the field **FILE_NAME**.

4.1.7. Display of another file

The user can also display another file in the plan view by selecting the box **Display file with extension**. To its right, the scrolling list shows the extension of all files in the input files directory beginning with the name of the file specified in the **FILE_NAME** field of the **SITE** table. The user selects the extension of the file to display.

For example, if the file name specified for the site is *Tailings*, the extension of all files starting with *Tailings* in the directory of input files will be in the scrolling list, such as *_rock.dtm* for the file *Tailings_rock.dtm*.

4.1.8. Display of the embankment

By checking the box **Display embankment**, the embankment calculated with the volume calculation (.dam file) will be displayed in the plan view for the selected dike.

4.1.9. Display of the cross section

By checking the box **Display cross sections**, the segments, markers and text representing the typical sections and the cross sections will be displayed in the plan view, with the attributes of the **Geometry**, **Section_1** and **Section_2** curves of the **PLAN_VIEW** graph (see paragraph 5.1).

If the plan view is in **3D**, the calculated cross sections are displayed with the colors of the components or materials (see paragraph 4.1.4). After a volume calculation, all the cross sections used for the calculation are displayed, until the user clicks at a certain chainage in the plan view or in the longitudinal section to calculate a cross section.

5. ORGANIZATION OF A GRAPHIC OUTPUT



The definition of graphs is established and updated in the graph editing window opened by selecting the **Graphs...** option of the **Tools** menu or by clicking this button. More details about the graph editing are available in paragraph 3 of chapter 6 of the X3D guide. Figure 1-2 shows the graph editing window in Dam.

The table in this window contains all the graphs defined in the style file used. Each graph is identified by a unique number in the **#** column. The first graph is always **Page** with **# 0**. This graph represents the graphic page and cannot be deleted.

All the other graphs are **primary** graphs, and the value in their **#P** cell is **0**. The next four graphs are identified by their number.

- **#1** always shows the **PLAN_VIEW**, for the display of a plan view.
- **#2** always shows the **LONG_SECTION**, for the display of the longitudinal section of the foundation along the axis.
- **#3** always shows the **CROSS_SECTION_1**, for the display of a first cross section of the dike.
- **#4** always shows the **CROSS_SECTION_2**, for the display of a second cross section of the dike.

For the **primary graphs**, the **Left**, **Width**, **Right**, **Bottom**, **Height** and **Top** fields define their position and dimension; the user can modify these values.

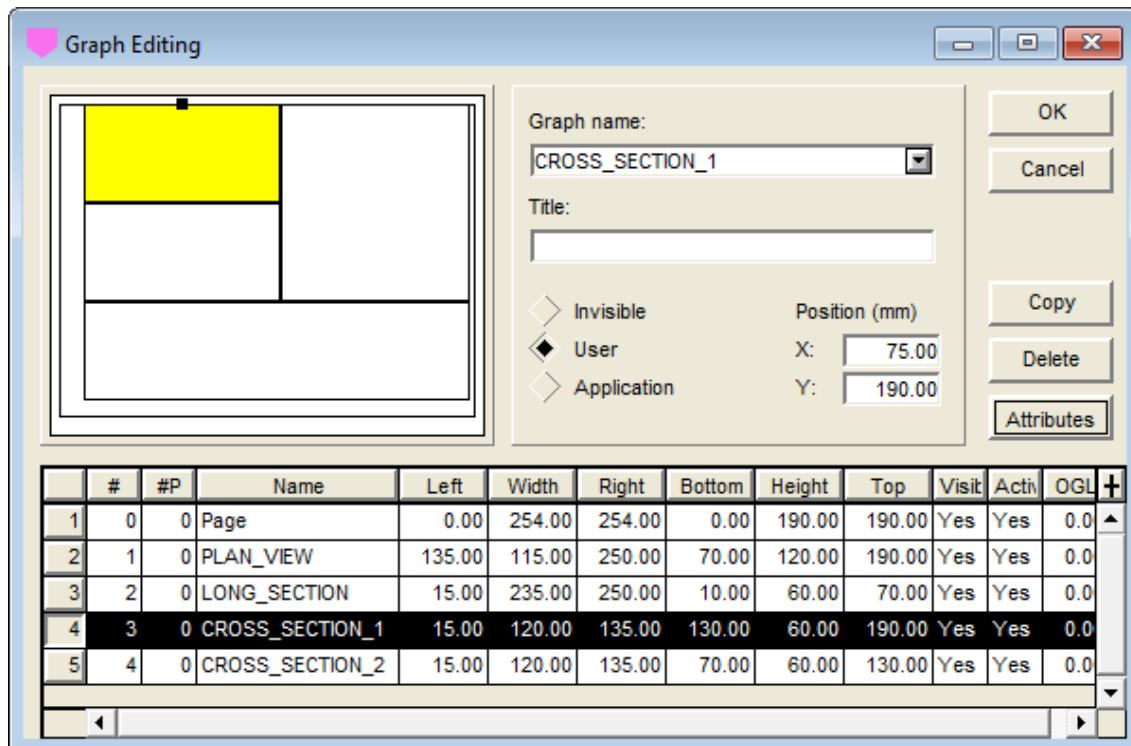


Figure 1-2 - Graph editing window

5.1. The PLAN_VIEW graph

The **PLAN_VIEW** graph shows the plan view of the site. It is always numbered #1. The plan view displays the dike retrieved with its associated axis. One or two topographic backgrounds as well as the cross sections can also be displayed. See the options for display and calculation in paragraph 4.1. Figure 1-3 shows the predefined curves of the PLAN_VIEW graph. The display of these curves is not affected by their type.

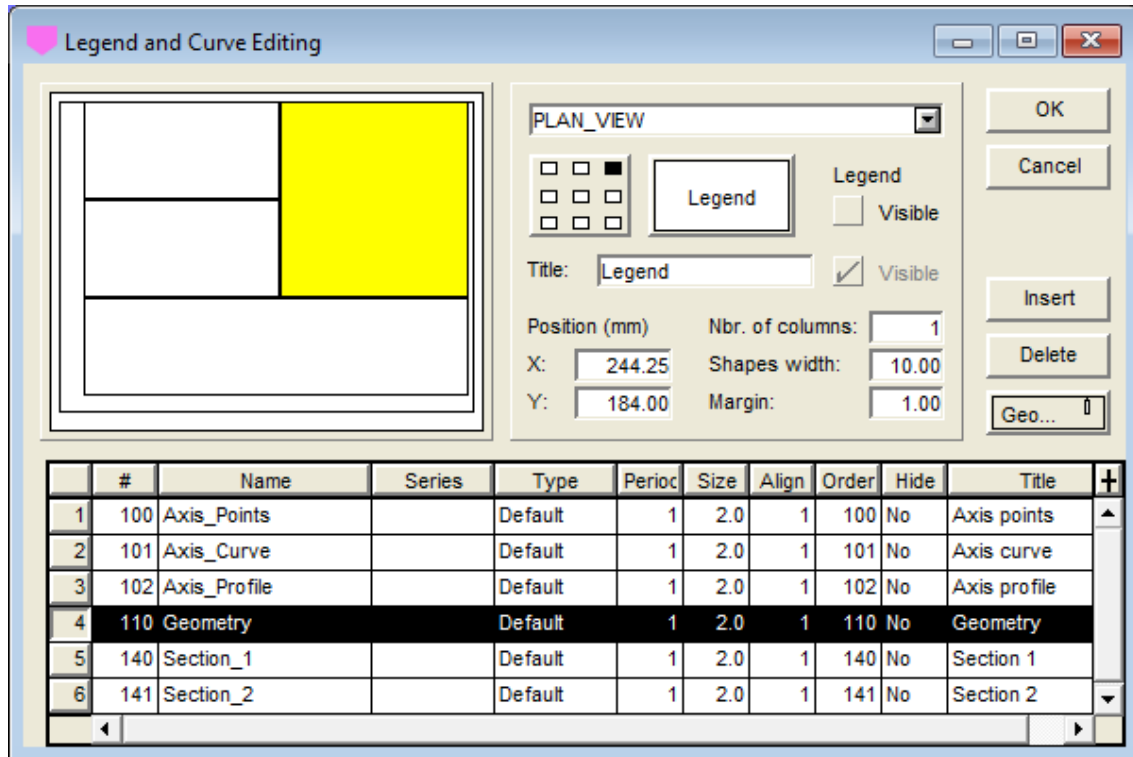


Figure 1-3 - Predefined curves of the PLAN_VIEW graph

The **Axis_Points** curve (#100) shows, for the axis of the selected dike:

- markers at its turning points; these markers are different from the end points of the axes;
- a line passing through its turning points; this line merges with the outline of the axis except in the curved sections;
- the attributes that can be modified for the **Axis_Points** curve are the line and the marker.

The **Axis_Curve** curve (#101) shows, for the axis of the selected dike:

- its outline; this line follows the eventual curves defined by a radius at some turning points;
- its identification; the name and symbol of the axis are displayed at both ends of the axis; the orientation of the text shows the origin of the axis: in reading position, the origin is left.

the marker used for the axis in the one in the current markers file whose name is the concatenation of the type and state of the axis, for example, LS_R for a realised seismic line. If no corresponding marker is found, the one defined for the Axis_Curve curve will be used. The color and dimension of the markers can always be modified.

- the attributes that can be modified for the **Axis_Curve** curve are the line, the text and the marker (color and dimension, the symbol has no effect if there exists a marker for the type and state of the axis in the markers file).

The **Axis_Profile** curve (#102) is not used.

The **Geometry** curve (#110) shows, for the selected dike:



- the location where begins the application of each typical section, by a segment along which the name of the typical section is displayed, as well as a marker at its ends. The marker VL_P is used by default.
- the attributes that can be modified for the **Geometry** curve are the line, the text and the marker.
- in the **Options** window, the user can decide to display or not the typical sections in the plan view (see paragraph 4.1.9).

The **Limit** curve (**#120**) shows, for the current site:

- the rectangular or polygonal limits saved in the database;
- the attributes that can be modified for the **Limit** curve are the line and the marker (for each corner of the limit).

The **Section_1** (**#140**) and **Section_2** (**#141**) curves show, for the selected dike:



- the location of the last two calculated cross sections, by a segment along which the name of the typical section that is applicable and the chainage are indicated, as well as a marker at its ends. The marker VL_R is used by default.

The cross sections are calculated when the user clicks at a certain chainage in the plan view or in the longitudinal section.

- the **Section_1** curve (**#140**) shows the last calculated section, and the **Section_2** curve (**#141**) shows the penultimate section.
- the attributes that can be modified for the **Section_1** and **Section_2** curves are the line, the text and the marker.
- in the **Options** window, the user can decide to display or not the cross sections in the plan view (see paragraph 4.1.9).

5.2. The LONG_SECTION graph

The **LONG_SECTION** graph shows the longitudinal section of the foundation along the axis for the selected dike. It is always numbered #2. Figure 1-4 shows the predefined curves of the **LONG_SECTION** graph. The display of these curves is not affected by their type.

