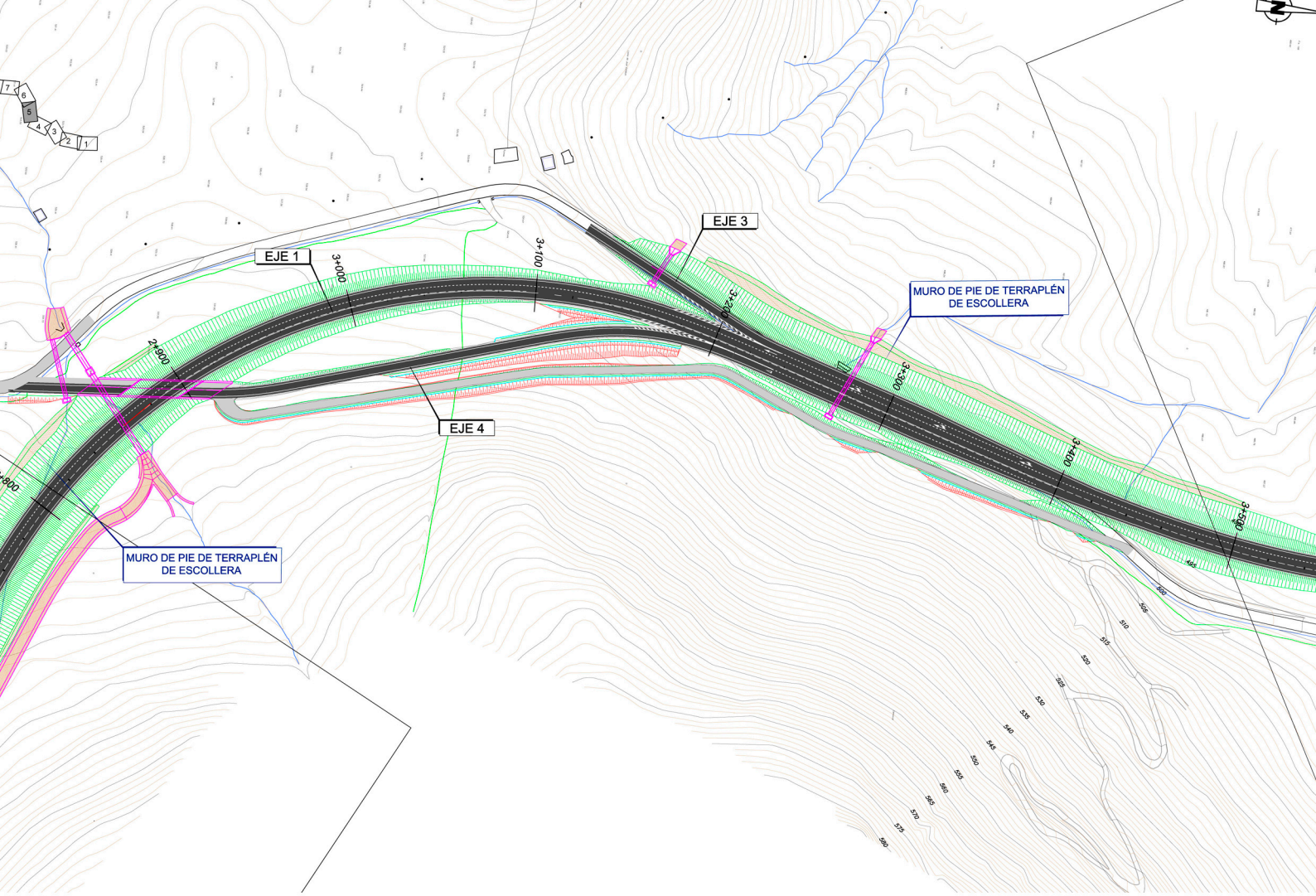


T.A.D.I.L.

MANUAL

USER'S MANUAL

TECHNIQUES FOR THE AUTOMATIC DESIGN OF LINEAR INFRASTRUCTURES

SOFTWARE TADIL

USER'S GUIDE

.

SOFTWARE TADIL

USER'S GUIDE

WORK TEAM:

Salvador Mansilla Vera (Algorithms Author, Guide and User's Guide Writer).

Juan Añón Izaguirre, (Responsible of Encoding the Software).

Tomás Quesada Jiménez, (Software Tester, User's Guide Writer).

Ángeles Rosa Álvarez, (Functions Programmer in CAD environment)

Salvador Toril Díaz, (Interface Graphic Designer, Generator of Templates for Serigraphy, Structures and Tunnels Sections, CAD Tester and MDT Generator).

Belén Jiménez Morales, (Guide, User's Guide and Software Translator).

Cristóbal Medina Ballesteros, (Collaborator in Geometric Algorithms).

Nataly García Coello, (Software Installation).

María José Sánchez Ibáñez (Project Manager and Administrator).

Construcciones Otero, (Collaborator in Beta Software Monitoring, Graphic Design and Digital Model of Land).

University of Malaga

José Luis Pérez de La Cruz Molina, (Project Director).

Lorenzo Mandow Andaluz, (Guidance).

CONTACT INFORMATION:

ACTISA S.L. (Actividades de Consultoría Técnica, Investigación y Servicios Avanzados S.L.).

C/Manuel Roldán Prieto, 3, 2º F. 18140 La Zubia, (Granada).

Phone and fax: +34.958.38.92.74

www.actisa.net

E-mail: actisa@actisa.net

Intellectual property registration. Record: GR-343-13

PRESENTATION

Up to now there have been too little researches aimed at defining methods of automatic draft in lineal works. Some of them have used classical techniques of mathematical optimisation; some others resort to heuristic search or to the knowledge-based methodology of systems to solve the problem. Most recently some techniques of stochastic local optimisation have been applied, mainly by using genetic and evolutionary algorithms.

In general, all these attempts have suffered from some of these lacks:

- Little realism when modelling the problem. Restrictions imposed by road regulations and instructions imply a range of possible solutions with a complicated topology and an irregular shape. On the other hand, the real environment where the lineal work is to be implemented is very complex too. All in all, the suggested systems go without one or several important aspect during modelling.

- Size of the maximum solvable problem. The number of possible solutions increases exponentially with the draft length; hence the approaches based on classical techniques of combinatorial optimisation can only deal, in practice, with very small problems.

- Partial approach of the problem. It is common in literature to find, for example, some software which only consider plan drafts or which only consider earthwork cost.

- Lack of integration with the real workplace. Most of the suggested systems still remain in the theoretical proposal or, at most, in the prototypes, without taking into account the real features of work specified by the planner.

TADIL overcomes all of these limitations to a greater or lesser extent:

- It allows us to model the largest part of the problem aspects and the possible solutions.

- It solves in a few minutes draft problems of order 50 Km.

- It provides complete drafts (plan and elevation) as well as indications about tunnels and crossing works.

- TADIL joins the baseline commercial tool in the field of the Engineering and provides a complete description of the proposed draft on the level of Informative Study.

Therefore, TADIL constitutes a significant step forward from the point of view of R&D in the field of Artificial Intelligence for engineering design.

José Luis Pérez De la Cruz Molina

Salvador Mansilla Vera y equipo.

CONTENT TABLE

IMAGES INDEX

1. GENERAL OVERVIEW USER'S GUIDE AND METHODOLOGICAL APPLICATION GUIDE

1.1. What is tadil

The initials TADIL stand for the Spanish term "Techniques for the Automatic Design of Linear Infrastructures". TADIL is, therefore, a software which covers several techniques in the field of artificial intelligence to design automatically linear infrastructures.

This software aims to generate infrastructures designs in a quick way. It is possible to define the route plan axis, the longitudinal profile, the cross sections, the earthwork plan and the infrastructure expropriation, the measurements and the earth movement, the earthwork balance, the budget, the profitability and the evaluation of alternatives.

The possibility of obtaining infrastructures in such a quick way will allow administrators, private promoters and consultants to be able to:

- know from the very beginning their investment needs and profitability without having to wait for the project to be completely developed.
- undertake a wide parametric study where multiple variables are considered (speed, type section, cut sections and embankment heights, etc.) enriching the view and analysis of different implementation possibilities of the new infrastructure.
- achieve the best possible integration between infrastructure and territory since geotechnical, environmental, climatic, socio-economical and patrimonial variables are considered.

1.2. Possibilities of application and abilities of software tadil

We must consider that TADIL is a software intended for designing linear infrastructures in a previous study level. TADIL can design, analyse and value multiple alternatives and select the best one. Afterwards, we might consider which tools are relevant to perfect and define the selected design.

Nevertheless, we must indicate that future versions of TADIL will incorporate new functions for perfecting these results and provide solutions more and more in line with those of an actual project. This will make user's work easier.

The software includes several algorithms which allow to consider both the ordinary variables in a design (speed, maximum slopes, etc.) and the criteria and preferences of design to be taken into account by the user (rectilinear design or with an harmonic sequence of curves, better adjustment to land or more direct design, etc.). The application of algorithms makes richer the alternatives to be included in the previous or informative study.

1.3. Methodological application guide

This Guide wants the user to become familiar with the software. We have designed software TADIL to be accessible both for users with experience in infrastructures design and starting users. Although users with experience in infrastructures projecting and designing will need no more than a quick read of this Guide to make new studies with software TADIL, we recommend them to read simultaneously the Methodological Application Guide.

The Methodological Application Guide provides a description of each variable taking part in the study as well as recommendations for its application.

It also provides a description of procedures, evaluations and calculations from software TADIL. Knowing these topics will allow the user to get a greater performance and, therefore, to obtain the best results from TADIL.

1.4. Steps to be taken with software tadil

When we work with software TADIL, the steps to be taken will depend on the type of study we want to make; in section 7 we describe the differences between previous study and informative study.

For the previous study, after having entered the design preferences and criteria, we can proceed to obtain the plan and profile design. For the informative study, before entering the design criteria, we should have first defined completely the Geographic Information System, the data base with the construction units and prices applied as well as the cross sections. In the same way, we will have to indicate those data allowing configuring the budget and the profitability study and, finally, the weighting coefficients of variables taking part in the multi-criteria evaluation.

Therefore, the steps to be taken in the informative study are the following:

- **a.** Defining the construction units and prices to be used in the study.
- **b.** Defining the Geographic Information System.
- **c.** Defining the type section.
- **d.** Budget data.
- **e.** Profitability data.
- **f.** Criteria for the valuation of alternatives.
- **g.** Entering criteria and preferences of design.
- **h.** Generating plan design.
- **i.** Generating elevation design.
- **j.** Obtaining cross and plan sections of earthwork and expropriations.
- **k.** Evaluating jointly the alternatives.
- **l.** Obtaining lists.

The previous study only includes steps g, h and i, obtaining exclusively the plan axis and longitudinal profile of the alternatives.

1.5. About this user's guide

This User's Guide aims, on the one hand, to give a general overview of this software and, on the other hand, to provide a Quick Guide of Use. For that reason, we include a complete example of previous study as well as of informative study.

The User's Guide distribution is the following:

- **In section 2** we give a general overview of the software structure.
- **In section 3** we describe the file management made by TADIL.
- **In section 4** we describe the layers management. This section together with section 3 are considered essential to achieve the best possible order in processing the great number of data necessary for making an informative study.
- **In section 5** we describe the installation process and the boot up process.
- **In section 6** we describe the available languages of TADIL, the User's Guide and the Application Guide.
- **In section 7** we explain in detail the differences between a previous and an informative study.
- **In section 8** we show a complete example of a previous study.
- **In section 9** we make a tour of each menu and show an example of informative study.
- **In section 10** we describe the lists we can obtain with TADIL.
- Finally, in **section 11** we describe the treatment of measure units and monetary units, **in section 12** we describe more frequent errors and **in section 13** we ask the FAQ.
- **In section 14** we make a general description of applied algorithms.

2. WORK ENVIRONMENT OF TADIL

The work environment of software TADIL is structured into two separate sections: the Database Administrator and the Project Administrator. Next we specify the content of each one

2.1. Database administrator

The Database Administrator is used for the development of informative studies, where we have a detailed study of the land, a basis of prices appropriate for the infrastructure to be planned and we know the type section.

The database administrator has the following windows:

- Construction Units and Prices
- Geographic information system
- Macro-prices
- Type Sections

2.2. Project administrator

The setting up will be different if we choose a Previous or an Informative Study.

When we are developing an informative study, we will be able to fill in the menus of the project administrator. In contrast, when we are developing a previous study, we will be able to calculate only the route plan axis of the alternatives and its longitudinal profile without cross sections, measurements and budgets, hence, without elaborating the profitability study. For developing the previous study, we do not need a database.

The project administrator consists of the following sections:

- ***Setting up - file paths***
- ***Initial Data***
- ***Informative Study, which in addition, is made up of:***

    - Visibility Axis
    - Type Section and General Areas
    - Basic Axis Editor
    - Solutions Editor
    - Budgets
    - Profitability
    - Evaluation of Alternatives
    - Report Manager

3. FILE AND COMMANDS MANAGER IN TADIL

The file generated with the project administrator will have always the extension "tadil", whereas the one generated with the database administrator will have the extension "tadbd".

The files of regulations will have extension "tadno" for defining the plan axis, whereas the files of regulation for defining its grade line will have the extension "tadkv".

The file of activation of TADIL in CIVIL 3D is acTadil.dll. is located in the folder 10.00-Tadil/app.

The files of design of section of structures, tunnels and barrier have an extension dwg and are located in the folder 10.00-Tadil/cad. We must not modify the name of the files to incorporate to TADIL, otherwise the software will not do the automatic search of the structure or tunnel section according to our preferences.

We can save the files of images in the folder 10.00-Tadil/img.

TADIL generates files of work in the folder 10.00-Tadil/gis.

Each time we want to load a new version in TADIL, we should replace the folder 10.00-Tadil in its location; afterwards, we should write "netload" in the Command Bar of CIVIL 3D, then we go to the location of the file "acTadil.dll" and we load it. Next we can load the database administrator by writing the command TDB or the project administrator by writing the command TDI.

To set the version switch, we use the command TDSET. After that, each time we open CIVIL, we just have to write the command TDI or TDB.

To change the menus into English we use the command TDEN and to change it into French, we use TDFR.

4. LAYERS MANAGEMENT

Given the great quantity of information inside TADIL, in the Geographic Information System, we recommend generating the areas and polylines of interest in differentiated layers before logging in the database administrator. This way, TADIL will be more effective as we will just need to select the corresponding polyline without having to wait for creating it. Searching the polyline will be easier too if it is located on a differentiated layer.

In turn, TADIL, as polylines are assigned to the database and the project administrator, generates layers in CIVIL 3D. Among others, TADIL generates the following:

- *_Tadil_VisibilidadEje*, which includes the visibility axis used.
- *_Tadil_VisibilidadGrafo*, which includes the degree of automatic visibility.
- *_Tadil_ZonasNoPasoPendiente*, which includes the triangles of maximum slope specified by the user.
- *_Tadil_ZonaNoPasoUsuario*, which includes the banned areas specified by the user.
- *_TADIL_Gis_XXX_xxx*, are the layers generated by TADIL, some of them environmental layers, (if it includes the term AMB), climatic, (if it includes the term CLI), socioeconomic, (term SOC), or patrimonial, (term PAT). Likewise, the layer name refers to the variable that we define (SECPRI for first sector, URBANO for urban land, etc.)

The layers whose name is _Tadil_Sol_ refers to the definition of basic axis, route plan axis, profile and sections of each one of the calculated solutions.

5. SOFTWARE INSTALLATION

The license of TADIL incorporates an Installation Wizard. This Wizard need to know the location of the folder 10.00 Tadil as well as the protection data of the software.

When we finish this process, we can use software TADIL.

We recommend a minimum RAM memory of 8 MB. For bigger cartographies, 12 MB RAM memories will speed up the process.

6. AVAILABLE LANGUAGES

Software TADIL is available in Spanish, English and French. The software, the User's Guide and the Methodological Application Guide are in these languages too.

For license support, written or telephonic enquiries can be attended in Spanish and English.

At the request of any user, ACTISA, the company commercializing, updating and supporting the software, will offer a translation into the applicant's language. This service is free if a determined number of licenses are requested.

We will be able to load the menus in English (with the command TDEN), in French (with the command TDFR) and in Spanish (with the command TDES).

7. PREVIOUS STUDY AND INFORMATIVE STUDY

A previous deep knowledge on the territory where the infrastructure is aimed to be implemented allows distinguishing both types of analysis:

- in the previous study we do not have a detailed study of the territory-defining variables. The infrastructure to be design aims to solve a problem between an origin and a destination (an infrastructure with a lack of capacity, absence of connection, etc.); we usually start from a study on traffic or demand and do not detail the type of infrastructure.

- in the informative study we start beforehand from defining the features of design. Likewise, we have a full study of the territory and all the variables affecting the design (environmental, geotechnical, climatic, socio-economical, patrimonial, etc.).

The main differences between both studies are as follows:

Design: whereas in the previous study different solutions of type sections are considered according to the decisions on the traffic previous study, in the informative study we start from a specific type section. On the other hand, whereas in the previous study we consider a range of speeds, in the informative study, speed is not generally detailed in advance. Finally, whereas in the previous study we analyse the possibilities of implementing route axis in the territory, in the informative study we make a detailed multi-criteria study analysing different alternatives regarding the occupied plan space of the linear infrastructure, the cross sections and the measurements of the construction units.