The height of the segments displayed in **LONG_SECTION** is specified in the **Options** window (see paragraph 4.1.3).

The **Axis_Points** curve (**#100**) shows, for the axis of the selected dike:

- the chainage at which the turning points of the axis are located, with vertically centered segments;
- the axis name and the index of the turning point, along each segment;
- the attributes that can be modified for the **Axis_Points** curve are the line, the text and the marker. The marker would be displayed at the ends of the segment.

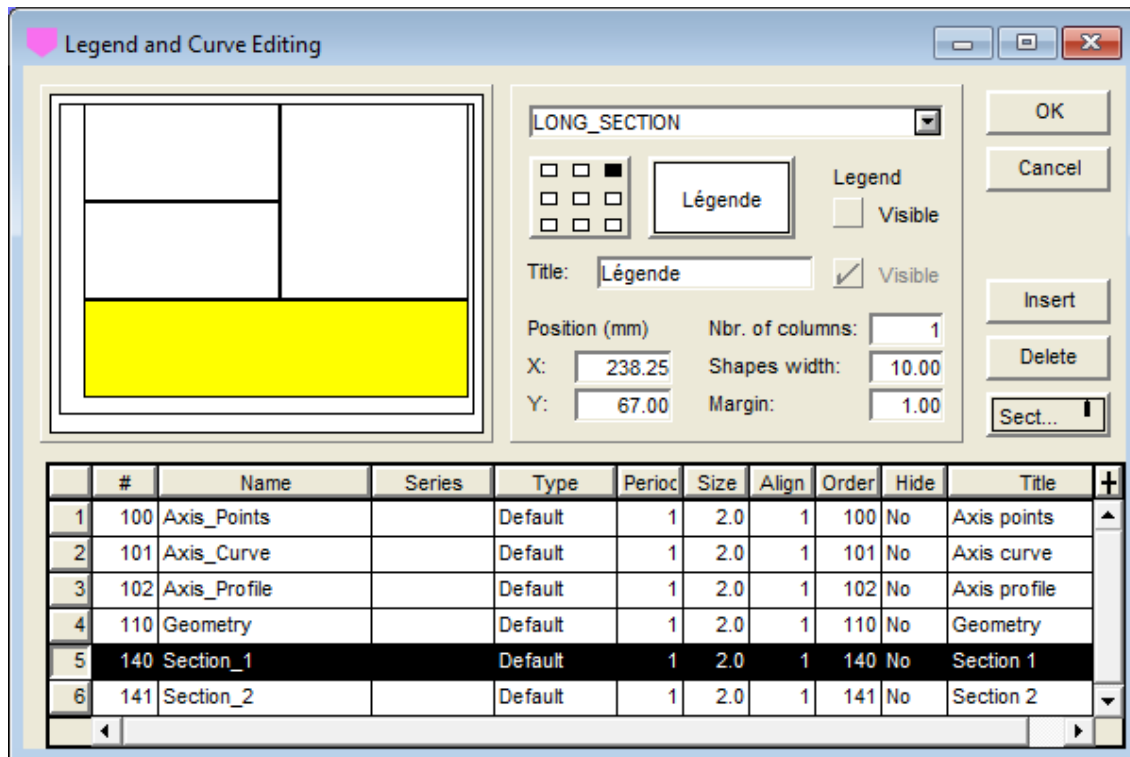


Figure 1-4 - Predefined curves of the LONG_SECTION graph

The **Axis_Curve** (#101) and **Axis_Profile** (#102) curves are not used.

The **Geometry** curve (#110) shows, for the selected dike:

- the location where begins the application of each typical section, by a segment along which the name of the typical section is displayed, as well as a marker at its ends. The marker VL_P is used by default.
- the attributes that can be modified for the **Geometry** curve are the line, the text and the marker.

The **Section_1** (#140) and **Section_2** (#141) curves show, for the selected dike:

- the location of the last two calculated cross sections, by a segment along which the name of the typical section that is applicable and the chainage are indicated, as well as a marker at its ends. The marker VL_R is used by default.

The cross sections are calculated when the user clicks at a certain chainage in the plan view or in the longitudinal section.

- the **Section_1** curve (#140) shows the last calculated section, and the **Section_2** curve (#141) shows the penultimate section.
- the attributes that can be modified for the **Section_1** and **Section_2** curves are the line, the text and the marker.

5.3. The CROSS_SECTION_1 and CROSS_SECTION_2 graphs

The **CROSS_SECTION_1** and **CROSS_SECTION_2** graphs show the first and second cross sections of the dam. They are always numbered #3 and #4. Figure 1-5 shows the predefined curve of the **CROSS_SECTION_1** graph. The display of this curve is not affected by its type.

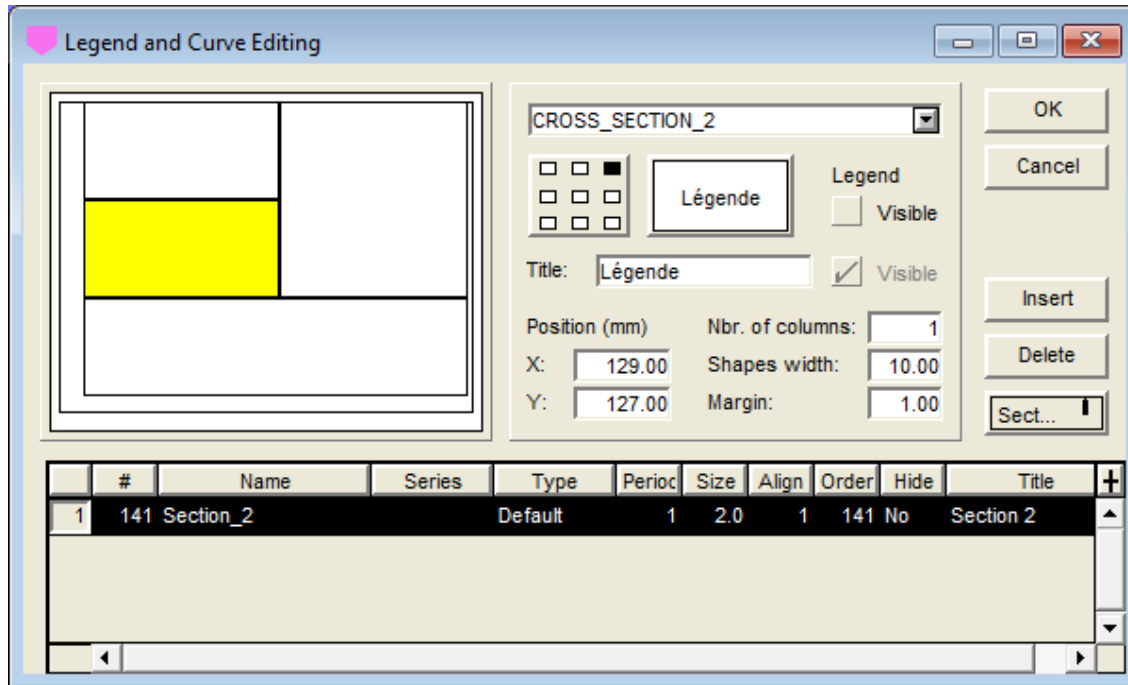


Figure 1-5 - Predefined curve of the **CROSS_SECTION_1** graph

The curves **Section_1** (#140) and **Section_2** (#141) (for the **CROSS_SECTION_2** graph) show:


- at the bottom of each cross-section, the name of the typical section that is applicable and the chainage of the cross section displayed.

The cross sections are calculated when the user clicks at a certain chainage in the plan view or in the longitudinal section.

- the attribute that can be modified for the **Section_1** and **Section_2** curves is the text.

6. DATA MENU

The options of the **Data** menu are detailed in chapter 7 of the X3D guide. In Dam, the retrieval by **simple query** is done on the **Dike** table.

In Dam, the data entry options available in the **Data** menu (**Entry** option) and with the buttons of the application toolbar () are those of **Dike**, **Site**, **Foundation**, **Reservoir**, **Axis**, **Geometry**, **Typical Section**, **Materials** and **Components**. Refer to chapter 2 for a description of these entry forms specific to Dam.



The **Color Selection** option is used for the OpenGL mode. See chapter 2 of the Site guide.

6.1. Calculation of cross sections

The **Cross-Section** option of the **Data** menu is active once a dike is retrieved. This option is used to calculate, at a certain chainage, a cross section of the dike.

Three calculation methods exist, depending on the method defined for the current foundation (see the definition of the Foundation entry form in chapter 2).

- Dam uses the longitudinal profiles defined in the **AXIS_PROFILE** table of the surfaces of stratigraphic horizons along the axis, up to 5, and extrapolates them laterally;
- Dam uses the longitudinal profiles of the surfaces of stratigraphic horizons defined in **.pro** text files;
- Dam uses the data terrain models as regular grids (**DTM**) of the limits of the stratigraphic horizons if they are available.

If the method with **DTM** is the calculation method, the calculation distance of cross sections is taken into account. This width is read in the dike definition, or in the options window, if no value was defined (see paragraph 4.1.1).

To start the calculation of a cross section, the user can:

- click a point along the axis in the plan view;
- click the desired location along the longitudinal profile;
- select the **Cross Section** option of the **Data** menu, this button or the **Calculate Cross Section** option of the interactive menu opened with a right click when the cursor is in the plan view or longitudinal profile.



The window shown in figure 1-6 is opened.

The location of the cross section to calculate is shown with a segment perpendicular to the axis in the plan view and with a segment vertically centered in the longitudinal view. If the plan view is in 3D, the calculated cross sections are displayed with the colors of the materials or components (see paragraphs 4.1.4 and 4.1.9).

Dam calculates the geometry of the cross section and displays it in graph #3 (**CROSS_SECTION_1**). If this graph already contained a cross section, its display is transferred to graph #4 (**CROSS_SECTION_2**).

At the bottom of the graphs showing the cross sections, the name of the applicable typical section and the chainage of the cross section are displayed. This information is also displayed in the plan view and in the longitudinal profile, along the segments showing the position of the last two cross sections calculated.

Figure 1-6 shows the calculation window of cross sections. The **name of the output files** is automatically the **concatenation of the site and dike numbers**, but the user can modify it. The files are saved in the output files directory, as indicated next to **Directory**.

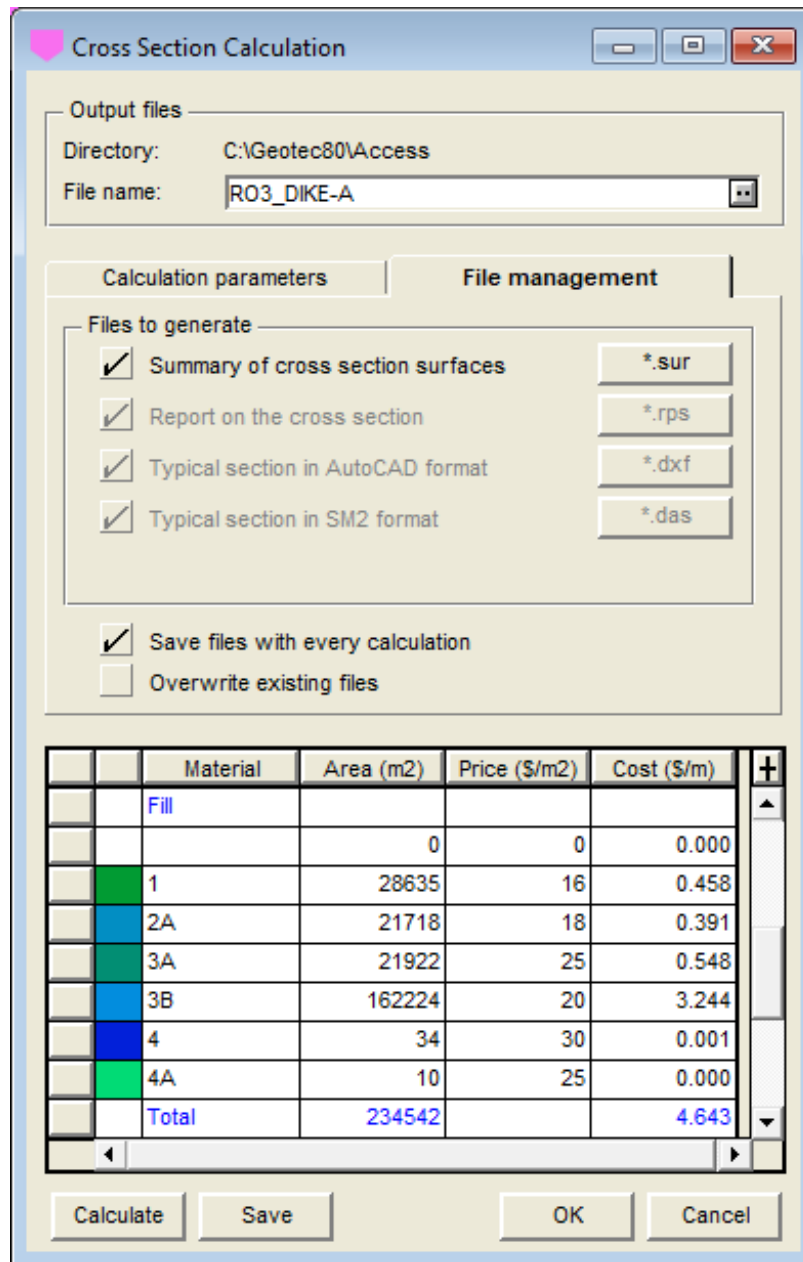


Figure 1-6 - Calculation of a cross section

Under the **Calculation parameters** tab:

- The **Calculation distance** contains the distance defined with the current dike. If the dike definition doesn't have a calculation distance, then **Calculation distance** shows the value defined in the options window (see paragraph 4.1.1).
- The **Chainage** is used to enter the chainage where to calculate the cross section.

If the calculation window for the cross section was called via the **Cross Section** option or button, the chainage of the middle of the current axis is written in the **Chainage** field. If the window is opened via the interactive menu with the right button of the mouse, the chainage of the point clicked in the plan view or in the longitudinal profile is indicated in the **Chainage** field.

- The **maximum level** can be indicated, to calculate only a part of the cross section.

In the **File management** tab, four files can be produced by checking the corresponding box. The buttons to their right open the corresponding files, once calculated.

- The **.sur** file is a summary of the cross-section surfaces.
- The **.rps** file is a report on the cross section.
- The **.dxf** file is a typical cross section in AutoCAD format.
- The **.das** file is a typical cross section in SM2 format.
- The checkbox **Save files with every calculation** is used to create the files each time the **Calculate** button is clicked.
- The checkbox **Overwrite existing files** is used to overwrite the existing files without a message being displayed.

The **Calculate** button launches the cross-section calculation. The results are displayed in the table and the **Save** button is then activated. The **Save** button is used to save the result files if they are not automatically saved (box unchecked).

The **OK** button saves the calculation parameters (calculation distance) in the dike definition. **Cancel** closes the window without saving the calculation parameters.

6.2. Calculation of volumes and costs

The **Volumes** option of the **Data** menu is active once a dike is retrieved. This option is used to calculate, between two chainages, the fill and cut volumes and the costs of backfill and excavation.

The volume calculation can be done using the same three methods as the calculation of cross sections (see paragraph 6.1).

For the calculation of volumes and costs, Dam determines the chainages for which a cross section must be calculated. From the initial to the final chainage, Dam uses the calculation step and adds all the chainages where a typical section is defined. The volumes are calculated by taking the average of the areas of the components of same type and material and by multiplying this value by the difference in chainage between two successive sections.

In the plan view, the calculated embankment and foundation can be displayed, as well as the cross sections used (see paragraphs 4.1.8 and 4.1.9), in 2D or 3D.

Remember that the calculation method is defined in the definition of the current foundation (see the definition of the Foundation entry form in chapter 2). If the method with **DTM** is the calculation method, the calculation distance of cross sections is taken into account. This width is read in the current dike definition, or in the options window, if no value was defined (see paragraph 4.1.1).



To launch the volume calculation of a dike, the user selects the **Volumes** option of the **Data** menu, this button, or the **Calculate Volumes** option of the interactive menu opened with a right click when the cursor is in the plan view or longitudinal profile. The window shown in figure 1-7 is displayed.

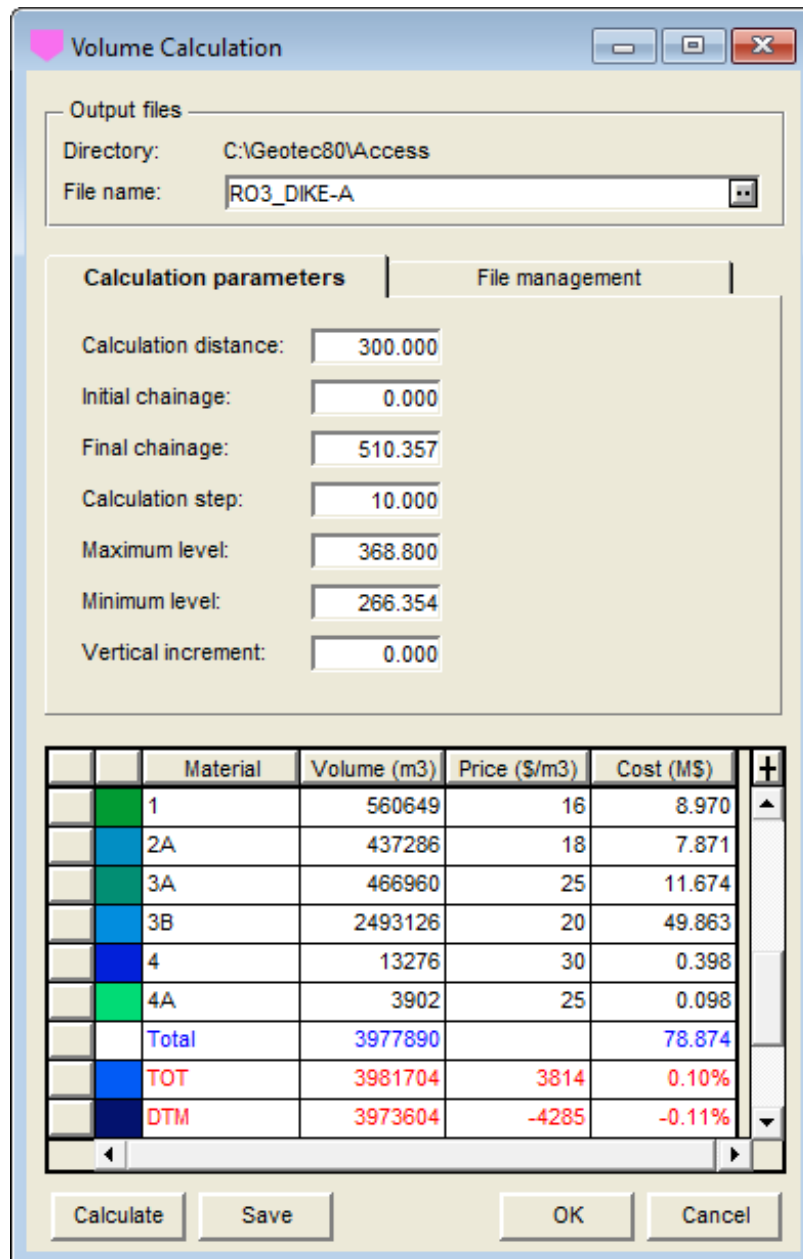


Figure 1-7 - Volume calculation - calculation parameters

The **name of the output files** is automatically the **concatenation of the dike and axis numbers**, but the user can modify it. The files are saved in the output files directory, as indicated next to **Directory**.

Under the **Calculation parameters** tab:

- The **Calculation distance** contains the distance defined with the current dike. If the dike definition doesn't have a calculation distance, then **Calculation distance** shows the value defined in the options window (see paragraph 4.1.1).

- The **Initial chainage** and **Final chainage** are used to enter the chainages between which the volume calculation will be done. By default, these fields contain the chainages at the beginning and end of the current axis.
- The **calculation step** contains the spacing between the cross sections that will be generated to do the volume calculation. The smaller this value, the more precise the results will be but the longer the calculation will take. This field contains the value defined with the current dike. If the dike definition doesn't have a calculation step, then the **Calculation step** takes a value of 20 by default.
- The **maximum** and **minimum levels** can be indicated, to calculate the volumes and costs between two elevations. By default, the minimum elevation is the minimum elevation of the natural ground on the site, and the maximum level is the crest level.
- The **vertical increment** indicates the interval for the volume calculations from the minimum to the maximum level.

In the **File management** tab, shown in figure 1-8, five files can be produced by checking the corresponding box. The buttons to their right open the corresponding files.

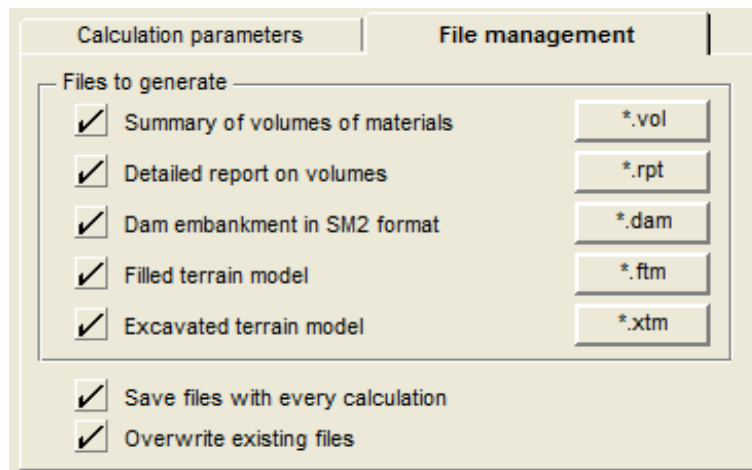


Figure 1-8 - Volume calculation - file management

- The **.vol** file is a summary of the volumes of materials. It contains:
 - the excavation volumes by stratum and the fill volumes by material;
 - the unit costs per m³ of excavation and rockfill;
 - the costs, in millions of dollars, of the excavation and rockfill per material;
 - the surface of foundation treatments, cumulated at each calculated chainage;
- The **.rpt** file is a detailed report on the volumes. It contains:
 - the excavated volumes per stratum, in m³, cumulated at each calculated chainage;
 - the fill volumes per material, in m³, cumulated at each calculated chainage;
- The **.dam** file is a dam embankment in SM2 format.
- The **.ftm** file is a filled terrain model.
- The **.xtm** file is an excavated terrain model.