Cartography: whereas in the previous study we use published cartographies going from the 25.000 to the 5.000, in the informative study we start generally from a specifically-made cartography for the studying area.

Costs: whereas in the previous study we consider global costs on implementation, cut sections, embankments, structures and tunnels, in the informative study we detail the units that best fit with the crossed geotechnical groups including earthwork, pavements and esplanades and we can also consider costs regarding different typologies of structures and tunnels.

Geotechnics: in the previous study we use geological and geotechnical regional analysis and we make general proposals for the cut section slopes and embankments; in the informative study we set out in detail features to differentiate geotechnical areas and groups with specific data on slope, protection, scaling, pavement and esplanade.

Structures and tunnels: in the previous study we only consider global costs whereas in the informative study we distinguish typologies of structures and tunnels with differentiated costs depending on the area.

Environment: in the previous study at most we consider environmental banned areas as for the alternatives, whereas in the informative study we can implement a wide range of variables depending on the full study of environmental impact, which establishes territory evaluations and, like in the previous study, creates banned areas.

Climatology: in a previous study the climatological variables are not usually considered, except for those which affect decisively to the design; in the informative study we analyse those conditioning aspects which affect traffic safety (frost, rain, fog, heavy wind, etc.).

Socio-economy: in the previous study we only consider those aspects regarding the traffic prognosis, whereas in the informative study we include a complete analysis of use areas with their corresponding productive evaluation.

Patrimony: whereas in the previous study we only consider big areas of patrimonial protection, in the informative study we carry out a wide study about the soil evaluation, distinguishing use areas, infrastructures crossings, farm tracks, etc.

The informative study can be preceded by a previous study, which will provide information about the type of infrastructure to be developed in the territory.

TADIL allows making previous studies without having to implement the GIS menu, the Construction Units and Prices menu or the Type Sections menu; just entering the data in the Design menu.

On the contrary, before developing an informative study, we should enter the GIS variables, the values of units and prices and the type sections to implement. Once all the information is entered, we would be able to access the Design menu and generate alternatives.

The information that we will be able to obtain in each study differs considerably as it is described next:

- Previous study:

  - Route plan axis.
  - Longitudinal profile

- Informative study:

  - Route plan axis.
  - Longitudinal profile

- Cross sections
- Earthworks plan.
- Budget and earthwork balance.
- Profitability results.
- Evaluation of alternatives.

8. PREVIOUS STUDY DEVELOPMENT

In this section we describe the process for making a previous study. To give the user an easier understanding, we are going to show an example:

The stretch of road B-131 in its section Villa Ana – Pueblo Viejo is part of the corridor of the Valley Río Sur and is 45 km length. Currently it is a single carriageway road and its geometric features are acceptable. However, it has some limitations: 11% of heavy traffic using this carriageway, roads that pass through the village or others very close to town centres and industrial sites; or the presence of several level intersections with complementary-network carriageways and provincial-roads. These limitations greatly affect the operability of its itinerary. More importantly, taking into account that this road works as a corridor associated to the structuring network (toll road network that is useful as support to long routes and main outside connections).

Currently, this stretch has 8945 v/d as ADT and a 3% growth per year. Its current average speed is 60 km/h. Its death rate is 84 and the hazardousness is 3. Therefore, an alternative road of high capacity is thought to be implemented.

In order to check the technical viability of designing this new road, we make a previous study with Software TADIL. TADIL studies have two main blocks perfectly defined: TDB and TDI. TDB is the database module, where every single determining factor is loaded regardless its nature. These determining factors will be detailed all along this user's guide. The TDI, after introducing some determining factors, is a module mainly aimed at calculating design and editing solutions as well as lists. A previous study does not need a database, since it mainly checks the technical viability, that is, the capacity of the land to provide space for infrastructures with the indicated features.

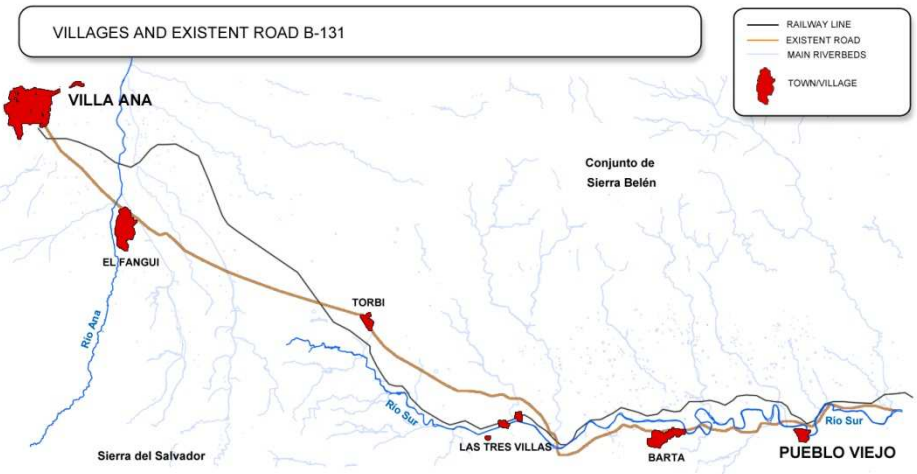


Image 1. Villages and existent road B-131

8.1. Load the software

TADIL is a software that works inside the software AutoCAD Civil 3D. Therefore, first of all, we must open the cartography in (.dwg) format.

After that, we load TADIL. For doing that, we need to write "netload" in the Command Bar. Then, when the dialogue box "Select .NET Assembly" will open, we select the folder where TADIL is in our system, we select the folder "app" and the "acTadill.dll" opens. To finish the installation process for TADIL, we write "TDSET" in the Command Bar. From now on, the software will be loaded automatically each time we open the software AutoCAD Civil 3D.

8.2. TDI Implementation

Once the software is activated, we make the following:

8.2.1. Load the TDI

To load the TDI menu, we just need to write "TDI" in the Command Bar of AutoCAD Civil 3D.

In the tab "File" from the loading window TDI, we select the option "New Previous Study". We name the file and, then, save it.

8.2.2. Settings

8.2.2.1. File paths

The first thing the software must know which regulations we are going to follow. TADIL comes by default with the Spanish Regulations but the user will be able to enter the convenient regulations at any time.

In our example, we will use the default one. Therefore, we push the "Select" button. Then, a window opens and, in the Software Folder we open the folder "dat". Finally, we open the folder "regulations", select the regulation and save.

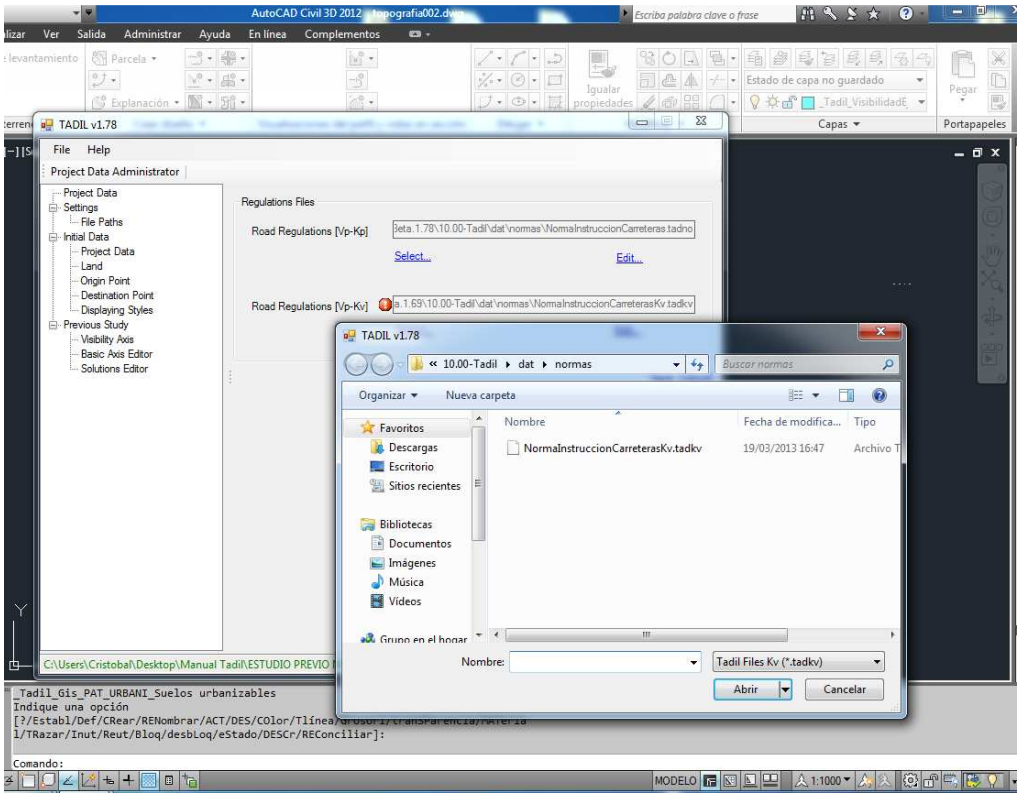


Image 2. Selection of regulation

- **Edit regulation**

If we opt for a different regulation, the process will be the same as described previously. By clicking on "Edit", we can modify the values of units in the tables. We can modify them directly or just by clicking on the secondary button and clicking on "Add Record" or "Remove Record". To save the modified data, we must click on "File" and select "Save".

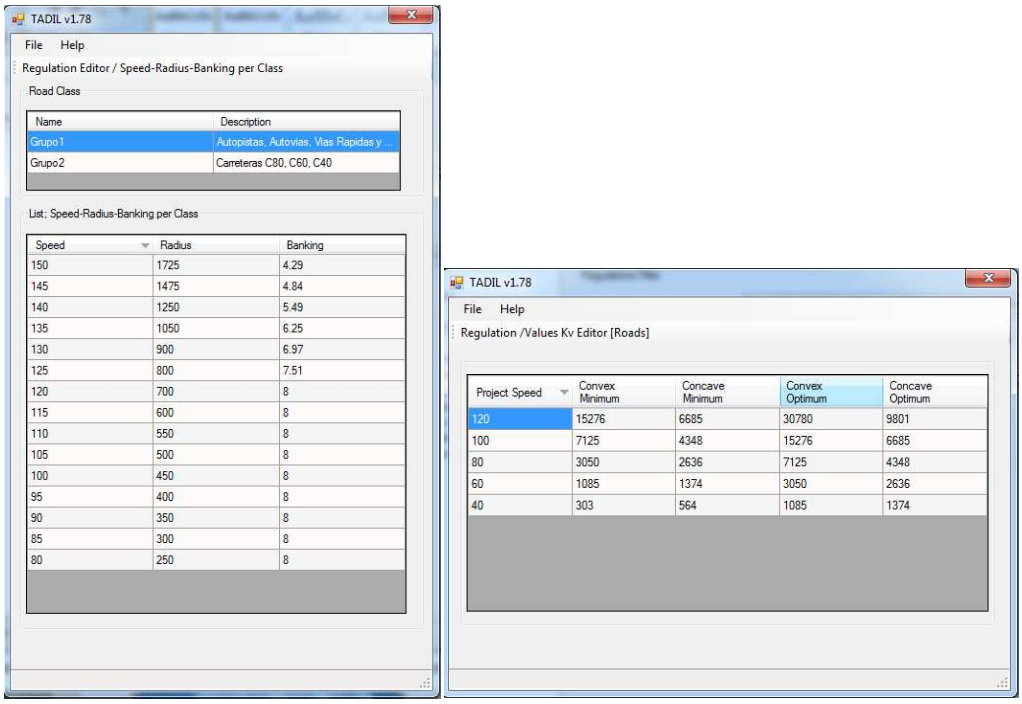


Image 3. Editing the regulation

8.2.3. Initial data

8.2.3.1. Project data

In this section we define the project name and its description, finally we save it.

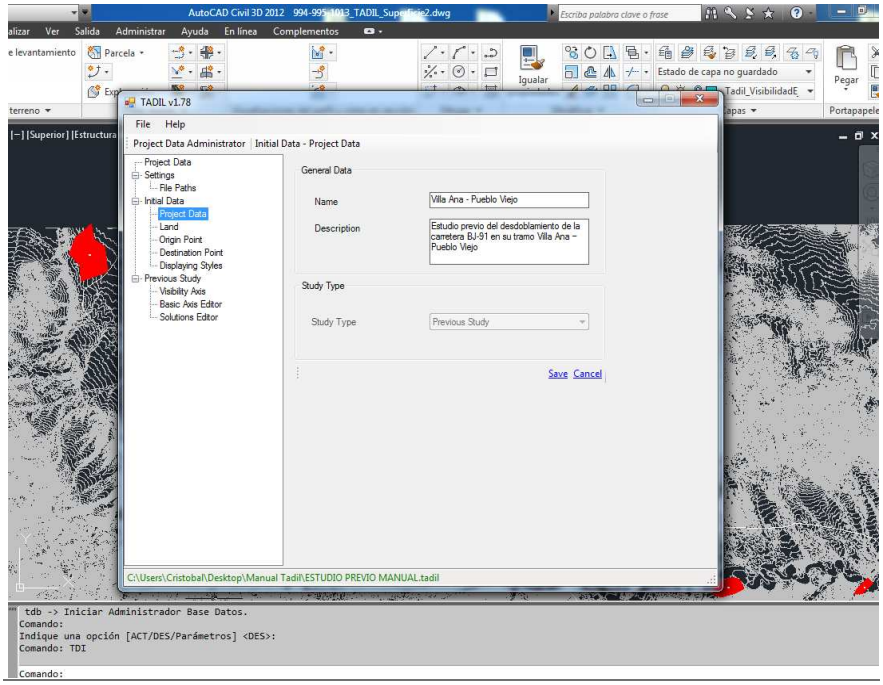


Image 4. Name and description of the previous study

8.2.3.2. Land

Next we define the land TADIL is going to work with, In the drop-down "Name", it will appear the land's name of the cartography TADIL is going to work with. We select it and push "Save".

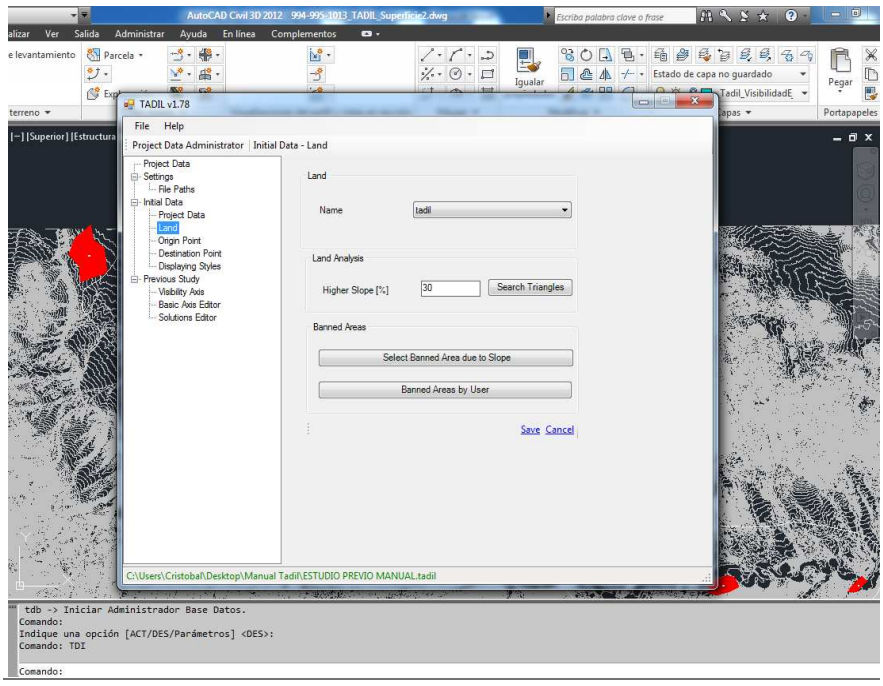


Image 5. Land selection

- **Land analysis**

At this point, we are going to identify the highest slopes according to a previously selected limit. In our case, we check slopes higher than 30%. When we push "Search Triangles", the software will identify in the cartography those areas whose slope is higher than 30%.

- **Banned areas**

  - **Banned areas due to slope:** Once we have the areas with a higher slope than the one we consider as critical (30% for us), we can draw a polyline (that must be closed) around the sections which have the aforementioned slope. When we push "Select Banned Area due to Slope" so selecting this polyline, TADIL will automatically avoid these banned areas in any design alternative.