- The checkbox **Save files with every calculation** is used to create the files each time the **Calculate** button is clicked.
- The checkbox **Overwrite existing files** is used to overwrite the existing files without a message being displayed.

The **Calculate** button launches the volume and cost calculation. The results are displayed in the table and the **Save** button is then activated. The dike span, the embankment and the foundation are also calculated. The **Save** button is used to save the result files if they are not automatically saved (box unchecked).

The **OK** button saves the calculation parameters (calculation distance, calculation step) in the dike definition. **Cancel** closes the window without saving the calculation parameters.

7. INTERACTIVE EDITING

In the plan view and the longitudinal profile, the user can display the interactive menu shown in figure 1-9 with the right button of the mouse. When the plan view is in 3D, the interactive menu is not available.

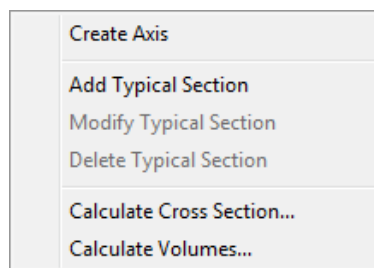



Figure 1-9 - Interactive menu


7.1. Tooltip of properties


If the cursor is on the axis, an axis point or a typical section in the plan view, or on an axis point or a typical section in the longitudinal section, a tooltip is displayed, indicating some information about the entity.

7.2. Create an axis



By selecting **Create Axis**, the cursor takes this format: . Left click at each point of the axis. A dotted line shows the movement of the cursor. When the last point of the axis is defined, right click to display the pop-up menu and select **Cancel** to erase the axis being created, or **Terminate** to edit and save the new axis. The axis entry form is then displayed and shows the coordinates of each point clicked. The user enters the axis number and any relevant information in the entry form, and saves.

7.3. Modify an axis

Any **planned** axis (state of axis: P) can be modified with the mouse. When the cursor is on an axis, it takes the format . Right clicking opens a pop-up menu. The **Information** option opens the axis editing window on the current axis.

By clicking on **Add an Axis Point**, the cursor becomes . The point will be added between the two closest points to the cursor. A message is displayed, showing the exact coordinates of the point. To stop the addition of points, right click and select **Terminate**.

When the cursor is over an axis point and there are more than two points in the axis, the option **Delete an Axis Point** is active. A message is displayed to confirm the deletion of the point.

When the cursor is on an axis point, it takes the format . By clicking on the point, it takes the format . Move the point to the desired position, and release the button of the mouse; a message is displayed to confirm the move.



Please note: the axis will be displayed in the plan view only if it is associated to the current dike.

7.4. Add a typical section

The option **Add Typical Section** of the interactive menu is available in the plan view and the longitudinal section. This option opens the **Geometry** entry form. The chainage clicked is indicated. The user can select the name of the typical section to add from the scrolling list.

7.5. Modify a typical section

The option **Modify Typical Section** of the interactive menu is available in the plan view and the longitudinal section when the cursor is directly on one of the typical sections. This option opens the **Geometry** entry form to modify the chainages and the typical sections used in the current geometry.

The user can also directly move a typical section. The cursor takes the format  when it is on a typical section. By clicking, it takes the format . Move the typical section to the desired position (a dotted line follows the cursor), and release the button of the mouse; a message is displayed to confirm the move.

7.6. Delete a typical section

The option **Delete Typical Section** of the interactive menu is available in the plan view and the longitudinal section when the cursor is directly on one of the typical sections. This option deletes the typical section from the current geometry. A message is displayed to confirm the deletion.

7.7. Calculate a cross section or volumes

These options are described in paragraphs 6.1 and 6.2.

CHAPTER 2. DATA ENTRY FORMS

The entry forms are used for the data entry, modification and deletion in the database. The forms are used directly in the Dam module. The forms use the same graphic interface as the one used in Geotec.

You will find the description of the generalities regarding the operation of the forms in chapter 1 of the entry forms guide.

1. DIKE



The **Dike** entry form is used to identify each dike of a site; information contained in the DIKE table.

The key for the records consists of the fields **Site** and **Dike number**.

- **Site** contains the number of the site to which the dike belongs.
- **Dike number** can have up to 20 characters.
- **Foundation** indicates the foundation number to associate to the dike. The scrolling list shows the foundation numbers defined and belonging to the current site.
- **Reservoir** indicates the reservoir number to associate to the dike. The scrolling list shows the reservoir numbers defined and belonging to the current site.
- **Axis** indicates the axis number to associate to the dike. The scrolling list shows the axis numbers defined and belonging to the current site.
- **Geometry** indicates the geometry number to associate to the dike. The scrolling list shows the geometry numbers defined and belonging to the current site.
- **Description** is a field of 255 characters to describe the dike.
- The **downstream level** (in meters) can be entered, for information purposes.
- The **camber** (in %) can be entered, for information purposes.
- The **calculation step** (in meters) is the difference in chainage between two successive sections used for the volume calculation. If no **calculation step** is defined in the dike definition, the one in the volume calculation window will be used.
- The calculation **distance** (in meters) defines the length over which the cross sections will be calculated on both sides of the dike's center line. The distance is expressed:
 - In the **plan view**, where each cross section is represented by a line more or less long (depending on the scale), when the user starts the calculation of a cross section or a volume.
 - In the **two cross sections**, where the X axis's length is the maximum calculation distance on both sides of the origin, i.e. the dike's axis.

The step for the tick marks on the X axis adjusts automatically depending on the length to represent.

If the distortion of the Y axis is imposed at 1, the step on the Y axis is also adjusted according to the calculation distance to keep the good proportions.

If no **distance** is entered in the dike definition, the one entered in the options window of Dam will be used.

- The **spacing** between the points for the calculation of the cross sections (in meters) is the minimum interval at which the elevation of the points is calculated, between the minimum and maximum X. For example, with a value of 2 m, the Z is calculated every 2 meters.

If a **spacing** is not entered in the dike definition, the one entered in the options window of Dam will be used.

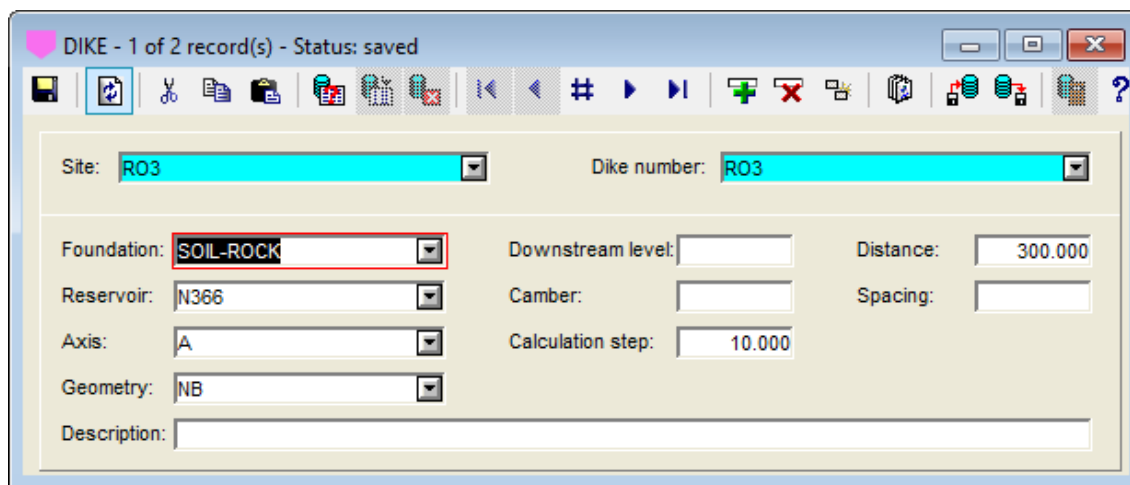


Figure 2-1 - Dike entry form

2. SITE



The **Site** entry form is used to identify and describe a site and to define the limits of the domain it covers; information contained in the SITE table. This entry form is also used in the exploration modules and each field is described in details in chapter 2 of the entry forms guide.

The fields of **Site** used in **Dam** are:

- **Site**, which is a 20-character string. It is the key for the records.
- The **name of the cartographic file**, in the **Management** tab. By clicking on the button to the right of the field, the file selection window is opened. The **.sit** file with this name in the input files directory can be displayed in the plan view. A second file with the same name as prefix can be displayed, if located in the same directory. See the options in chapter 1.

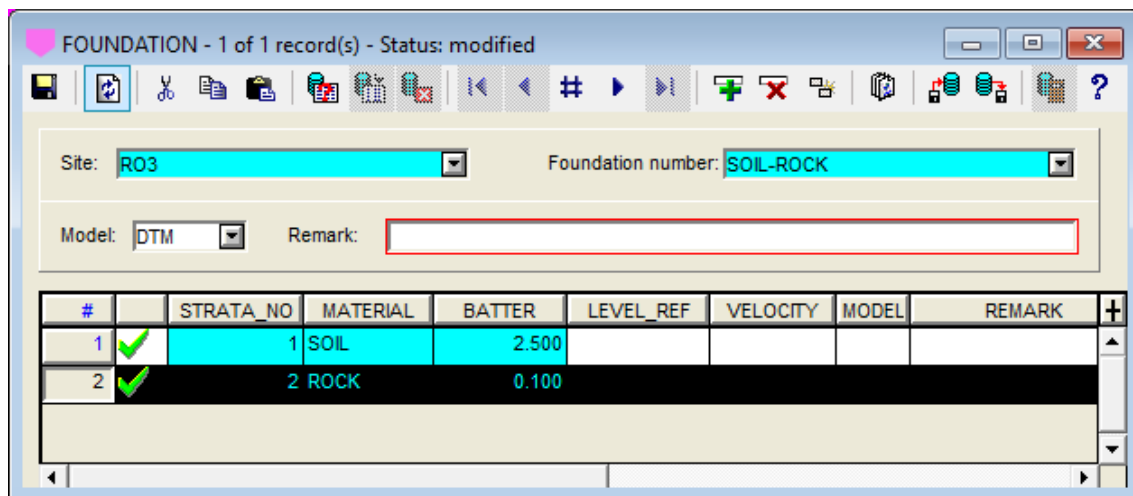
3. FOUNDATION



The **Foundation** entry form is used to define a foundation and its horizons; information contained in the FOUNDATION table and its secondary table, FOUNDATION_STRATA.

The key for the records of FOUNDATION consists of the fields **Site** and **Foundation number**.

- **Site** contains the number of the site to which the foundation belongs.
- **Foundation number** can have up to 20 characters.
- The **model** is the type of terrain model used for the calculation of the strata in the cross sections and the longitudinal section. The scrolling list shows four options:
 - **DTM** uses the numerical terrain models saved in **.dtm** files.
The name of each **.dtm** file must begin with the file name entered in the site definition, followed by the “_” character and the name of the foundation strata.
In the following example, the files would be *dike-f_sol.dtm* and *dike-f_roc.dtm*. The files must be located in the input files directory.
 - **GRD** is similar to DTM, but the files have the **.grd** extension instead of **.dtm**.
 - **PRO** uses **.pro** files. This option is for future development.
 - **MDB** uses the data of the AXIS_PROFILE table for the axis associated to the dike. This option is for future development.
- The **remark** has up to 255 characters.



FOUNDATION - 1 of 1 record(s) - Status: modified

Site: RO3 Foundation number: SOIL-ROCK

Model: DTM Remark:

#	STRATA_NO	MATERIAL	BATTER	LEVEL_REF	VELOCITY	MODEL	REMARK
1	1	SOIL	2.500				
2	2	ROCK	0.100				

Figure 2-2 - Foundation entry form

In the bottom table corresponding to FOUNDATION_STRATA, the key for the records consists of the fields **Site**, **Foundation number** and **Strata**. This table shows each stratum defined for the foundation.

- The **stratum number** is the order in the foundation from top to bottom. It is an integer.
- **Material** contains the material type of the stratum. The list shows all the materials of **strata** type in the MATERIAL table for the SPEC site. A value is required.
- The excavation **batter** for the stratum is also required.
- The other fields are not currently used.

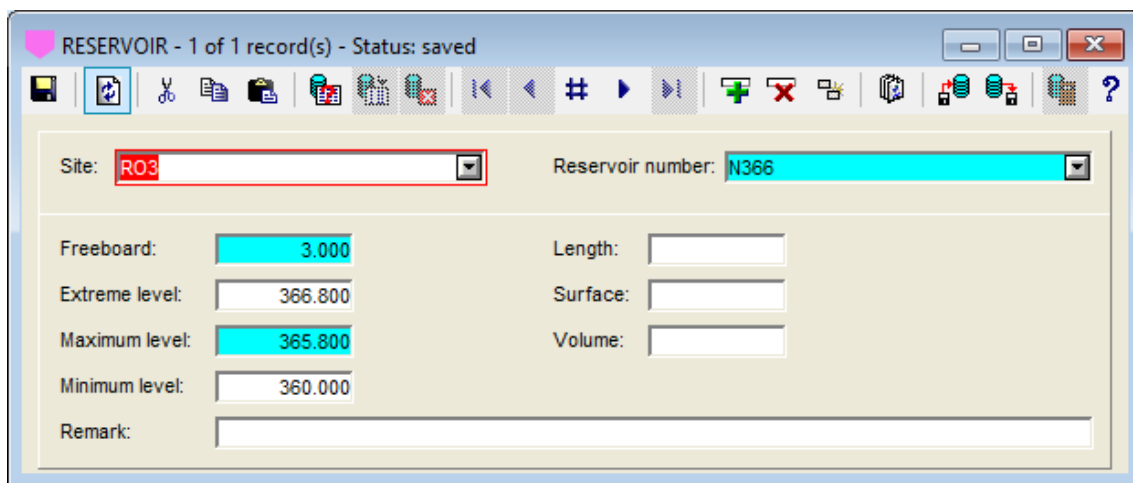
4. RESERVOIR



The **Reservoir** entry form is used to define several reservoirs for a site, to evaluate different levels for example; information contained in the RESERVOIR table.

The key for the records consists of the fields **Site** and **Reservoir number**.

- **Site** contains the number of the site to which the reservoir belongs.
- **Reservoir number** can have up to 20 characters.
- The **freeboard** (in meters) is required. It is the difference in level between the maximum level of the reservoir and the level of the crest of the dike.
- The **extreme flood level** (in meters) is indicated for information purposes only in the current version.
- The **maximum level** of the reservoir (in meters) is required.
- The **minimum level** of the reservoir (in meters) is indicated for information purposes.
- The **length** (in km), the **surface** (in km²) and the **volume** (in km³) of the reservoir are then entered.



RESERVOIR - 1 of 1 record(s) - Status: saved

Site: RO3 Reservoir number: N366

Freeboard: 3.000 Length:

Extreme level: 366.800 Surface:

Maximum level: 365.800 Volume:

Minimum level: 360.000

Remark:

Figure 2-3 - Reservoir entry form

5. AXIS



The **Axis** entry form is used to define the axes or cross-sections; information contained in the AXIS table. This entry form is also used in the exploration modules and each field is described in details in chapter 2 of the entry forms guide.

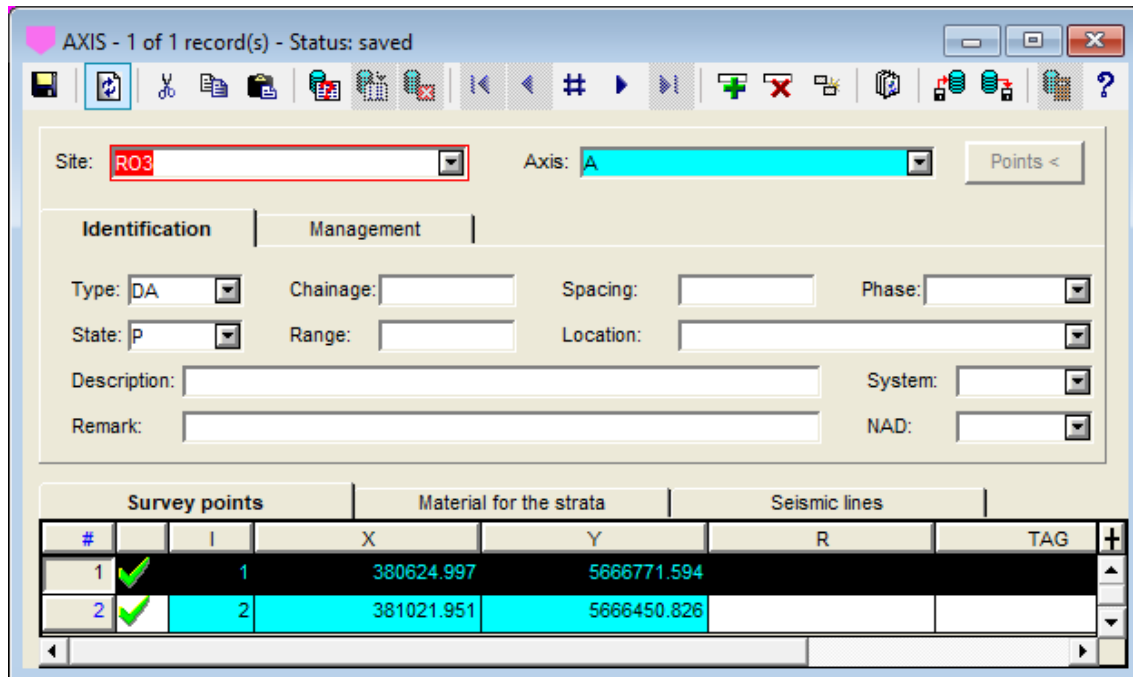
The fields of **Axis** used in **Dam** are:

- **Site**, which contains the site number to which the axis belongs.
- **Axis**, which can have up to 20 characters.

These two fields constitute the key for the record.

Under the **Survey points** tab, the user can define the turning points of the axes; information contained in the AXIS_PI secondary table.

The control points of an axis can be the end points of the axis, the break points of the axis if it's a broken line, and/or the intersection points (PI) to the tangents at the extremities of the curved sections.



#	I	X	Y	R	TAG
1	1	380624.997	5666771.594		
2	2	381021.951	5666450.826		

Figure 2-4 - Axis entry form

The key for the records consists of the **Site**, **Axis** and **Index (I)** fields.

- **Index (I)** contains the order number of the control points. It is an integer.
- The UTM **X** and **Y** coordinates for each point are then provided; the suggested unit is the meter. The numbers are double precision with 3 decimals by default. Values are required.
- The **radius (R)** of curvature at the axis point is 0 if the axis is a broken line, and greater than 0 if the points is a turning point. The direction of curvature is defined by the position of the control points around the current point.

6. GEOMETRY



The **Geometry** entry form is used to define the geometry of the dike; information contained in the GEOMETRY table and its secondary table, GEOMETRY_CH.

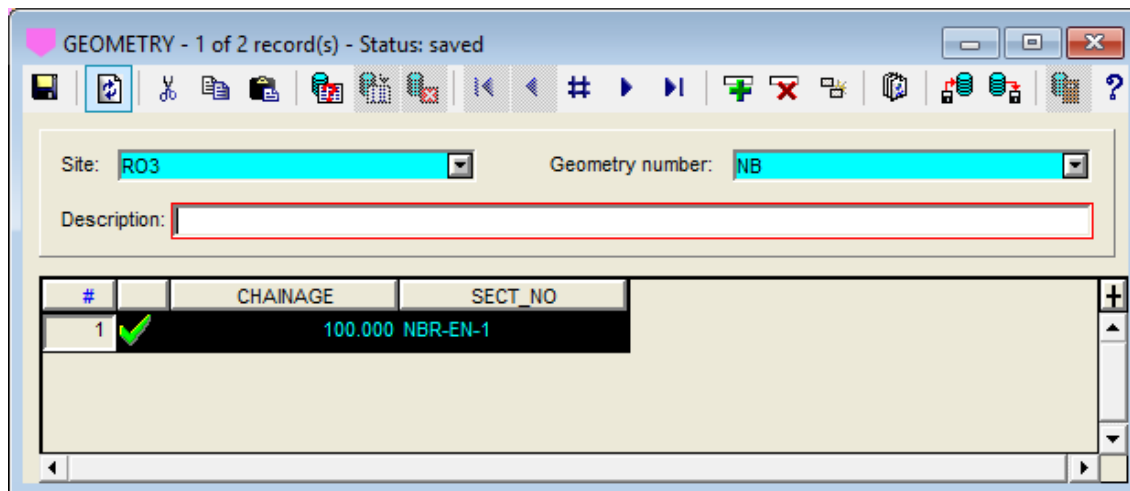
The key for the records of GEOMETRY consists of the fields **Site** and **Geometry number**.

- **Site** contains the number of the site to which the geometry belongs.
- **Geometry number** can have up to 20 characters.

- A **description** of 255 characters can be added.

In the bottom table corresponding to GEOMETRY_CH, the key for the records consists of the fields **Site**, **Geometry number** and **Chainage**. This table shows the **chainage** from which the typical section applies, as well as the **number of the typical section**.