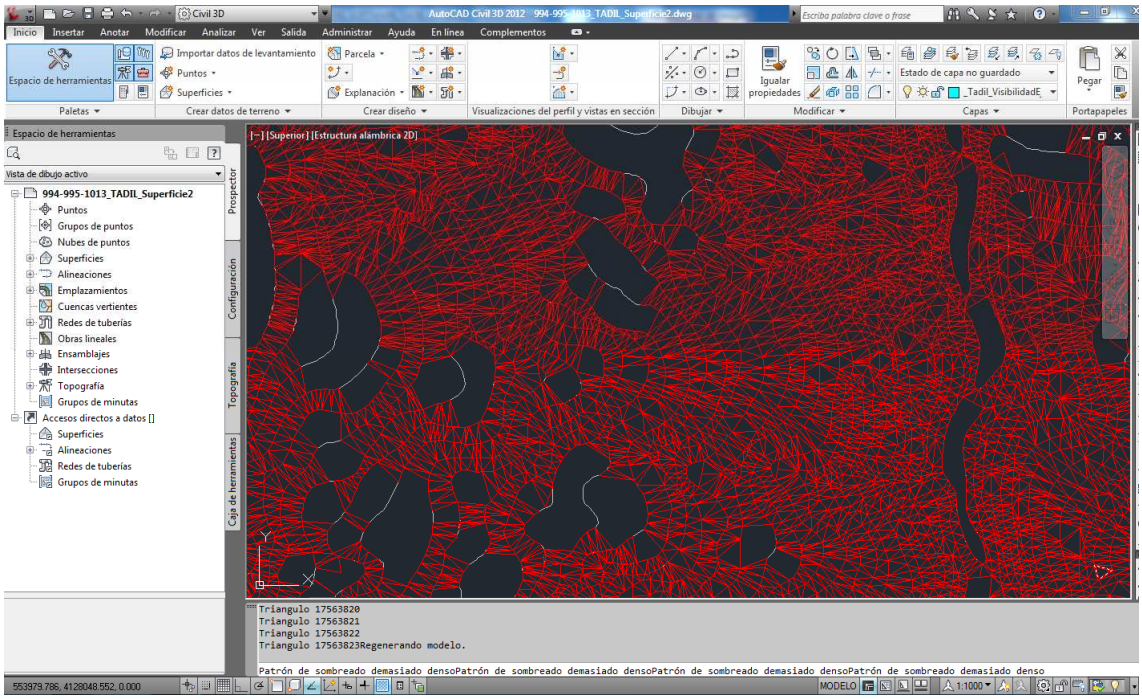


Image 6. Triangulation which TADIL makes for higher slopes than defined.

  - **Banned areas defined by the user:** In this case we are allowed to delimit banned areas at will. As for our example, we just mark the city centres as banned areas. Likewise, we draw polylines around the city centre, we push "Banned Areas by User" and TADIL will avoid crossing these sectors.

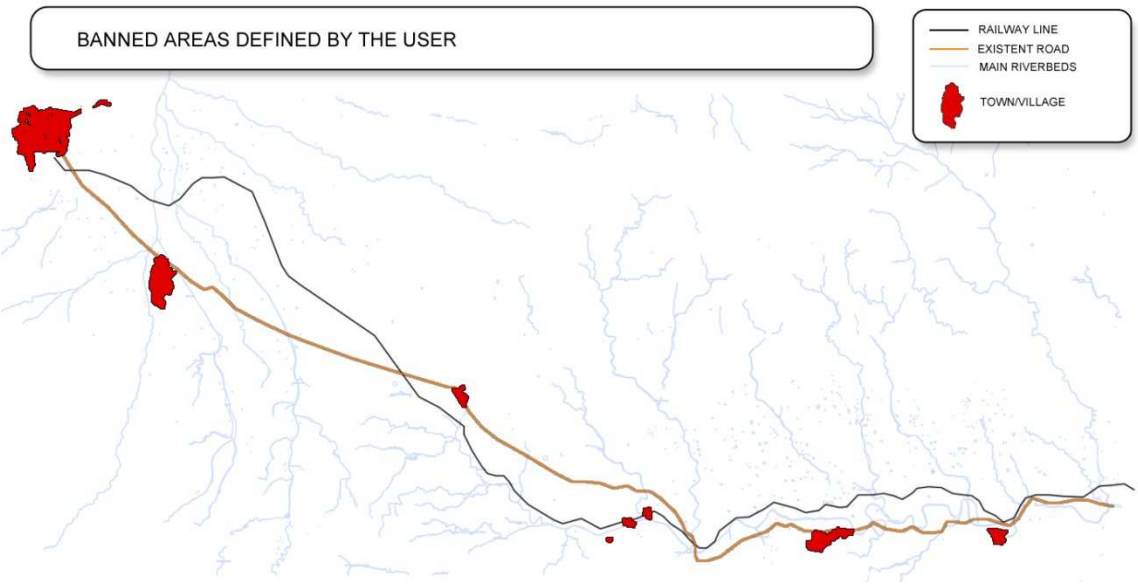


Image 7. Banned areas defined by the user.

8.2.3.3. Origin point

The biggest advantage of TADIL is its straightforwardness and speed of design calculation. Therefore, if we define an origin point and a destination point, the software will analyse the determining factors introduced and will select the best design option.

We can define the origin point directly over the surface of our .dwg (pushing "Specify Point on Surface" and clicking any point of the cartography) or we can introduce its coordinates manually (pushing "Specify Point with Coordinates…").

For our example, we will select an origin point over the surface. We will locate this origin point near the town Villa Ana.

- **Define azimuth**

  Pushing "Define Azimuth", we will be able to determine an azimuth of origin for the future road.

- **Define length**

  With TADIL we can also specify a length of origin at will pushing the box "Define length". This option is applicable when our connection must start from an existing road, whose length is known. When we mark this option, we must also stablish the azimuth.

- **Define slope**

  Likewise, we can also make the future design start with a fixed slope. If the slope is positive, this will be ascending and vice versa. This option can be marked in "Define slope". Just as in the previous section, this option is useful when we have an origin or destination point connected with an existing road.

As for out study, we have determined an azimuth of origin of 120°, a length of origin of 1600 m and a slope of -0.5 %. The data are determined when we push "Save".

We must take into account that the origin length is conditioned by the class of road and speed. Therefore, having defined this, we recommend checking this length fulfils the data given by TADIL before calculating the basic axis.

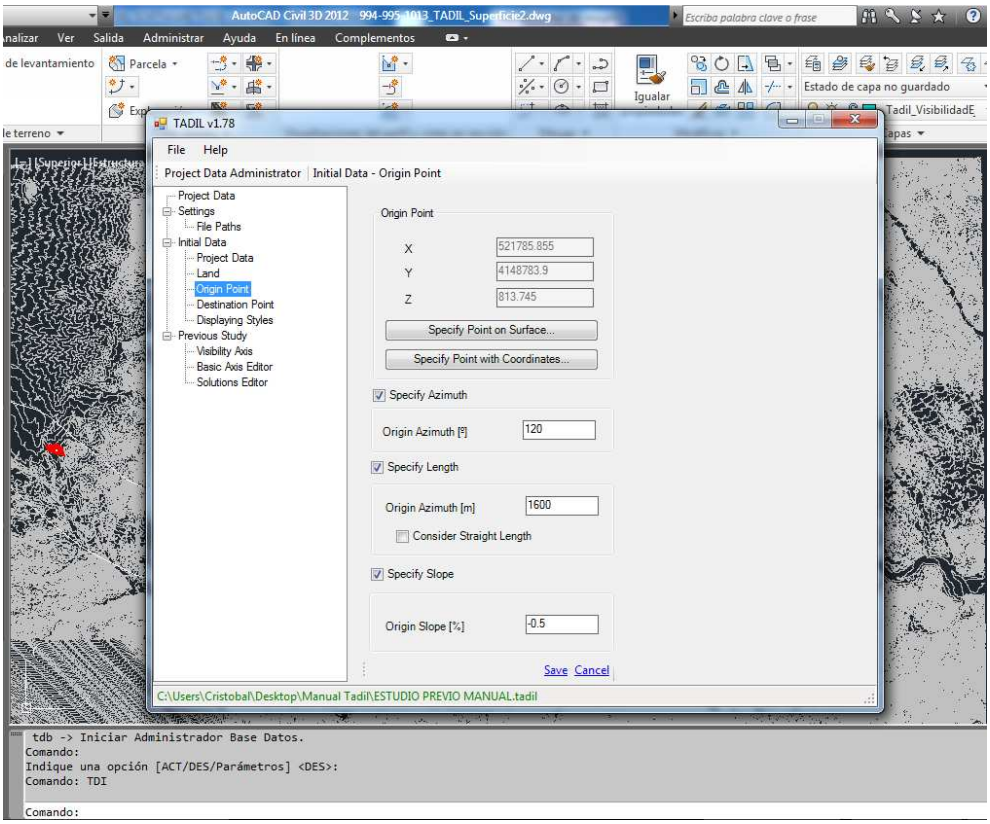


Image 8. Data for the origin point.

8.2.3.4. Destination Point

We establish the destination point like we established the origin point. We establish the destination point near Pueblo Viejo's town centre, with an azimuth of destination of 300°, a length of destination of 1650 m and a slope of destination of -1 %.

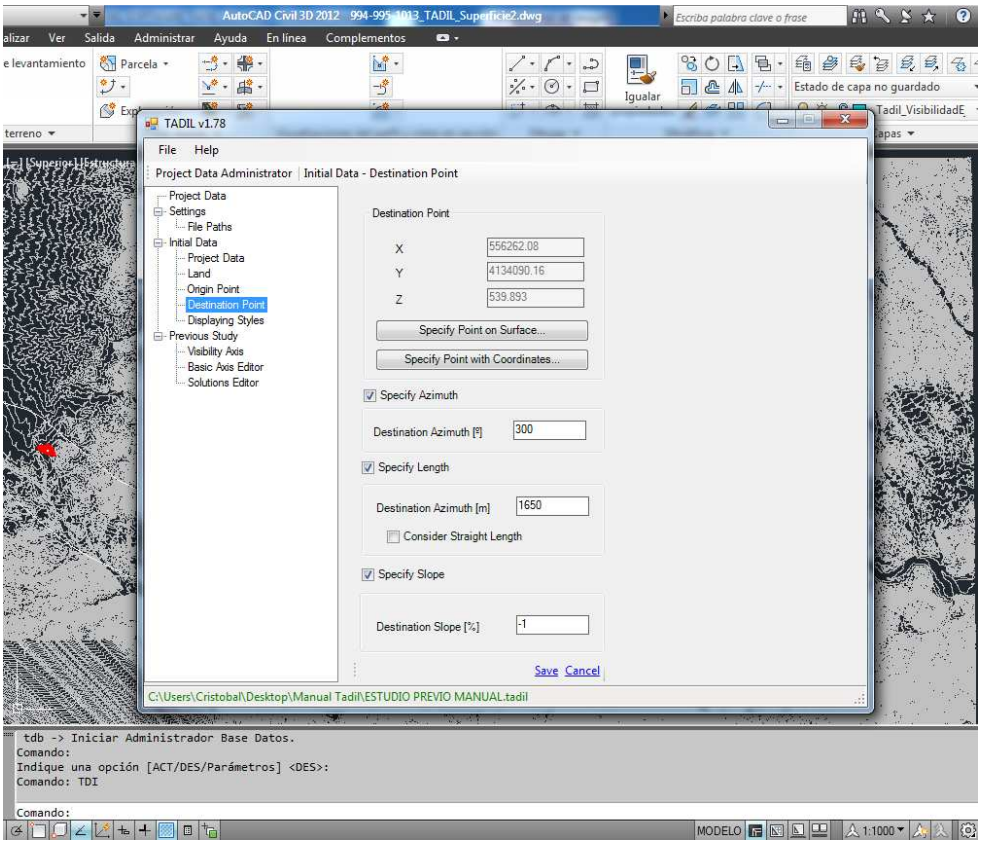


Image 9. Data for the destination point

8.2.3.5. Displaying styles

We will be able to create our own displaying styles and to load them or load the default ones (for more information, we recommend having a look to the section "9.3.3.4. Displaying styles" in this Guide).

In this previous study we will load and save the displaying styles of TADIL.

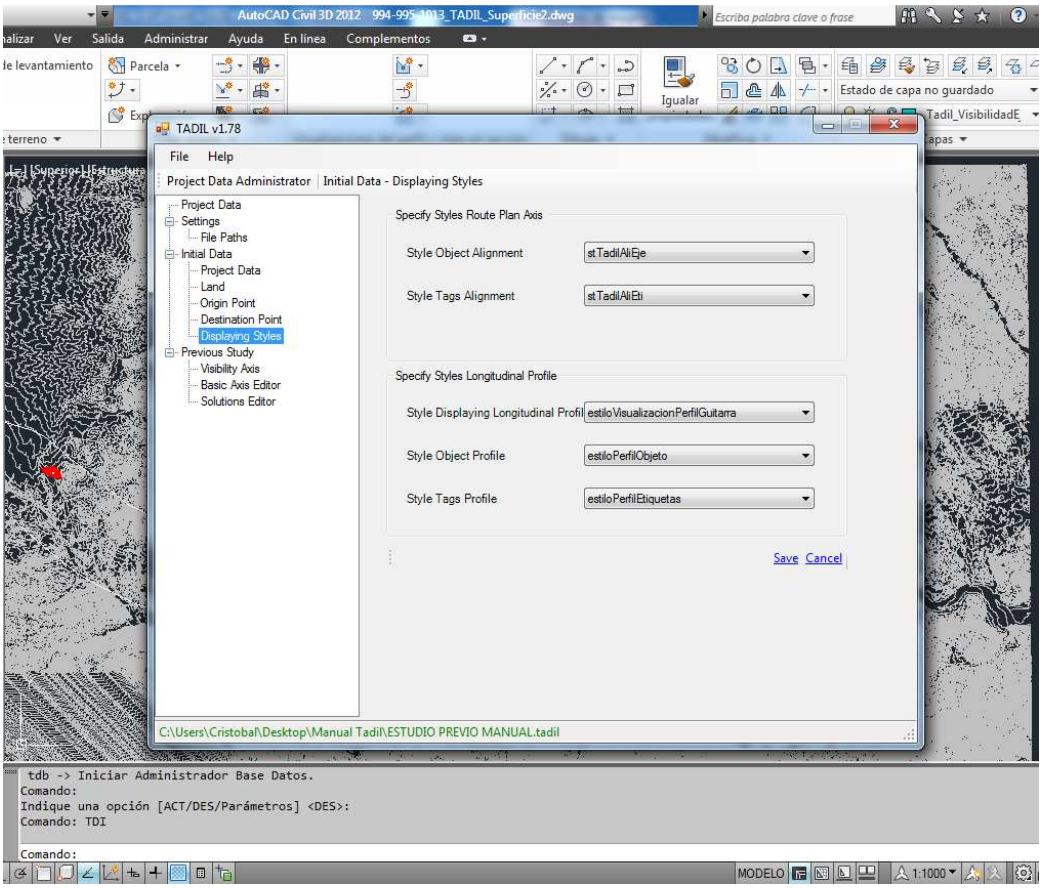


Image 10. Displaying styles defined by TADIL.

8.2.4. Previous study

8.2.4.1. Visibility axis

This allows creating a tracker polyline from the origin point to the destination point, that goes along the edge of the banned areas with the shortest possible length of the polyline, and defines, therefore, a tracker axis for the basic axis.

We can create the visibility axis in two ways:

- **Obtain the automatic visibility axis**

With this option, TADIL will calculate automatically the optimum visibility axis for our project.

- **Select the visibility axis**

For this option, we need to have previously drawn a polyline in AutoCAD Civil 3D. The origin point and the destination point previously determined must be the same than the start and end of the polyline. Therefore, if we want to select a visibility axis from a polyline created by the user, we should mark the exact origin and destination point on the cartography so that we can draw the polyline afterwards.

For our example, we have selected a visibility axis previously created because, since it is a previous study, we have not enough data as to obtain great differences between alternatives of TADIL. The visibility axis was created close to several intermediate towns between Villa Ana and Pueblo Viejo.

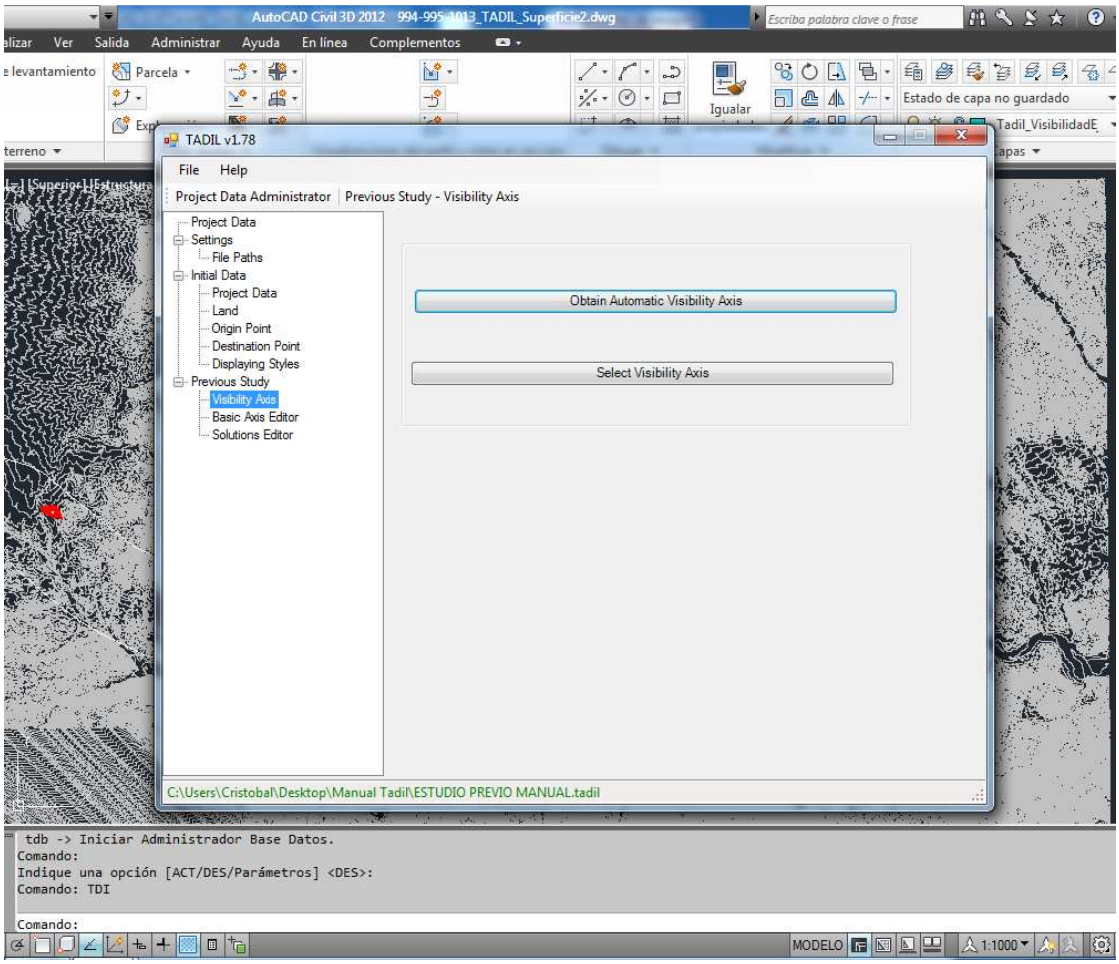


Image 11. Visibility axis.

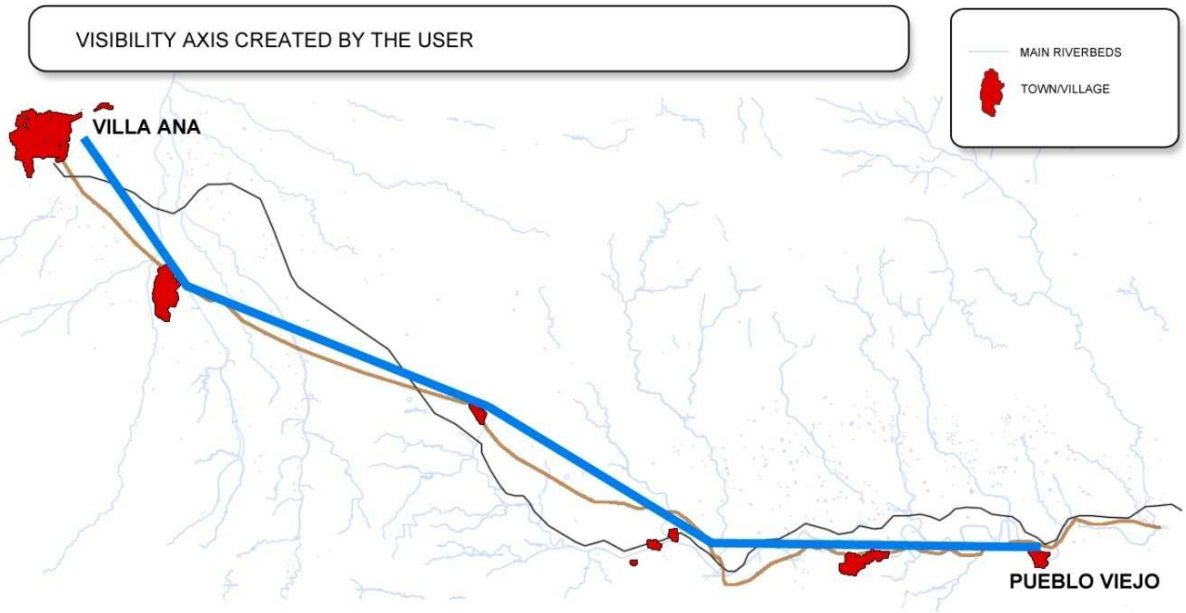


Image 12. Visibility axis created by the user.

8.2.4.2. Basic axis editor

The basic axis is a polyline which constitutes the skeleton of our design and has a geometry able to be turned into a conventional axis of design.

- **Road**

In this menu, the fist thing to do is to select a road. We can select it by pushing the button and choosing the road in the sub-menu. For our design, we choose a road from group 1 with a speed of 120 km/h. Once we have selected the road, we automatically define the geometrical determining factors, according to the regulation previously loaded.

As for the design variables, we have to choose, according to our preferences, between rectilinear or curved alignments. The main differences between both studies are as follows:

- if we choose rectilinear alignments, we will look for inserting straight sections as long as possible according to the regulations and linked by sequences of symmetrical clothoid-curve-clothoid. When there are orientation changes, we will insert straight sections between the clothoids.
- if we choose curved S-alignments, we will insert S-clothoids with no straight intermediate sections when there are orientation changes. The curves will involve a greater development (the percentage of design in curve and clothoid is usually greater).

We can allow isolated speed reductions. These will make more versatile the search for itineraries with complex orography, where we should reduce the speed at some point in order to make the calculation of alternatives easier.

The planners are also free to choose between the minimum and desirable Kv for their design.

Once we know the available variables for this menu, in our example, we select straight sections, with not isolated speed reductions and minimum Kv.

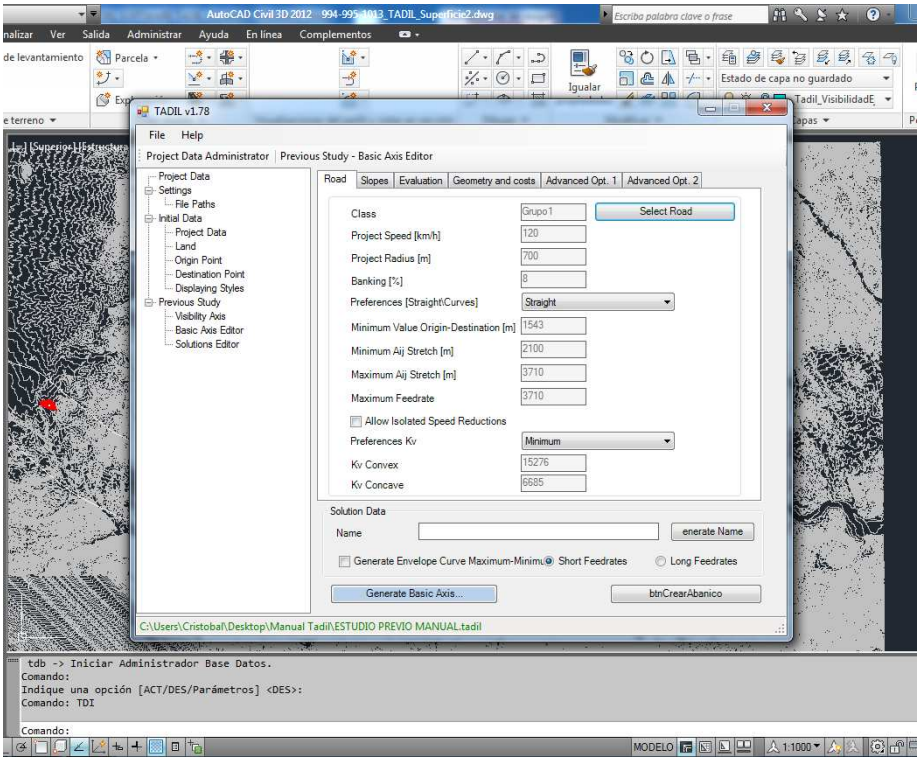


Image 13. Selecting the road.

- **Slopes**

In the second tab "Slopes", we can specify the maximum and minimum slope both for the design in general and for the structures and tunnels to be implemented. TADIL comes by default with some design values. For our example, we take these values.

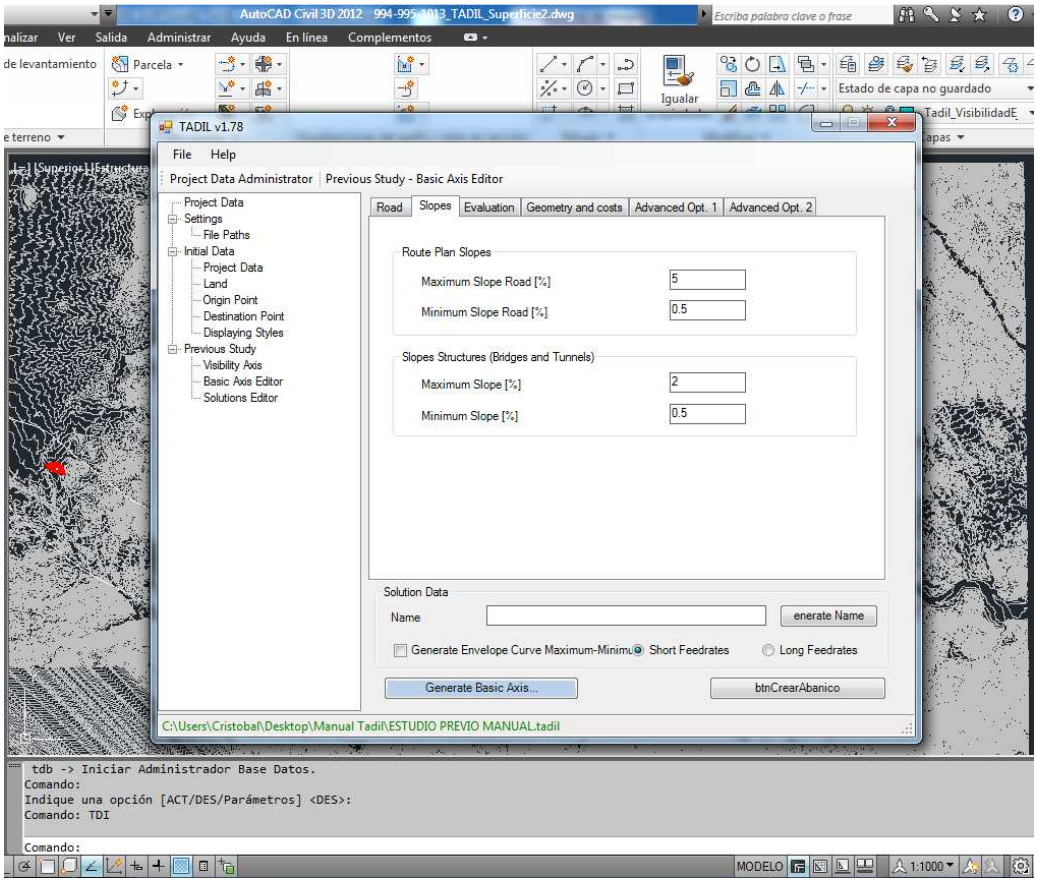


Image 14. Slopes defined by the user

- **Evaluation**

In this section we specify our preferences of design, which will depend on the weighting values given to each essential variable: distance, orography and total cost. The addition of weighting percentages will be always 100%.

If we considered only the global cost as 100%, we would surely obtain a road of less volume of excavation. However, the road would be less direct than introducing an evaluation percentage regarding its proximity. In this case, the arrival to destination would not be the target, so the calculation would not be successful: TADIL would go into an endless loop, selecting always the cheapest itineraries.

If we considered only the proximity to the destination point as 100%, we would surely obtain a very direct design but more expensive to build. If we want to guarantee a successful calculation with TADIL, we should consider the percentages of the distance variable to be higher than 50%. Nevertheless, for a very complex orography, we can make iterations by reducing the percentage of distance evaluation and raising the orography and the cost of implementation until we get a solution.

Finally, introducing the orography variable allows more flat designs. If we combine this variable with banned areas due to great slope, we will obtain more "friendly" implementation areas, which will lead to an easier construction. Anyway, this variable should not be weighed up more than 30% and values between 10% and 20% are suitable for obtaining quality design.

Modifying the percentages of the aforementioned variables, according to several hypothesis, we would obtain multiple alternatives too, improving the level and depth of the study.

TADIL offers some guiding values for these variables, which we use for our example.

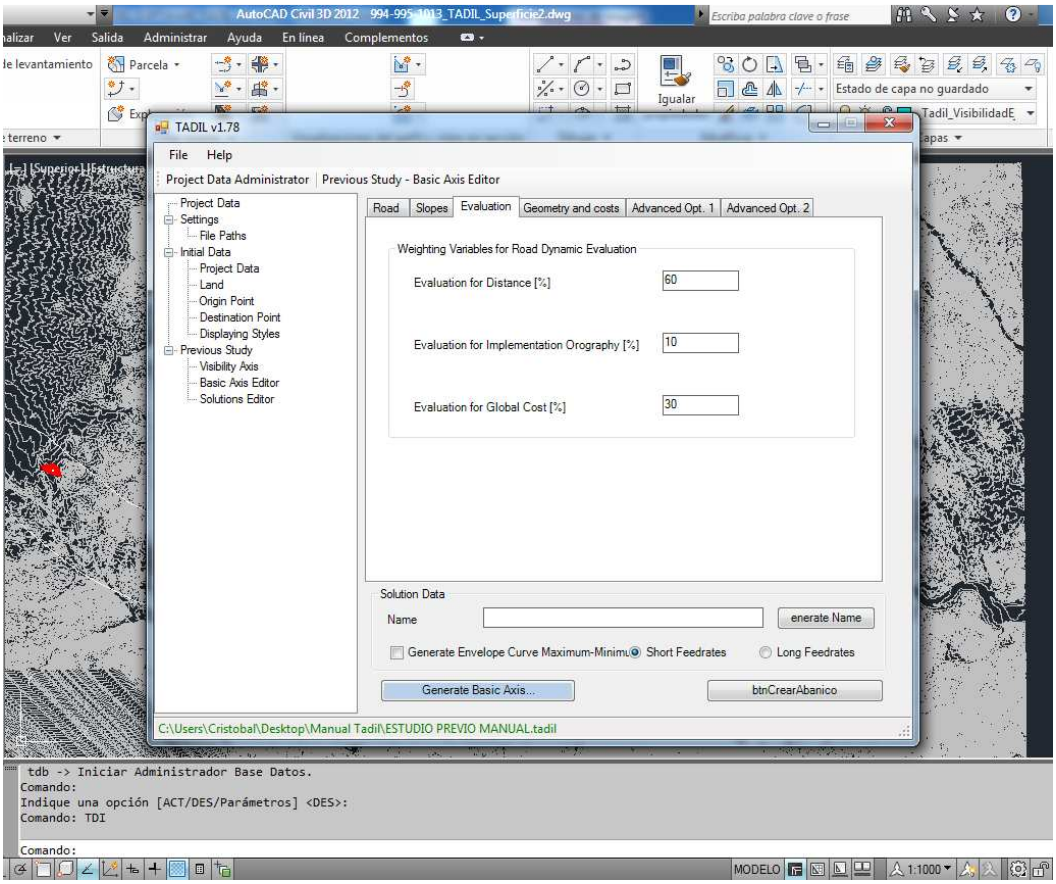


Image 15. Evaluation.

- **Geometries and costs**

This sections aims to specify data regarding road geometry and costs.

So, we must indicate the maximum height of cut section and embankment. The measures must be made over the route plan, the cut section slopes and embankment, and the platform width.

The most interesting thing in this section is the possibility of designing a road with/out structures and/or tunnels. By selecting the option "Generate bridges and viaducts", we can specify the maximum pier height for our project.

The cost of implementation is the guiding cost of our building work when executing the platform.

The cost of cut section includes the price of material from cut section (material to be used in work) and the price of material to landfill (material not to be used in works and to send to landfill). An average value between both costs is given.

We also establish the embankment cost by giving an average value between both the price of material from cut section (material from the work to be used in the same work) and materials from borrow pits (material not existing in the workplace due to its features and bought from near quarries).

The cost of bridges and viaducts is given by m^2 finished structure (deck). However, the tunnel cost is expressed in length of finished tunnel, in this case, in kilometres.

For our example, we leave the default data allowing the insertion of structures.

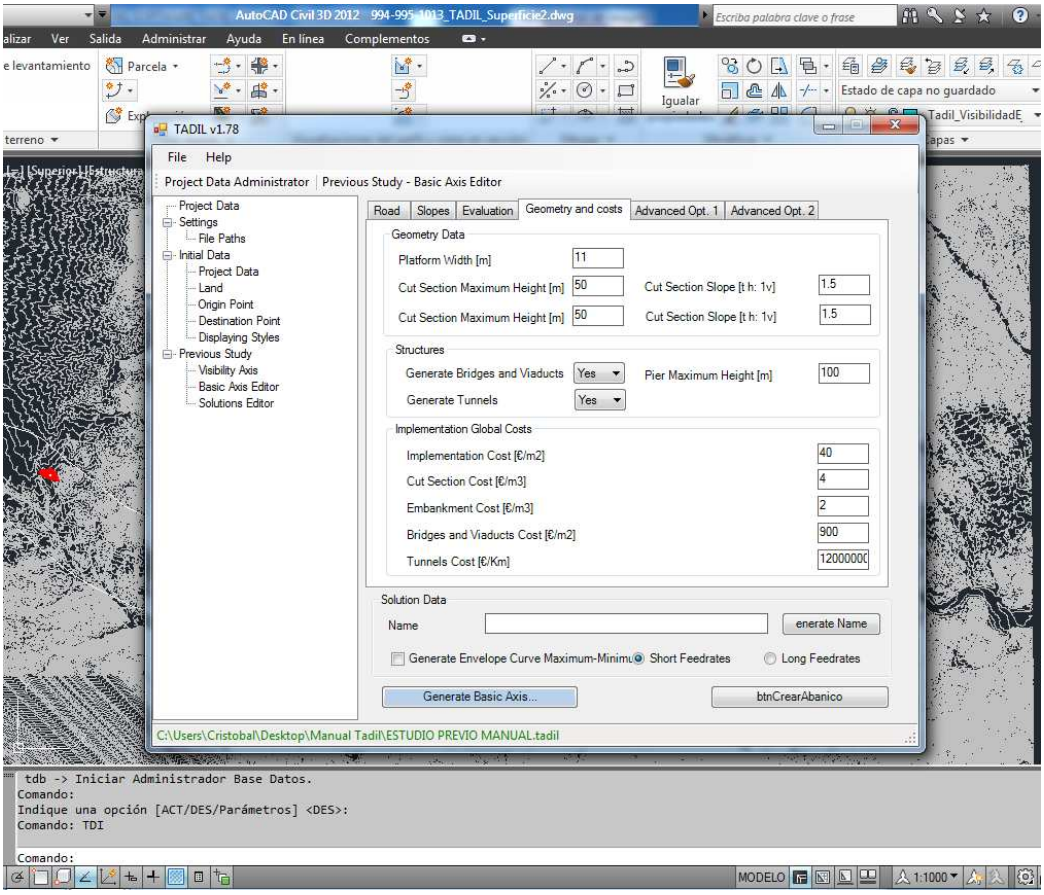


Image 16. Data from "Geometry and Costs"

- **Advanced options 1**

The dynamic evaluation of roads has to be with the data that the algorithm uses. These data are used for searching road itineraries. We recommend not modifying the default data.