A scrolling list with all the normalized typical sections belonging to the SPEC site is available. **When a typical section is selected, a copy is done for the current site, which can then be modified for this specific site.**



#	CHAINAGE	SECT_NO
1	100.000	NBR-EN-1

Figure 2-5 - Geometry entry form

7. TYPICAL_SECTION



The **Typical Section** entry form is used to define the various typical sections used in the geometries. The window is split in several zones; the information are contained in the TYPICAL_SECTION, FILL, FILL_POINT and CUT tables.

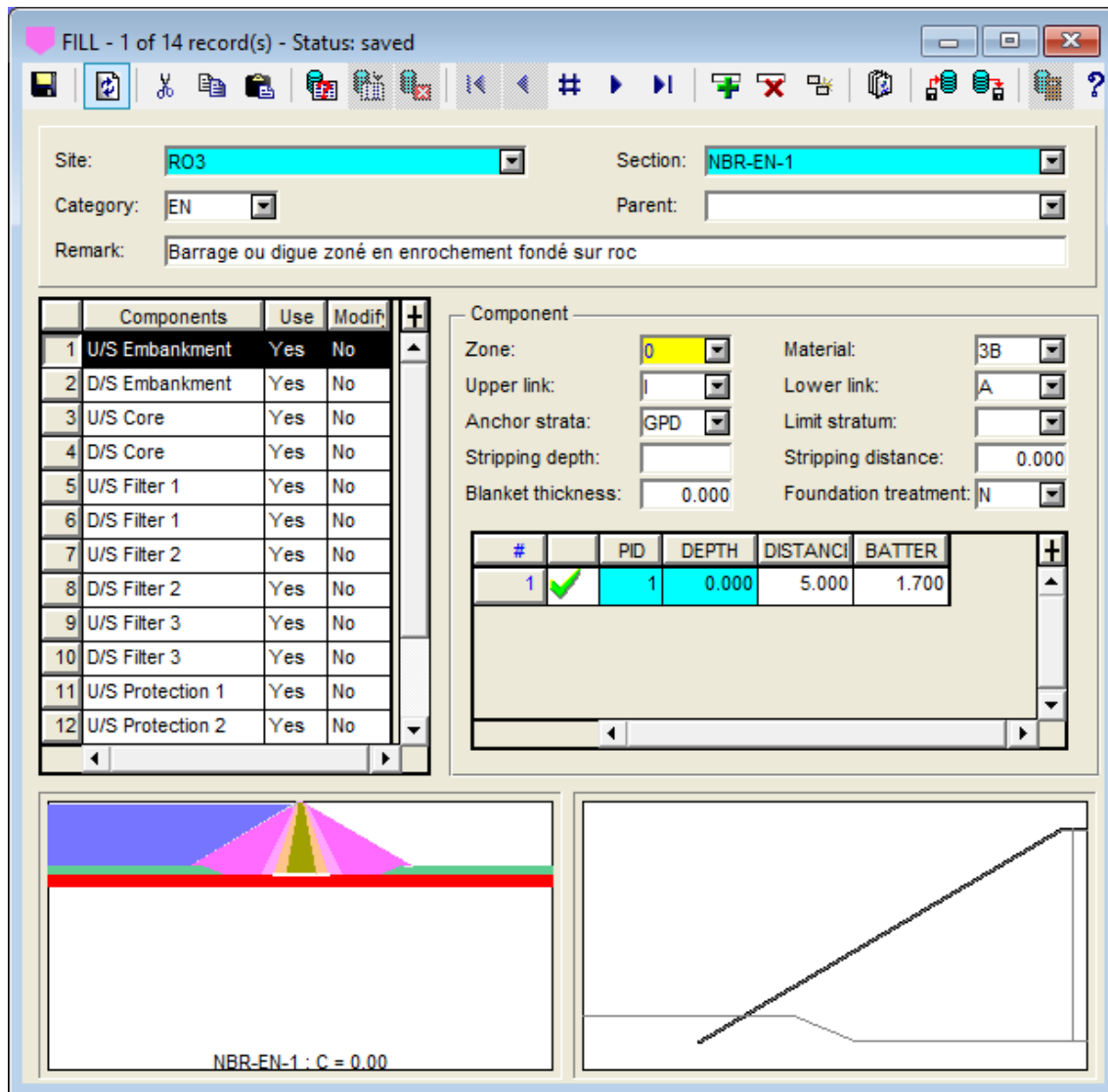
The normalized typical sections belong to the SPEC site. When a typical section is selected in the Geometry entry form, a copy of the normalized typical section is done in the current site, and this typical section can then be modified without affecting the normalized typical section. The materials of type **Fill** used in the selected typical section are also copied in the MATERIALS table for the current site, allowing the user to adjust the color and cost of the materials for each project.

The section at the top of the entry form contains the information of the TYPICAL_SECTION table. The key for the records consists of the fields **Site** and **Section** number.

- **Site** contains the number of the site to which the typical section belongs.
- **Section** number can have up to 20 characters.
- The **category** is used to group the typical sections by family, for example: Bituminous Core; RockFill; Homogeneous; etc.
- A **parent** section can be selected in the scrolling list of the typical sections already defined to associate a parent section to the current one. Then, a modification to a component in the

parent section would also be done in its dependant sections (see the description of the Modify column).

- A **remark** of 255 characters can be entered.



FILL - 1 of 14 record(s) - Status: saved

Site: RO3 Section: NBR-EN-1

Category: EN Parent:

Remark: Barrage ou digue zoné en enrochement fondé sur roc

Components	Use	Modif
1 U/S Embankment	Yes	No
2 D/S Embankment	Yes	No
3 U/S Core	Yes	No
4 D/S Core	Yes	No
5 U/S Filter 1	Yes	No
6 D/S Filter 1	Yes	No
7 U/S Filter 2	Yes	No
8 D/S Filter 2	Yes	No
9 U/S Filter 3	Yes	No
10 D/S Filter 3	Yes	No
11 U/S Protection 1	Yes	No
12 U/S Protection 2	Yes	No

Component

Zone: 0 Material: 3B

Upper link: Lower link: A

Anchor strata: GPD Limit stratum:

Stripping depth: Stripping distance: 0.000

Blanket thickness: 0.000 Foundation treatment: N

#	PID	DEPTH	DISTANCI	BATTER
1	✓	1	0.000	5.000 1.700

NBR-EN-1 : C = 0.00

Figure 2-6 - Typical Section entry form - Fill component

The section at the left of the entry form shows the list of fill and cut components forming the typical section. The fields in the right section are used to define the selected component. The fields vary with the type of component (fill, key trench or toe drain).

- The first column shows the name of the components. A scrolling list is available for the last row of the table (new component) showing the list of components in the COMPONENT table that have not yet been defined in the typical section.
- The **Use** column allows to use or not each component. To change the value, double-click in the cell.

If a component is not used, the parameters defining the component are kept, but it is not drawn in the typical section or in the cross sections associated to this typical section. If the component not being used is a fill component, its space is taken up by the adjacent component upstream or downstream, depending if the unused component is upstream or downstream.

For **Dam** to be able to display a typical section or a cross section, the **Upstream Embankment** component must be defined and used.

- The **Modify** column is used for dependent sections. When a component is set to “Modify”, any change made to this component in the parent section will also be made in the dependent typical section.

The rectangle at the bottom left of the entry form shows the complete typical section, with a flat stratigraphy.

The rectangle at the bottom right of the entry form shows graphically the current component. The display of this component changes with the modifications of the fields defining the component, when the typical section is saved.

In both rectangles, the colors are either the ones of the materials or of the components, depending on the selection in the options window of Dam (see the options in chapter 1).

The **Component** rectangle shows the parameters of each component. Figure 2-6 shows the fields of a fill component. The fields are from the FILL table.

- **Zone** is an inactive field. It shows the component number, as defined in the COMPONENT table.
- **Material** contains the material type of the component. The scrolling list shows all the materials of **Fill** type in the MATERIAL table for the SPEC site. A value is required. When a material is selected, it is automatically copied in the current site; the color and cost of the material in the current site are used.
- The **upper link** indicates how the program will extend the upper portion of the component below the first specified control point. The options are:
 - E** : **external** horizontal link, i.e. towards the dike embankment
 - I** : **internal** horizontal link, i.e. towards the center of the dike
 - O** : **oblique** link at 45° towards the top and the outside
 - U** : **upward** vertical link towards the top of the dike
- The **lower link** indicates how the program will extend the lower portion of the component beyond the last specified control point. The options are:
 - A** : parallel to the **acceptable** foundation (see next paragraph)
 - E** : **external** horizontal link, i.e. towards the dike embankment
 - X** : parallel to the **excavated** foundation (see next paragraph)
- The **anchor stratum** identifies the foundation strata, i.e. the layer on which the component stops. The scrolling list shows all the materials of **Strata** type in the MATERIAL table for the SPEC site.

The upstream and downstream sides of the core must be anchored to the same layer. If it is not the case, the anchor stratum on the downstream side is used if it is shallower than the upstream side.

The anchor stratum of a component cannot be deeper than the anchor stratum of the adjacent inner component. For example, the filter cannot be anchored to a layer deeper than the anchor stratum of the core.

The anchor stratum is not generally used for the riprap, its transitions and the protection layers.

With respect to the lower link, the **acceptable** foundation is defined by the anchoring of the fill type components. The **excavated** foundation also includes the cut type components.

- The **limit stratum** identifies the lowest stratum that the component can reach. A limit stratum is only taken into account if a stripping depth is defined. The scrolling list shows all the materials of **Strata** type in the MATERIAL table for the SPEC site. This option is for future development.
- The **stripping depth** (in meters) is the anchoring depth required for the component. This depth is only used if the lower link is **A** or **X**. This option is for future development.

The anchor stratum is excavated based on the depth indicated unless the excavation previously reaches the layer indicated in the **Limit stratum** field. The excavation batter is defined in the Foundation entry form for the material of the anchor stratum.
- The **stripping distance** (in meters) is the horizontal distance to be stripped following the anchor stratum, from the intersection point of the outside limit of the component and of the said stratum. This distance is used if the lower link is **A** or **X**.
- The **blanket thickness** (in meters) is the height of the blanket measured vertically. If this field contains a value, the component is extended to create a blanket following the acceptable foundation or the excavated foundation. The lower link must be **A** or **X**.
- The **foundation treatment** takes a value of Yes (Oui) or No. If the foundation treatment is done, the costs and surfaces can be calculated.

The last table of the entry form shows the information about the control points, from the FILL_POINT table.