Not using stretches with more length increases than indicated by the user is an option that allows segments of road to have harmonious lengths, so limiting specially the length increase of a straight alignment with regard to the preceding one.

Considering constant Aij requires every feedrate of the basic axis to have the same length. For calculating our informative study, we do not tick the box of constant Aij.

Tolerance towards the target point, we recommend using a percentage higher than 50%, since this percentage allows less winding and more direct roads. With this option we can bring forward the target points of the visibility axis.

The total angle is the projection angle of design options in the local search algorithm.

Degrees discretization has to be with the division of pre-polylines in the algorithm of local search.

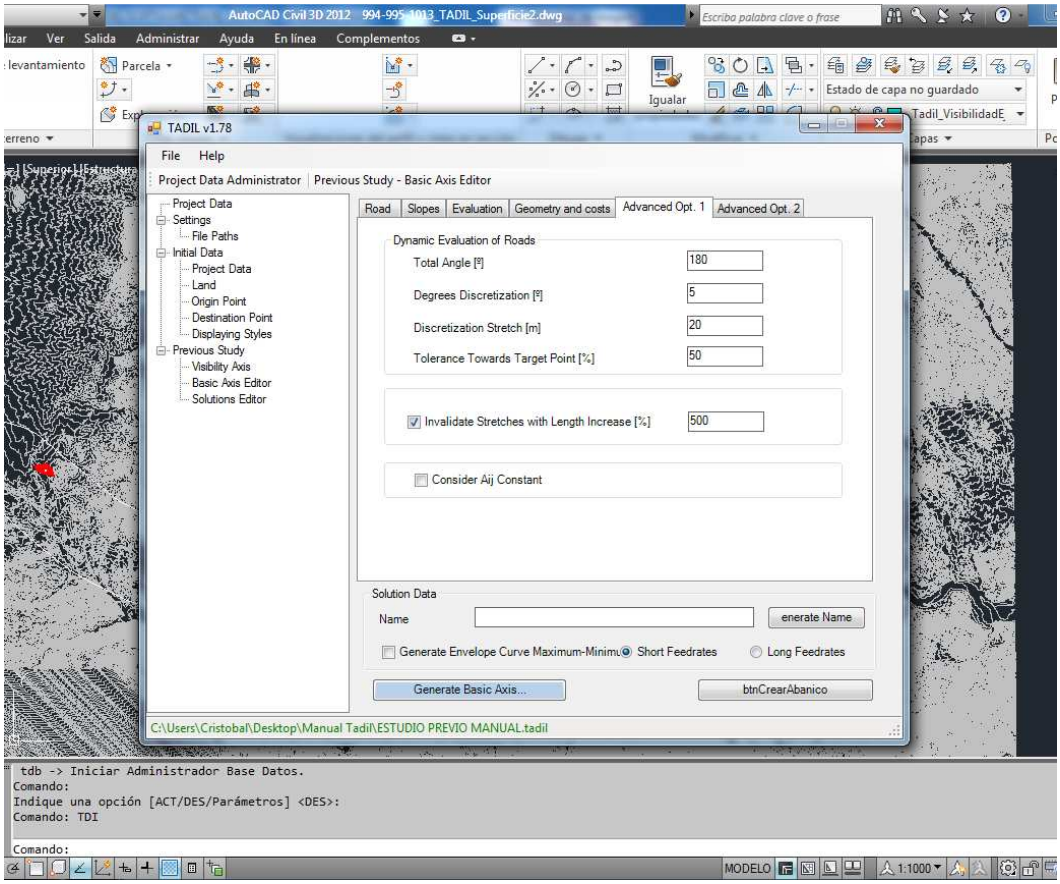


Image 17. Data from "Advanced options 1"

- **Advanced options 2**

We define coefficients of reduction. By modifying these coefficients we can obtain a wide and assorted range of alternatives. To obtain safer calculations, we must reduce the design slopes and structures as well as the maximum heights of cut sections, embankments and viaduct pier.

It must be highlighted that if we measure height of cut sections and embankments over the road axis, we may have a higher slope. So, just with the coefficient of reduction we would largely overcome this "excessive height".

We leave default values and continue with the calculation of the previous study.

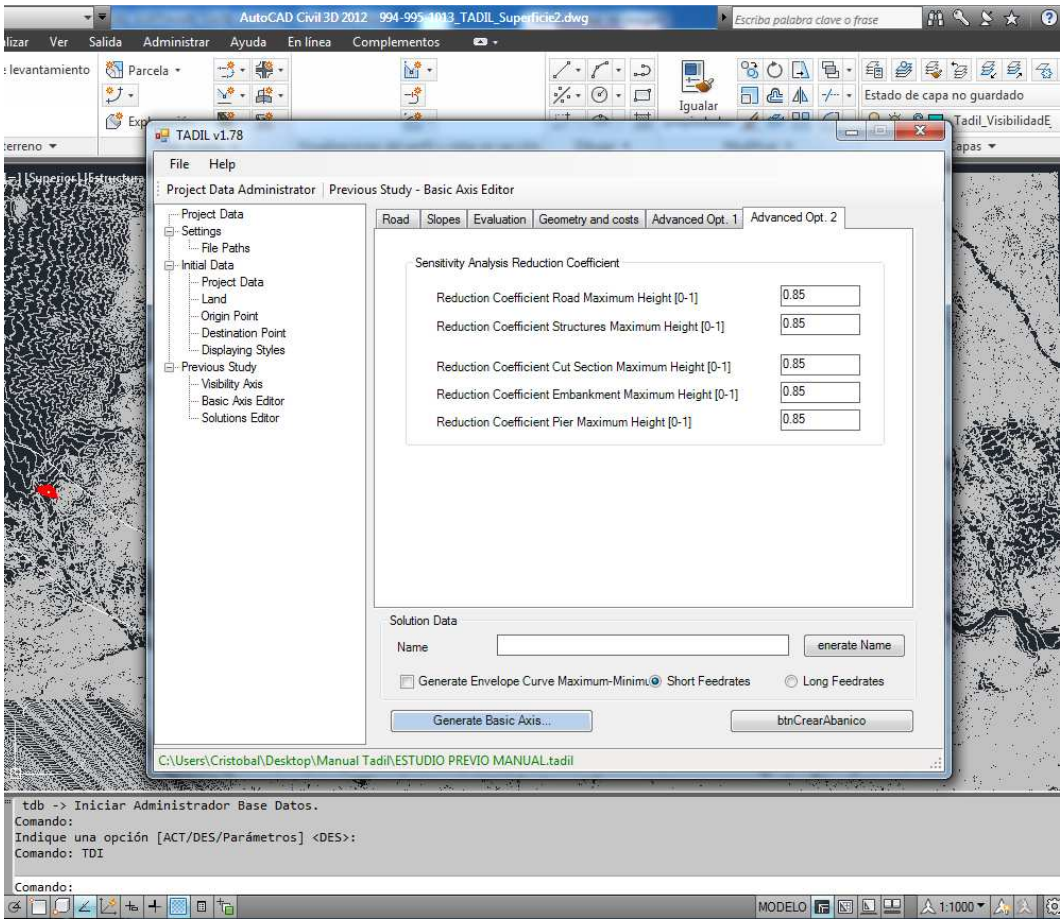


Image 18. Data from "Advanced options 2"

- **Solution data**

The first value we can define for this solution is its name. The name can be generated personally by the user or we can make TADIL generate one by clicking "Generate name". TADIL generated a name for each solution and indicated the class of road, the speed, the preference for straight or curves design, the preference for Kv, the evaluation given to distance, orography and infrastructure cost as well as the preference for short or long feedrates. For our example, we make TADIL generate the name.

By using short feedrates we obtain alignments better adaptable to land whose length is according to the considered regulation.

Instead, by using long feedrates we obtain simpler alignments with the maximum length established by regulation.

For both feedrates, once the alternative is calculated, we can obtain sub-variables (minimum and maximum envelope curves).

In both sub-variables we obtain the points of envelope curves from the original alternative's basic axis. The sub-variable of the maximum envelope curve is obtained by directing the itineraries towards these maximum points. Likewise, the minimum envelope curve is obtained by directing them towards the minimum points.

By using these procedures (short and long feedrates) and by obtaining the envelope curves (maximum and minimum), we can obtain three sub-variables per original alternative.

For our previous study, we choose short feedrates and we make TADIL generate maximum and minimum envelope curves.

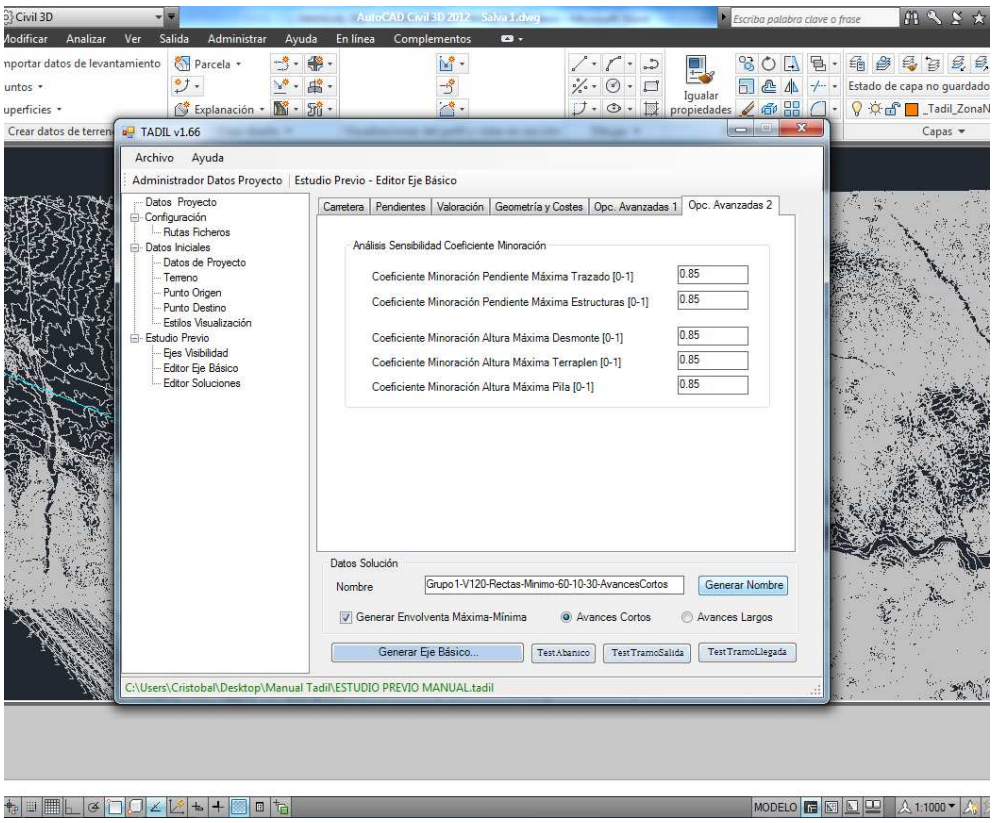


Image 19. Data from "Solution Data"

Finally, after entering these values, we can generate the basic axis by clicking on the button of the same name. As we have made TADIL generate both maximum and minimum envelope curves, we obtain three solutions.

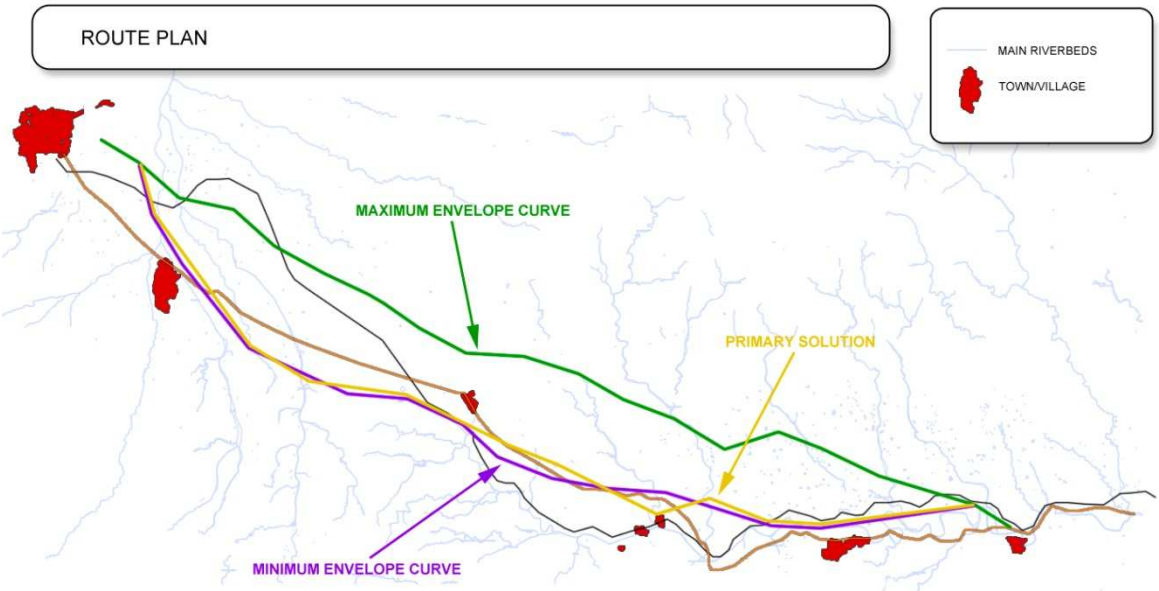


Image 20. Route plan.

8.2.4.3. Solutions editor

In this tab we can see the solutions that TADIL has generated for our example.

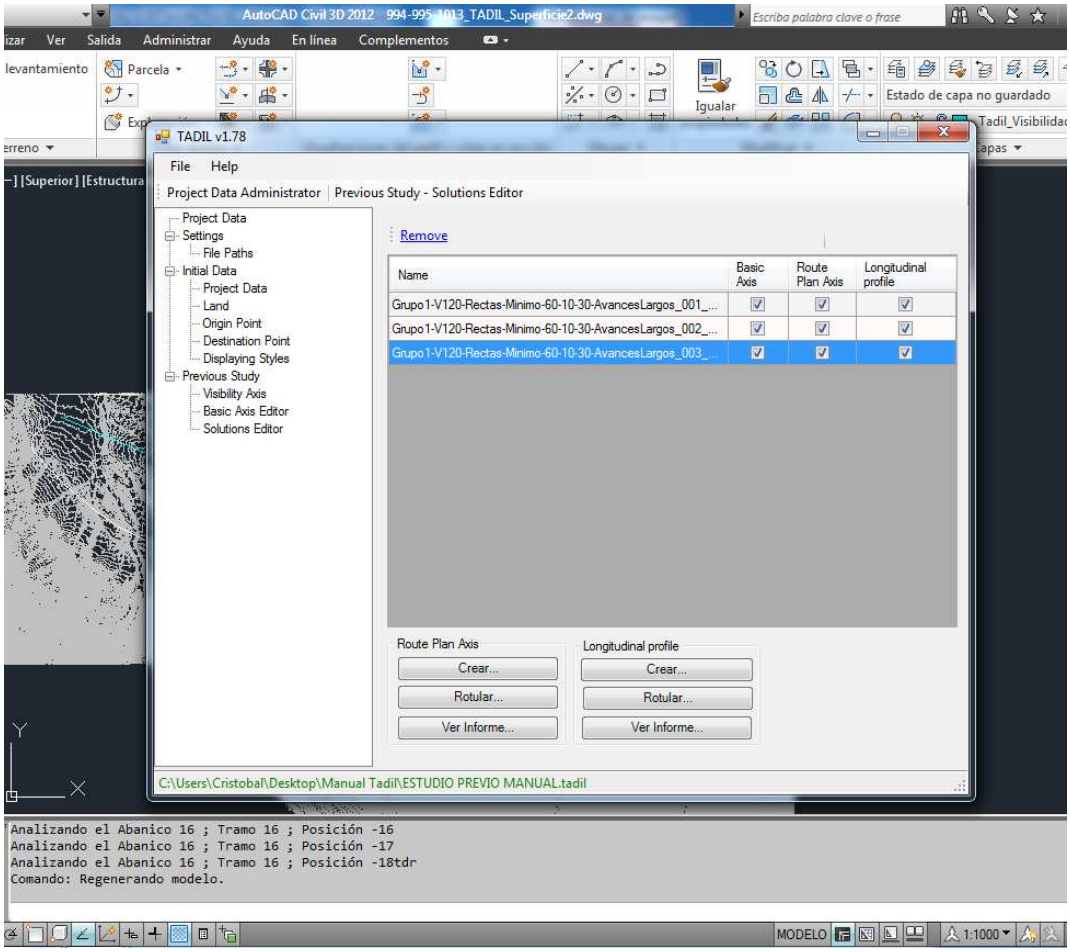


Image 21. "Solutions Editor"

This solution matches the first solution TADIL had calculated previously. The second solution is the maximum envelope curve and the third one is the minimum envelope curve.

- **Route plan axis**

The route plan axis is a conventional axis including straight sections, curves and track transition curves - clothoids.

If we click on one of the solutions and we push the button "Route plan axis", TADIL draws the route axis of the aforesaid solution. Therefore, for our example, we select the route plan axis of the first solution.

Once the route plan axis is drawn, we see how the straight alignments are in red, the track transition curves (clothoids) are in green and the circular curves are in yellow.

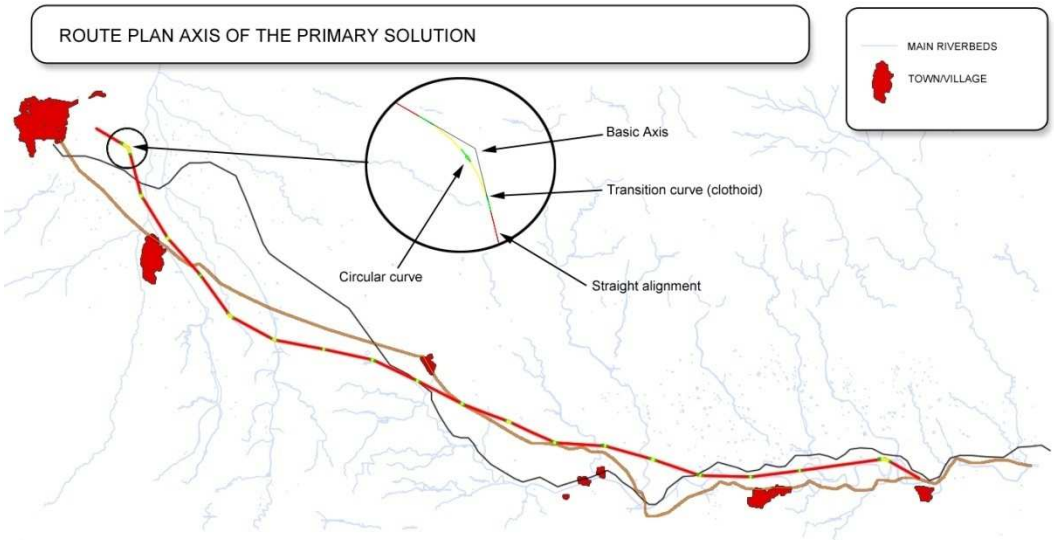


Image 22. Route plan axis of the primary solution

- **Longitudinal profile**

The longitudinal profile supposes defining the grade line of the plan axis obtained.

We create the longitudinal profile as we have created the the route plan axis. For our example, once selected the first solution, we click "Longitudinal Profile". Then, TADIL ask us to insert a point. We click on any point of the .dwg and we draw the longitudinal profile (for more information about inserting the longitudinal profile, we recommend having a look to the section "9.3.4.4. Solutions Editor", in its section "Longitudinal profile" from this Guide).

In this solution we can see two lines. The grade line is in green and the land profile is in yellow.

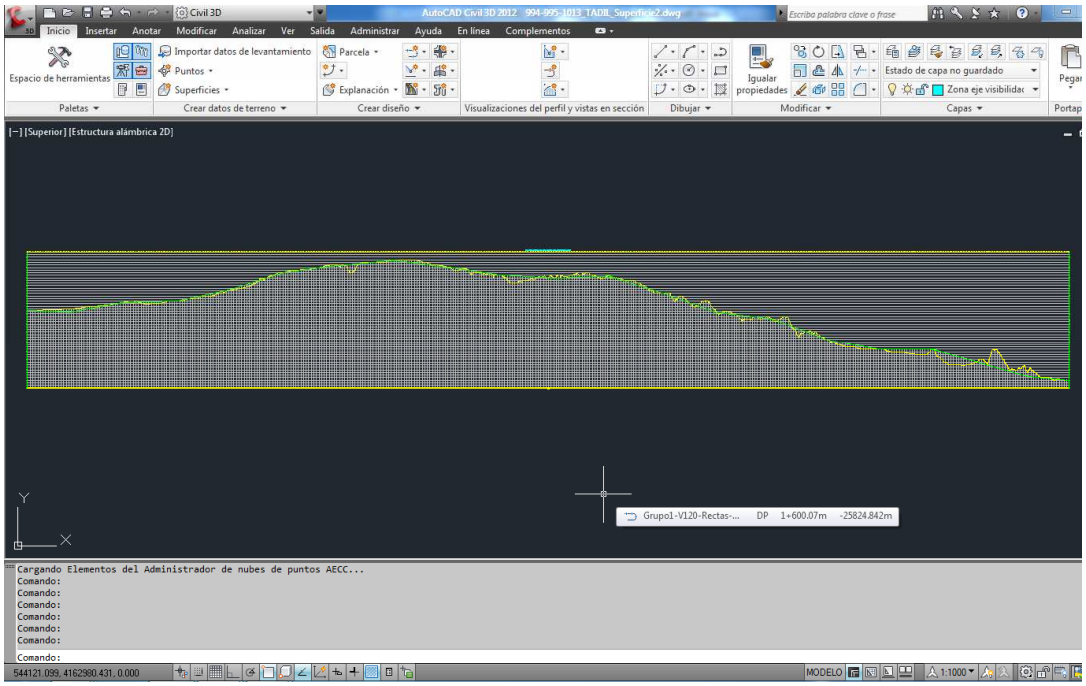


Image 23. Longitudinal profile of the first solution

Once we know how TADIL works, we obtain the following three solutions of our example.

- Route plan

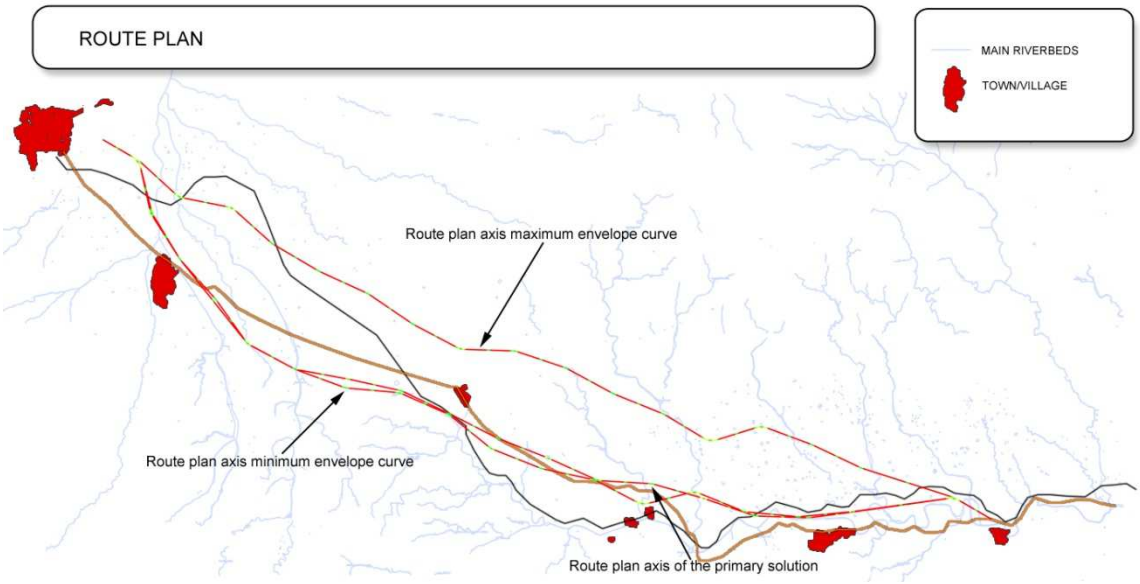


Image 24. Route axis plan of the three solutions

- Longitudinal profile of the maximum envelope curve

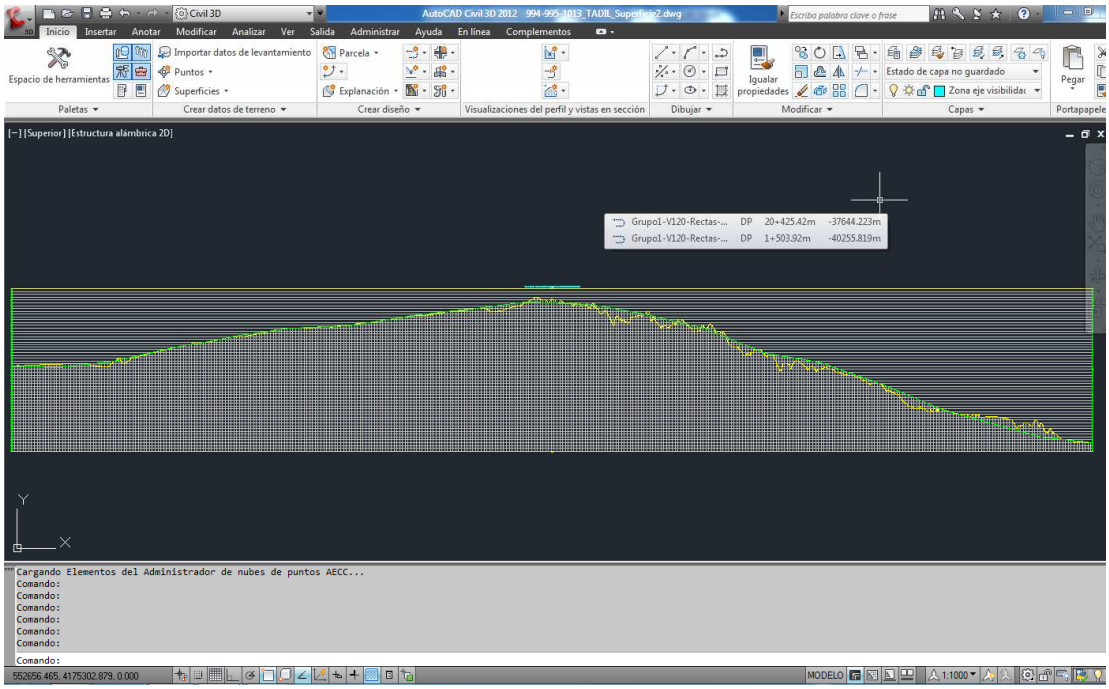


Image 25. Longitudinal profile of the maximum envelope curve.

- Longitudinal profile of the minimum envelope curve

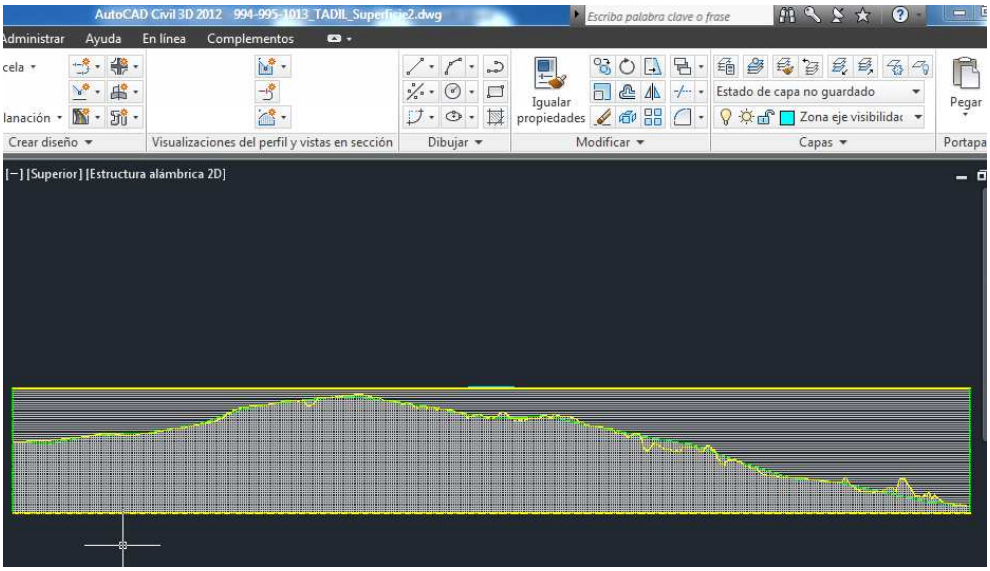


Image 26. Longitudinal profile of the minimum envelope curve.

8.3. Example with automatic visibility axis and long feedrates

If we want to make an even richer previous study we must add three more alternatives than in the previous section, a first solution plus its two minimum and maximum envelope curves.

These three alternatives start from the same origin and destination points as defined in the previous section. Moreover, the previous conditions remain.

Therefore, the difference between these three variables with regard to those of the previous example has to be mainly with two aspects:

- **Automatic visibility axis**

In this case, we make TADIL calculate the visibility axis automatically.

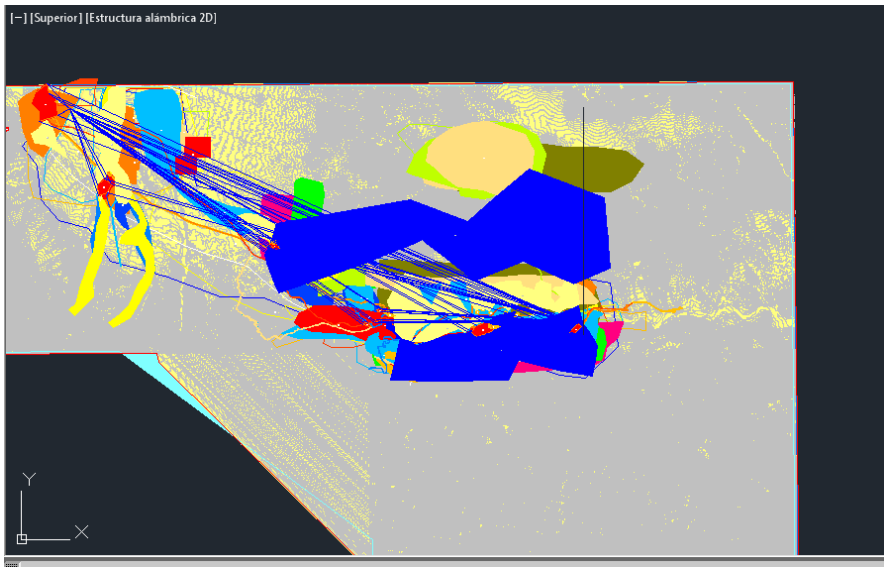


Image 27. Calculation made by TADIL for finding the visibility axis.

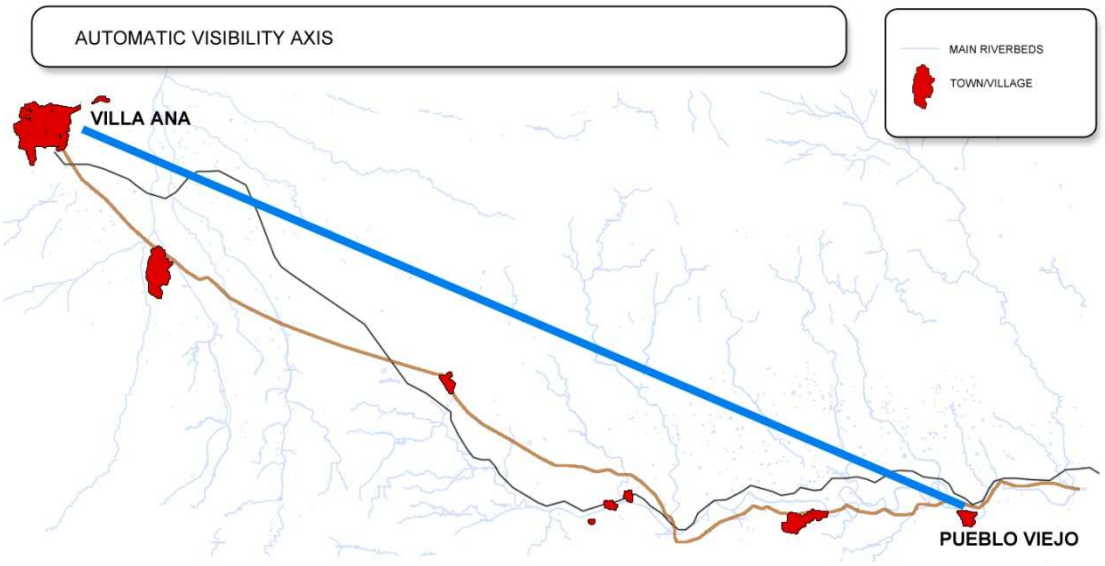


Image 28. Automatic visibility axis.

- **Long feedrates**

Unlike the previous example, now we choose long feedrates for the design. We obtain simpler alignments with the maximum length established by regulation. Once we have selected the box "Long feedrates", we click on "Generate name" and we generate the basic axis.