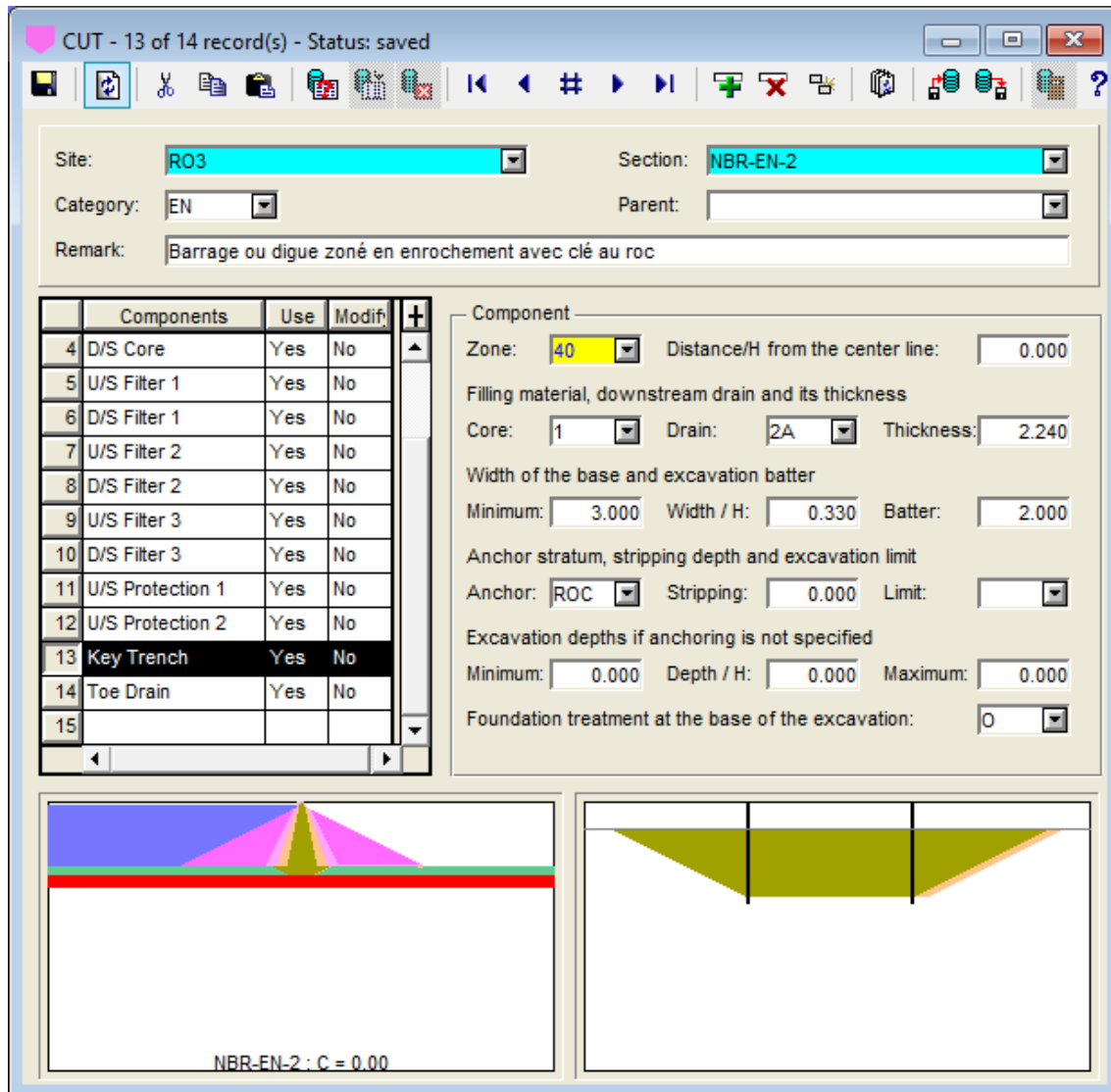
- The **point number** is required and is entered automatically.
- The point **depth** is the depth measured with respect to the crest of the embankment (in meters). A value is required.
- The point **distance** is measured with respect to the adjacent component (in meters).

For the **protection** components (**Riprap**, **riprap transition**, etc.), the distances are measured from the outside inwards, from the embankment line, i.e. the outside envelope of the dike, or from the outer component. For the other components, the construction is done from the dike's center line, i.e. the distances are measured from the inside outwards, from the center line or from the inner component.

If the distance is not specified, the position of the first point will coincide with the adjacent inner or outer component, depending on the component type.

- The **batter** from the point indicates the inverse of the slope of the line starting at the point and going down, eventually joining the next point. This value is used if the distance of the next point is not defined. Otherwise, the distance specified for the next point will determine its position.

Figure 2-7 shows the fields of an excavation component, the key trench. The fields are from the CUT table.



CUT - 13 of 14 record(s) - Status: saved

Site: RO3 Section: NBR-EN-2

Category: EN Parent:

Remark: Barrage ou digue zoné en enrochement avec clé au roc

Components	Use	Modif.
4	D/S Core	Yes No
5	U/S Filter 1	Yes No
6	D/S Filter 1	Yes No
7	U/S Filter 2	Yes No
8	D/S Filter 2	Yes No
9	U/S Filter 3	Yes No
10	D/S Filter 3	Yes No
11	U/S Protection 1	Yes No
12	U/S Protection 2	Yes No
13	Key Trench	Yes No
14	Toe Drain	Yes No
15		

Component

Zone: 40 Distance/H from the center line: 0.000

Filling material, downstream drain and its thickness

Core: 1 Drain: 2A Thickness: 2.240

Width of the base and excavation batter

Minimum: 3.000 Width / H: 0.330 Batter: 2.000

Anchor stratum, stripping depth and excavation limit

Anchor: ROC Stripping: 0.000 Limit:

Excavation depths if anchoring is not specified

Minimum: 0.000 Depth / H: 0.000 Maximum: 0.000

Foundation treatment at the base of the excavation: 0

NBR-EN-2 : C = 0.00

Figure 2-7 - Typical Section entry form - Excavation component: Key trench

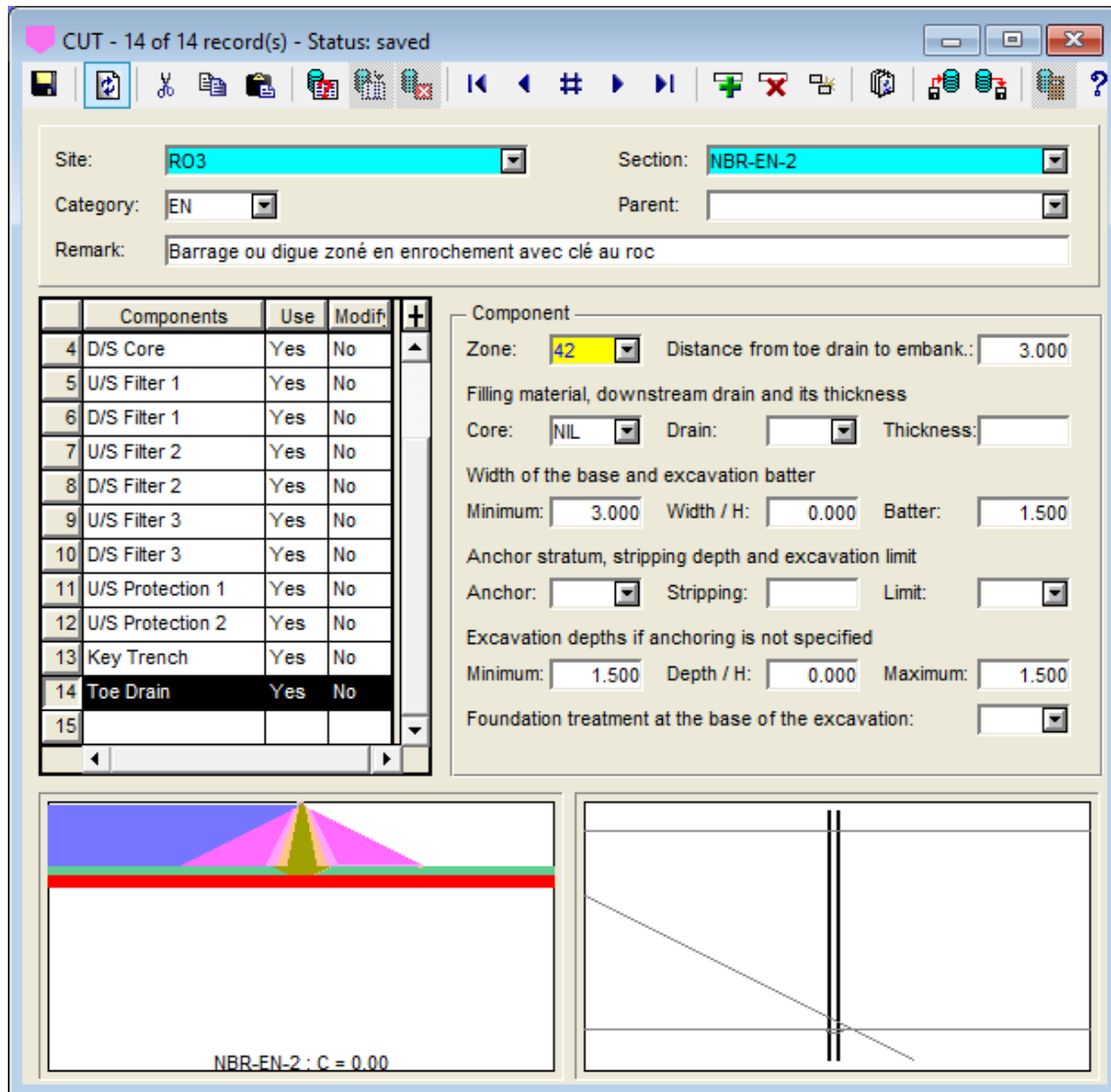
- **Zone** is an inactive field. It shows the component number, as defined in the COMPONENT table.
- The **Distance / H from the center line** is used to position the center of the impervious section of the key trench with respect to the dike axis. The distance is obtained by multiplying the value entered in this field by the hydraulic head, i.e. the upstream water level minus the level of the acceptable foundation at the dike center (between excavating the key trench). The distance, measured in meters, is positive towards downstream.
- In the Filling material, downstream drain and its thickness section, the user enters:
 - In **Core**, the material type of the key trench. The scrolling list shows all the materials of **Fill** type in the MATERIAL table for the SPEC site. When a material is selected, it is

- automatically copied in the current site; the color and cost of the material in the current site are used.
- In **Drain**, the material type of the downstream drain of the key trench. The scrolling list shows all the materials of **Fill** type in the MATERIAL table for the SPEC site. When a material is selected, it is automatically copied in the current site; the color and cost of the material in the current site are used.
 - In **Thickness**, the perpendicular thickness of the downstream drain of the key trench (in meters).
 - In the Width of the base and excavation batter section, the user enters:
 - In **Minimum**, the minimum width of the key trench, measured horizontally, at the base of the excavation. It is the minimum width of the impervious section of the excavation, excluding the downstream drain.
 - In **Width / H**, the multiplication factor of increase of the width at the base of the excavation as a function of hydraulic head.
 - In **Batter**, the excavation batter of the key trench, i.e. the inverse of its upstream and downstream slopes. This value is independent of the excavation batters of the layers in which the key trench is anchored.
 - In the Anchor stratum, stripping depth and excavation limit section, the user enters:
 - In **Anchor**, the anchor stratum of the component. The scrolling list shows all the materials of **Strata** type in the MATERIAL table for the SPEC site.