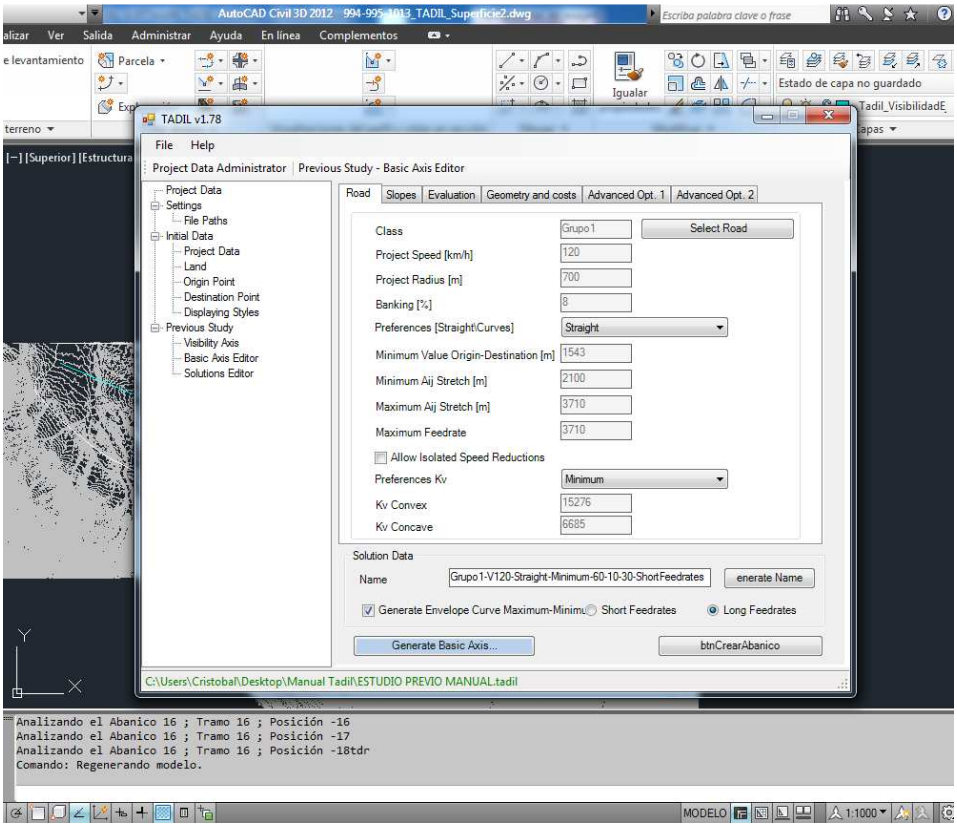


Image 29. Example with long feedrates.

8.3.1. Basic axis

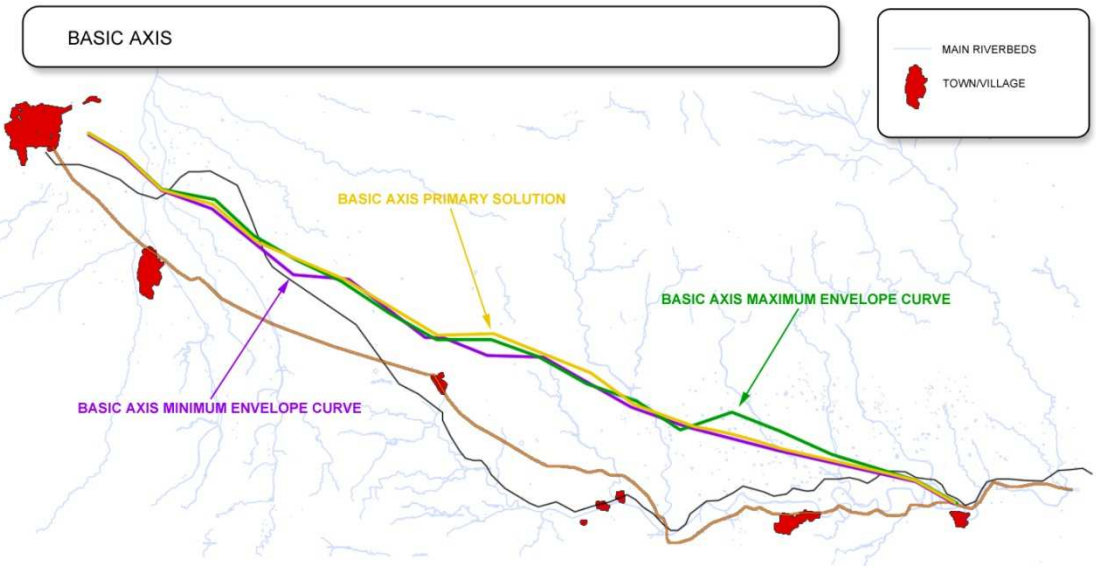


Image 30. Basic axis from the example with long federates.

8.3.2. Route plan

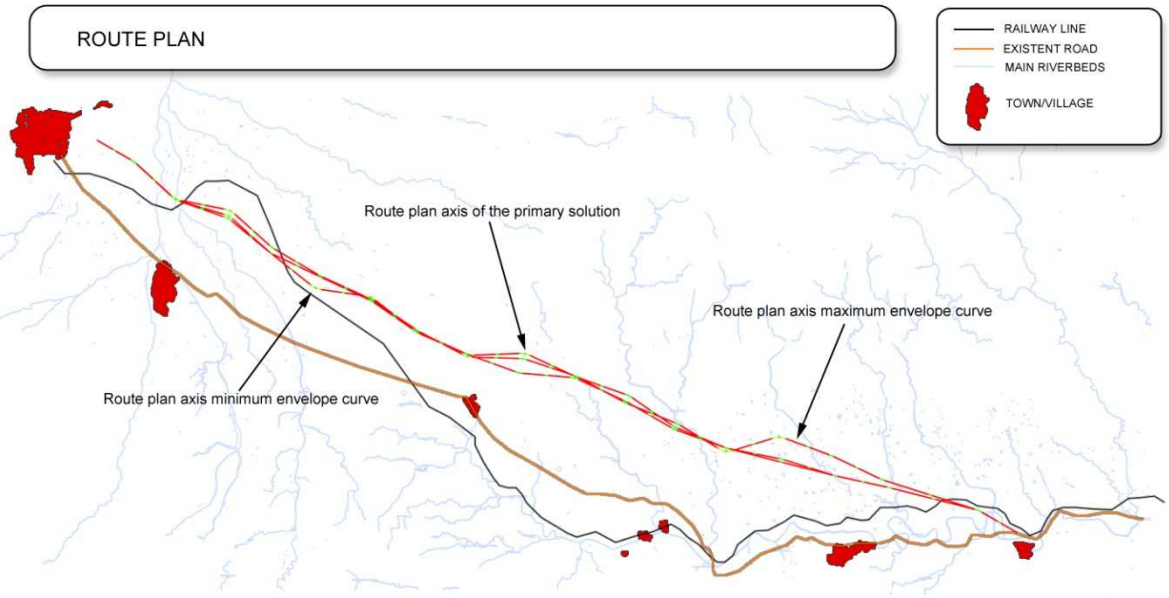


Image 31. Route plan axis from the example with long federates.

8.3.3. Longitudinal profiles

- **Longitudinal profile of the first solution**

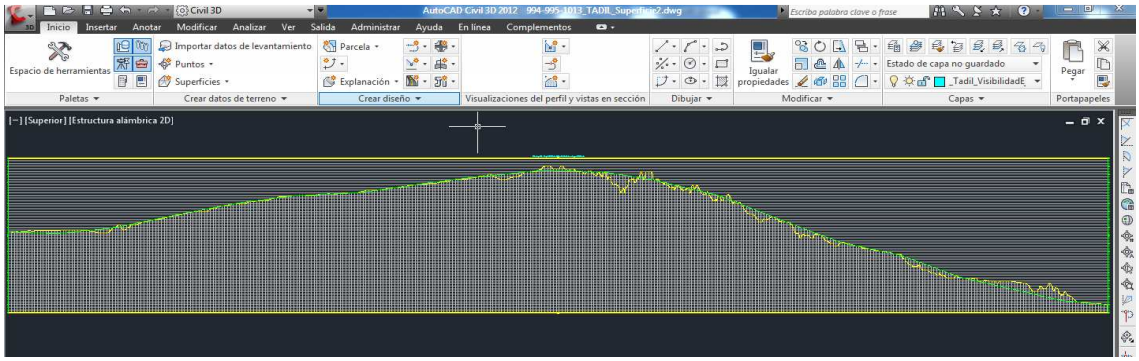


Image 32. Longitudinal profile of the first solution with long federates

- **Longitudinal profile of the maximum envelope curve**

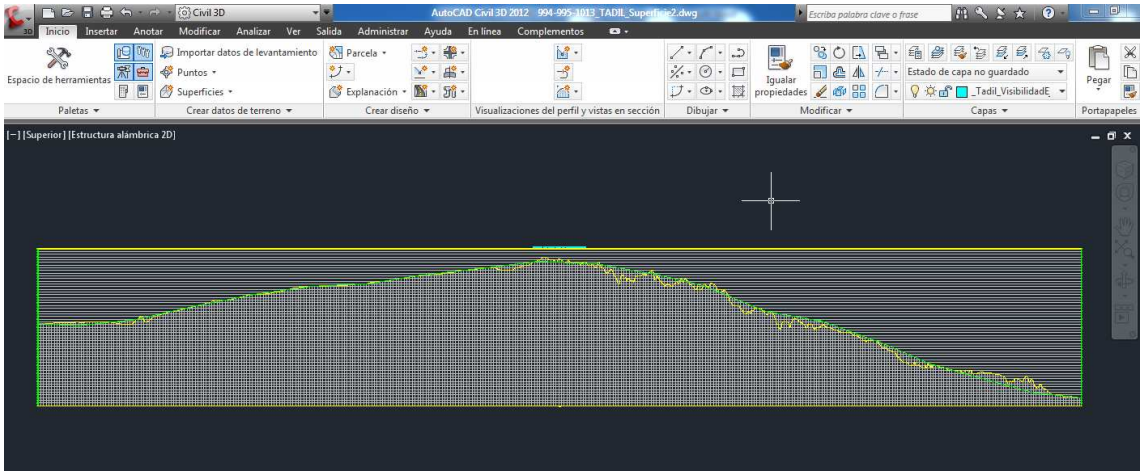


Image 33. Longitudinal profile of the maximum envelope curve with long federates

- **Longitudinal profile of the mínimum**

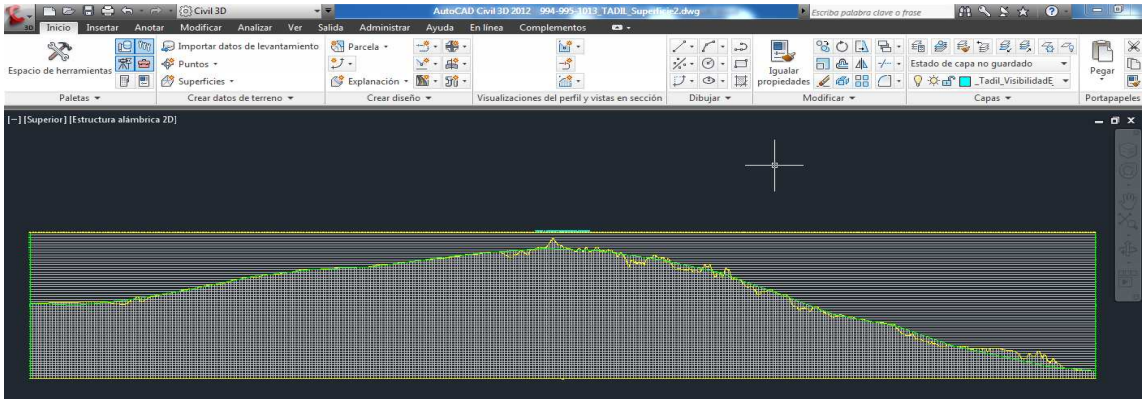


Image 34. Longitudinal profile of the minimum envelope curve with long federates

9. DEVELOPMENT OF AN INFORMATIVE STUDY

An informative study develops a complete study including all the land variables.

To better understand the informative study, we will solve the same case as in the previous study.

9.1. LOAD THE SOFTWARE

TADIL is a software that works inside the software AutoCAD Civil 3D. Therefore, first of all, we must open the cartography in (.dwg) format.

After that, we load TADIL. For doing that, we need to write "netload" in the Command Bar. Then, when the dialogue box "Select .NET Assembly" will open, we select the folder where TADIL is in our system, we select the folder "app" and the "acTadill.dll" opens.

9.2. LOAD DATA BASE (TDB)

To load the TDB menu, we just need to write "TDB" in the Command Bar of AutoCAD Civil 3D.

We must highlight that the same TDB serves to any work and cartography. So, we recommend entering many data and alternatives in the TDB and charging the required data specifically for each project. The TDB is also feeding when we make and edit different informative studies.

The TDB is divided into four big blocks: Construction units and prices, Geographic Information System, Macro prices and Sections.

9.2.1. CONSTRUCTION UNITS AND PRICES

In this first section we define the construction units we have and their prices. Entering data is almost the same in every construction unit. We specify how to enter these data next:

9.2.1.1. Units

- **Monetary unit**

We can define the monetary unit we want to use for measuring our informative study.

9.2.1.2. Cut sections

- **General**

The first box is the measurement units. We define the monetary unit before entering data into the TDB and this monetary unit remains like that the whole project. The measurement units are constant in each section and we can see which units are used for measuring each construction unit.

For creating a unit of cut section, click on "New", then we see the menu "Detail". We finish the construction unit by filling the gap and clicking "Save". Once created, construction units can be edited and removed by selecting "Edit" and "Remove".

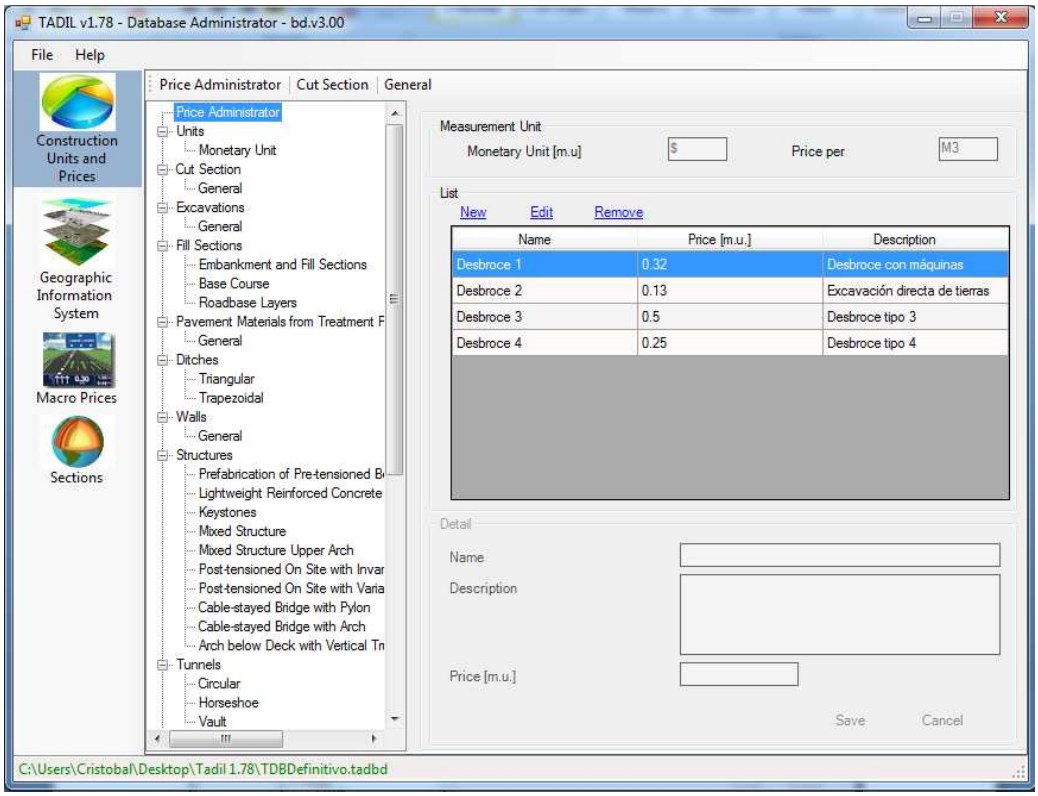


Image 35. Entering cut section data.

9.2.1.3. Excavations

- **General**

Entering data here is very similar to the aforementioned way. But, at this point, we enter two different variables:

- Price of the embankment material: The price we must pay for excavating and using the material from the workplace.
- Price of landfill: The price we must pay for excavating and driving the material from the workplace to a landfill because it is not suitable for the workplace or because we have surplus of this material.

We must take into account that in this section we must enter data according to the type of material from the geotechnical zone so that we are consistent with the area study.