If an anchor stratum is specified, only the position of this layer controls the excavation depth. In this case, the criteria for the minimum and maximum depth and the depth relative to the hydraulic head do not apply.
 - In **Stripping**, the stripping depth to fix the base of the excavation in the specified anchor stratum. In this case, the base of the excavation is parallel to the foundation stratum.
 - In **Limit**, the inferior stratum that the key trench can reach. A limit stratum is taken into account only if a stripping depth is defined. The scrolling list shows all the materials of **Strata** type in the MATERIAL table of the SPEC site.
 - In the Excavation depths if anchoring is not specified section, the user enters:
 - In **Minimum**, the minimum depth of the excavation, i.e. the elevation difference between the acceptable foundation and the bottom of the excavation measured at the center of the excavation. It is expressed in meters.
 - In **Depth / H**, the multiplication factor of increase of the depth at the base of the excavation as a function of hydraulic head.
 - In **Maximum**, the maximum depth of the excavation in the case where it is function of hydraulic head.

These three fields are used only when the anchor stratum is not defined. In this case, the bottom of the excavation is horizontal. The excavation can then go through one or several stratigraphic layers.
 - The **Foundation treatment at the base of the excavation** takes the value of Yes or No. If the foundation treatment is done, the costs and surfaces can be calculated.

Figure 2-8 shows the fields of an excavation component, the toe drain. The fields are from the CUT table.



CUT - 14 of 14 record(s) - Status: saved

Site: Section:

Category: Parent:

Remark:

Components	Use	Modif.	
4	D/S Core	Yes	No
5	U/S Filter 1	Yes	No
6	D/S Filter 1	Yes	No
7	U/S Filter 2	Yes	No
8	D/S Filter 2	Yes	No
9	U/S Filter 3	Yes	No
10	D/S Filter 3	Yes	No
11	U/S Protection 1	Yes	No
12	U/S Protection 2	Yes	No
13	Key Trench	Yes	No
14	Toe Drain	Yes	No
15			

Component

Zone: Distance from toe drain to embank.:

Filling material, downstream drain and its thickness

Core: Drain: Thickness:

Width of the base and excavation batter

Minimum: Width / H: Batter:

Anchor stratum, stripping depth and excavation limit

Anchor: Stripping: Limit:

Excavation depths if anchoring is not specified

Minimum: Depth / H: Maximum:

Foundation treatment at the base of the excavation:

NBR-EN-2 : C = 0.00

Figure 2-8 - Typical Section entry form - Excavation component: Toe drain

- **Zone** is an inactive field. It shows the component number, as defined in the COMPONENT table.
- The **Distance from toe drain to embankment** is used to enter the distance between the intersection of the embankment with the acceptable foundation and the output point of the toe drain. It is in meters.
- In the Filling material, downstream drain and its thickness section, the user enters:
 - In **Core**, the material type of the toe drain's core. The scrolling list shows all the materials of **Fill** type in the MATERIAL table for the SPEC site. When a material is selected, it is automatically copied in the current site; the color and cost of the material in the current site are used.
 - In **Drain** and **Thickness** are not used.

- In the Width of the base and excavation batter section, the user enters:
 - In **Minimum**, the minimum width of the toe drain, measured horizontally, at the base of the excavation.
 - In **Width / H**, the multiplication factor of increase of the width at the base of the excavation as a function of hydraulic head.
 - In **Batter**, the excavation batter of the toe drain, i.e. the inverse of its upstream and downstream slopes. This value is independent of the excavation batters of the layers in which the toe drain is anchored.
- In the Anchor stratum, stripping depth and excavation limit section, the user enters:
 - In **Anchor**, the anchor stratum of the component. The scrolling list shows all the materials of **Strata** type in the MATERIAL table for the SPEC site.

If an anchor stratum is specified, only the position of this layer controls the excavation depth. In this case, the criteria for the minimum and maximum depth and the depth relative to the hydraulic head do not apply.
 - In **Stripping**, the stripping depth to fix the base of the excavation in the specified anchor stratum. In this case, the base of the excavation is parallel to the foundation stratum.
 - In **Limit**, the inferior stratum that the toe drain can reach. A limit stratum is taken into account only if a stripping depth is defined. The scrolling list shows all the materials of **Strata** type in the MATERIAL table of the SPEC site.
- In the Excavation depths if anchoring is not specified section, the user enters:
 - In **Minimum**, the minimum depth of the excavation, i.e. the elevation difference between the acceptable foundation and the bottom of the excavation measured at the center of the excavation. It is expressed in meters.
 - In **Depth / H**, the multiplication factor of increase of the depth at the base of the excavation as a function of hydraulic head.
 - In **Maximum**, the maximum depth of the excavation in the case where it is a function of hydraulic head.

These three fields are used only when the anchor stratum is not defined. In this case, the bottom of the excavation is horizontal. In addition, the excavation can then go through one or several stratigraphic layers.
- The **Foundation treatment at the base of the excavation** takes the value of Yes or No. If the foundation treatment is done, the costs and surfaces can be calculated.

8. MATERIAL



The **Material** entry form is used to define information about materials found on a site; information contained in the MATERIAL table. The data are also used in the exploration modules of Geotec.

The key for the records consists of the fields **Site**, **Type** and **Material**.

- **Site** will generally be the dummy site named SPEC to define the normalized materials. The user can also modify the materials for specific sites.

- **Type** shows a list of 4 values from the LIST_ENG table: backFill, Strata, Unified and eXcavation.
- **Material** is the material code, with up to 20 characters.
- A **description** of the material can be added with 255 characters.
- **Color** is used to define a specific color for the material. Double-click in the field and a color definition window opens to ease the color selection. A value is required.
- The material **cost** per cubic meter is entered (in \$).
- **Depth** indicates the top depth where the material layer is found.
- **Batter** is the excavation batter.

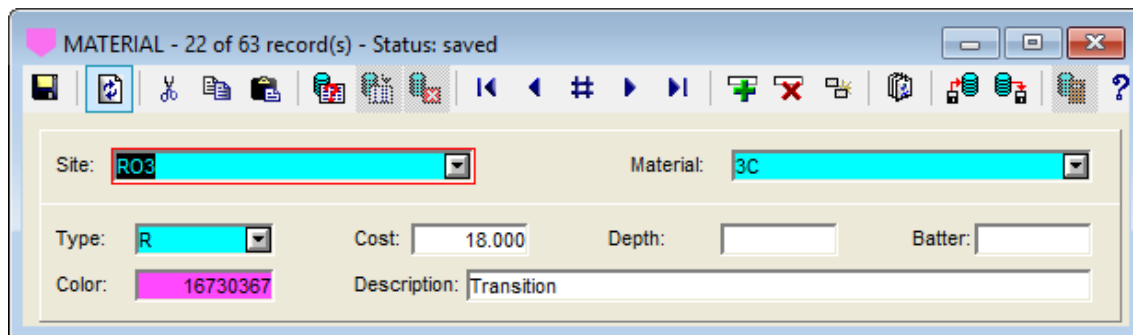


Figure 2-9 - Material entry form

For each site, the materials of type Fill used in its cross-sections are copied in the MATERIALS table for the current site, allowing the user to adjust the color and cost of the materials for each project.

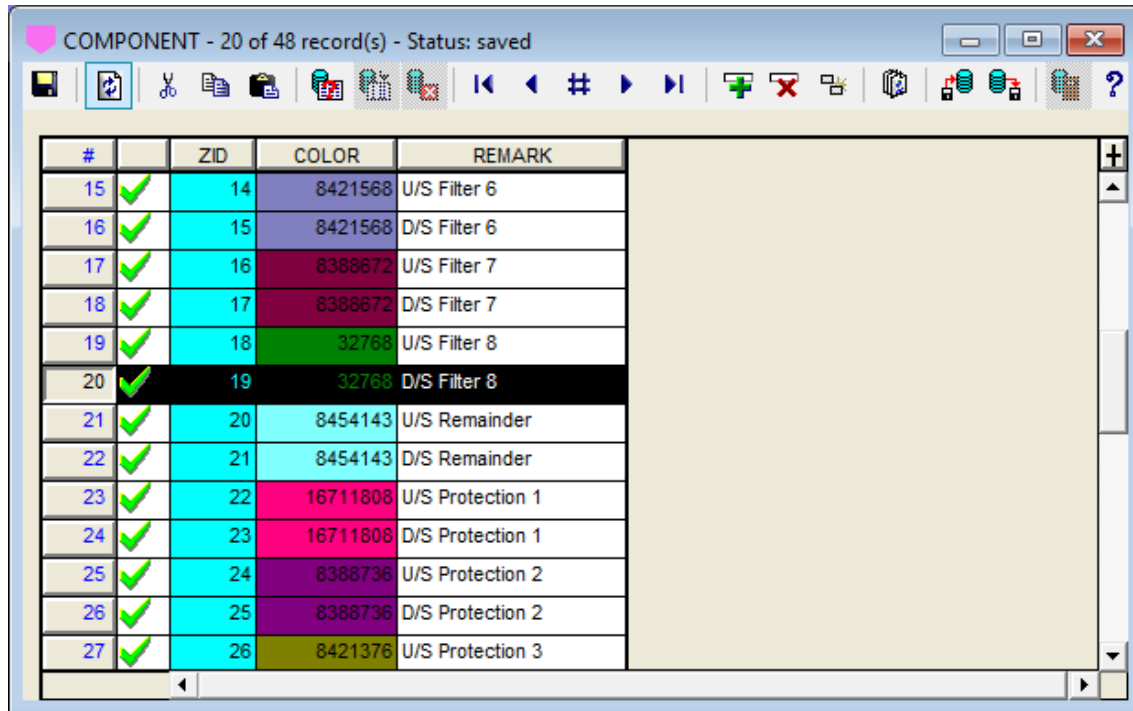
9. COMPONENT



The **Component** entry form shows the different components of a dike and their associated color; information contained in the COMPONENT table. Values are automatically added in the databases.

- The key for the records consists of the **ZID** field. The order should not be changed; it is important during the creation of the cross sections of the dike.
- The **color** of each component can be modified by double-clicking in the field. A color definition window is then opened to ease the color selection. A value is required.
- A **description** of each component is displayed. It can be modified, but should remain explicit because it is with their description that the components are selected in the typical section window.

COMPONENT - 20 of 48 record(s) - Status: saved



#	ZID	COLOR	REMARK
15	14	8421568	U/S Filter 6
16	15	8421568	D/S Filter 6
17	16	8388672	U/S Filter 7
18	17	8388672	D/S Filter 7
19	18	32768	U/S Filter 8
20	19	32768	D/S Filter 8
21	20	8454143	U/S Remainder
22	21	8454143	D/S Remainder
23	22	16711808	U/S Protection 1
24	23	16711808	D/S Protection 1
25	24	8388736	U/S Protection 2
26	25	8388736	D/S Protection 2
27	26	8421376	U/S Protection 3

Figure 2-10 - Component entry form