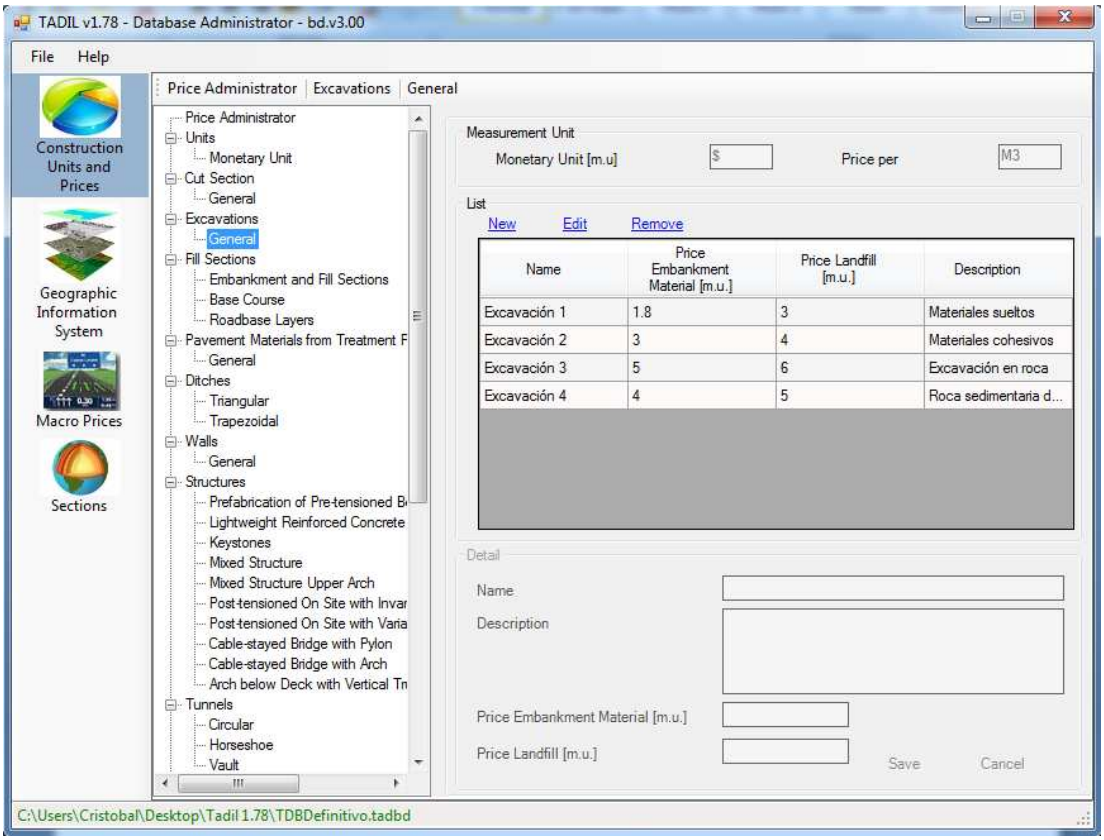


Image 36. Entering excavation data

9.2.1.4. Fill sections

We follow the same steps as in the section "Excavation" but with two slight nuances:

- Price of the embankment material: The price we must pay for using material from the workplace and making fill section with it.
- Price of the borrowed material: The price we must pay for buying material from near quarrying exploitations and driving it to the workplace.

Therefore, we can see how to enter data in "Embankments and Fill sections" and, in the same way, in "Basecourse Layers" and "Roadbase Layers".

Just like in the previous section, the filling material has to be consistent with the excavation material from the workplace itself as well as with the geotechnical study carried out.

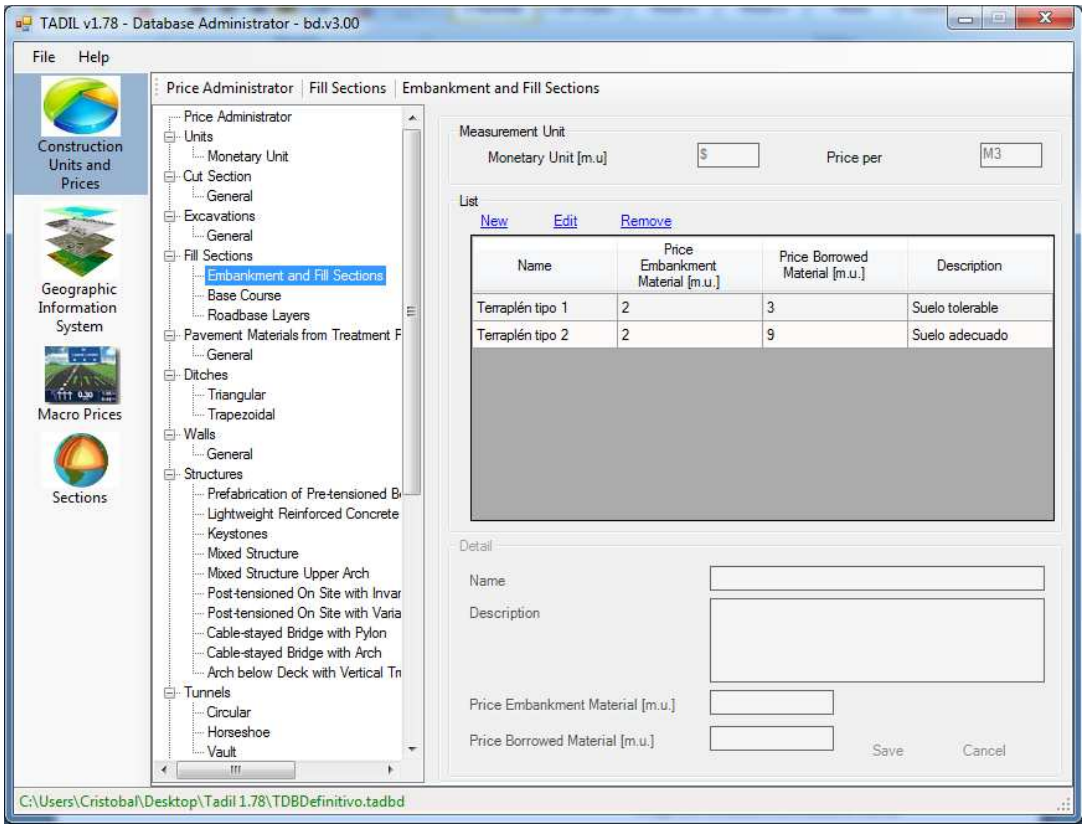


Image 37. Entering fill section data

9.2.1.5. Pavement materials from treatment plants

- **General**

We make it in the same way.

We use the pavement materials from treatment plants to make the roadbase layer. To choose one material or another for making the roadbase layer may vary according to the conditions and needs of the future road. The most common materials are the asphalt mixes and concrete.

The price we confer to the units of pavement materials from treatment plants can significantly vary depending on the location of the treatment plant as it can be fixed (around the workplace) or inside the workplace itself.

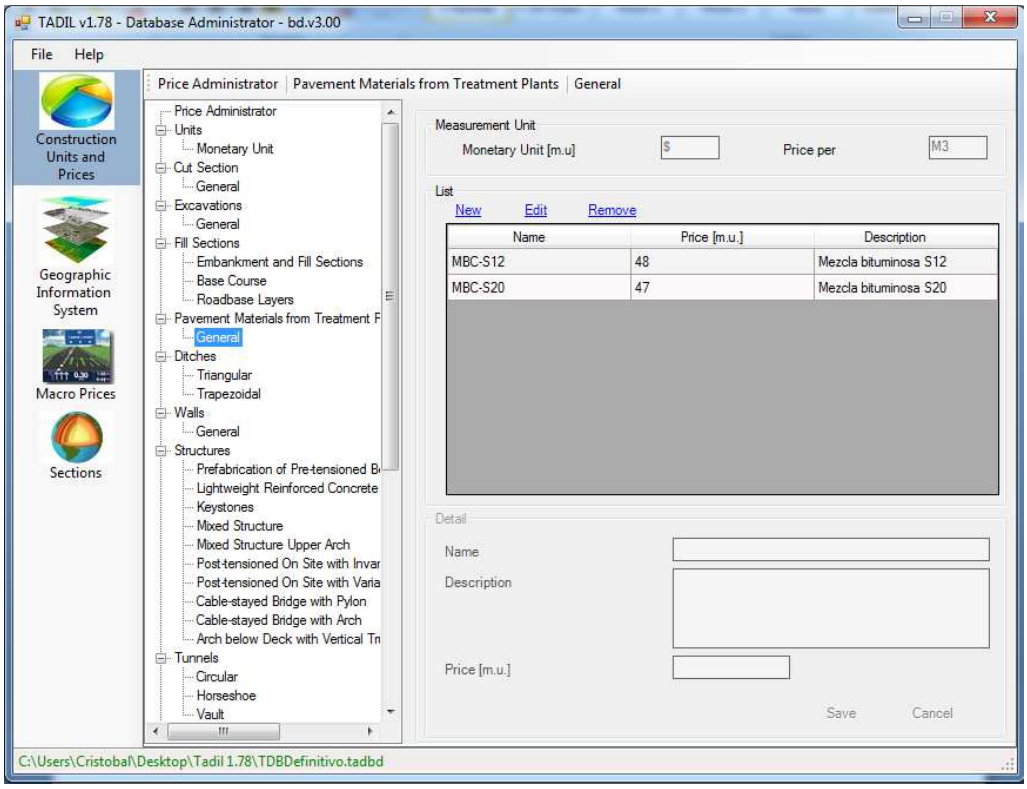


Image 38. Entering data of materials from treatment plants.

9.2.1.6. Ditches

As an example, we enter triangular ditches.

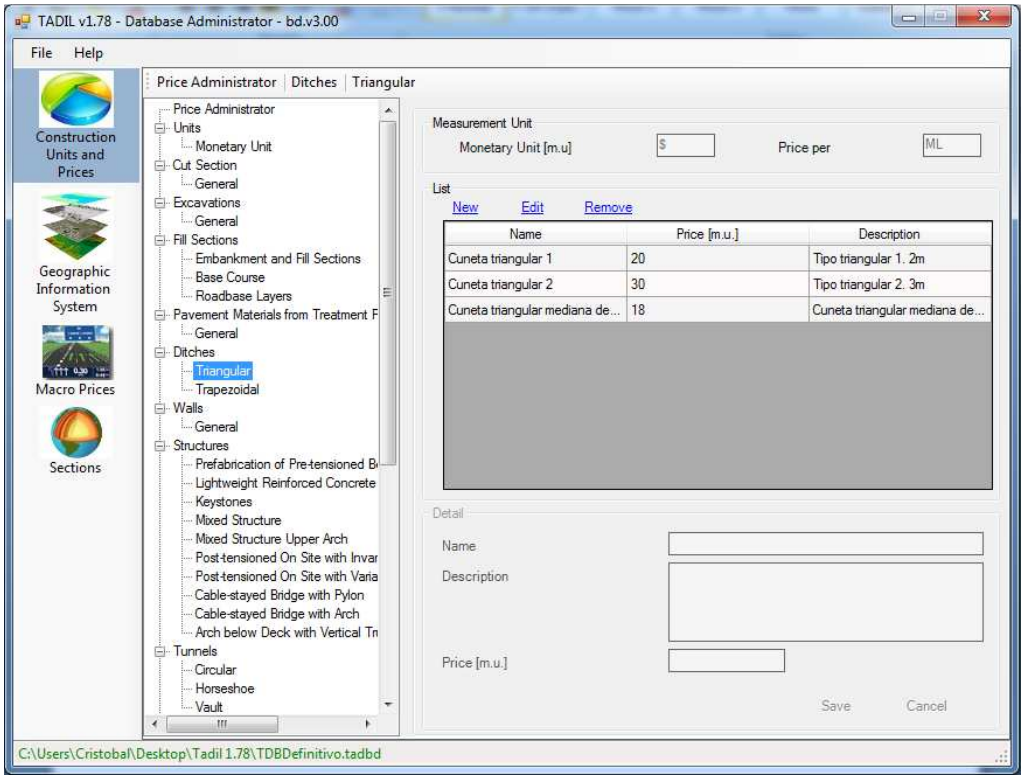


Image 39. Entering ditch data.

We make the same for the remaining construction units in the menu.

9.2.1.7. Walls

When we calculate the wall cost, we must take into account that this costs is given by cubic metre and this price also includes the whole wall construction process. For example, for a reinforced concrete wall, we would include concrete, steel, formwork, the staff… and for a breakwater wall we would include the material itself, the machinery, etc.

9.2.1.8. Structures

It is important to highlight that in this section, the price we enter is given by square metre of finished deck. For obtaining the deck price we have to take into account all the conditions to the construction. For example, the pier height and the building way so that the higher the prefabricated deck's pier is, the more expensive. Another important aspect we pay attention is the lightened area between piers since the bigger lightened area, the more deck's edge we will need.

9.2.1.9. Tunnels

In contrast, the tunnels price is given by kilometre of finished tunnel and we must to consider all the process costs such as special treatments, tunnel entrance, bolting, forepole umbrellas in tunnels, etc.

9.2.2. GEOGRAPHIC INFORMATION SYSTEM (GIS)

The GIS is an information system able to include, store, edit, analyse, share and show the information geographically referenced. That means it is a tool we can use for holding on interactive consults, analysing spatial information, edit data, maps and show the results from all of these.

The GIS works as a database with geographic information joined by an identifier which is common to the graphical objects of a digital map. Therefore, if we mark the object, we can know its attributes and, inversely, if we ask for a record in the database, we can know its location in the cartography.

9.2.2.1. Geotechnical variables

9.2.2.1.1. Earthwork

In this section, we define everything related to earthwork in the workplace, the generating process of cross sections, roadbase packets and esplanades. To see how this works in greater detail, we create a geotechnical area of earthwork. Once we have defined it, we can edit or remove clicking on the homonym buttons. By clicking on "New", we start defining our geotechnical area.

- **General data**

In "Lithological Group", we have to name that geotechnical area. We can also choose if we ban the passage or not in this area due to geotechnical risks. We can activate or deactivate this option in the box "Ban Passage" Geotechnical Risk Area". With the option select colour we just make TADIL assigns that colour to the lithological group in plan, once we have assigned the polyline (see below).

We select the cuts material, the UNS, the excavation material, the granular material, the roadbase layers material, the embankment material, the scaling embankment material and the scaling cut section material from a drop-down menu. This menu shows us the material we have previously defined in "Construction Units and Prices".

After selecting the material from the excavation, we move on to see how much material we can use in the workplace. For doing that, we begin with the upper layers, in particular, with the granular roadbase layers. We define the use percentage of the excavation material and the kind of material. Likewise, we define the basecourse layers and the embankment layers. At this point, we can understandably presume that the use percentage will raise from upper to lower layers, since it would be senseless using more materials for layers which need better materials than for layers which do not require high-quality materials. For more information, please see the Methodological Application Guide, in the section Earthwork Balance Generation.

We can also use TADIL for setting up the fill section and cut section scaling. Therefore, we must click on "Set up Scaling Fill Sections" and "Set up Scaling Cut Section". We must highlight that the maximum slope without step of the embankment refers to the maximum slope for that scaling so that the embankment is stable. If we have more slope than the defined, the embankment foundation is not stable and we have to carry out scaling with steps.

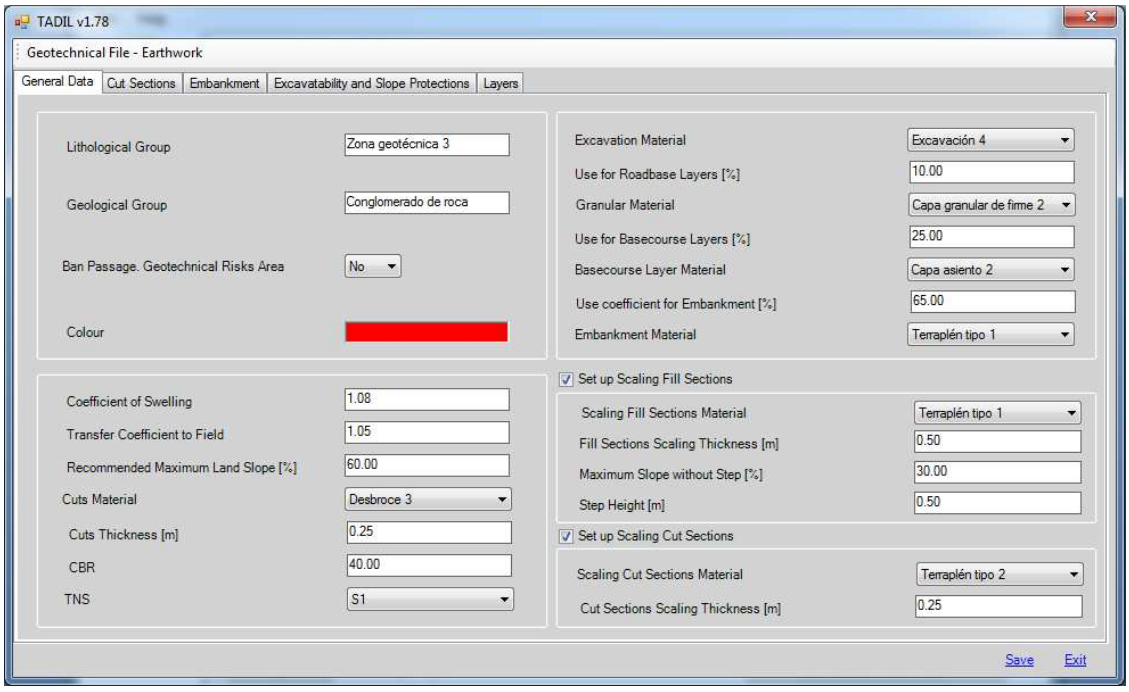


Image 40. Entering earthwork general data.

We click on "Save" and move on to the next tab.

- **Cut sections**

We have three options: Carrying out the cut section with constant slope, with wall on the side or with slope with berms. TADIL carries out the kind of cut section we select among these three according to the geotechnical area. If we want to carry out a cut section with wall on the side, the wall material must be chosen among a list offered by TADIL depending on what kind of wall we have defined previously in "Construction Units and Prices".

Once we have specified the cut section in this lithological group, we click on "Save".

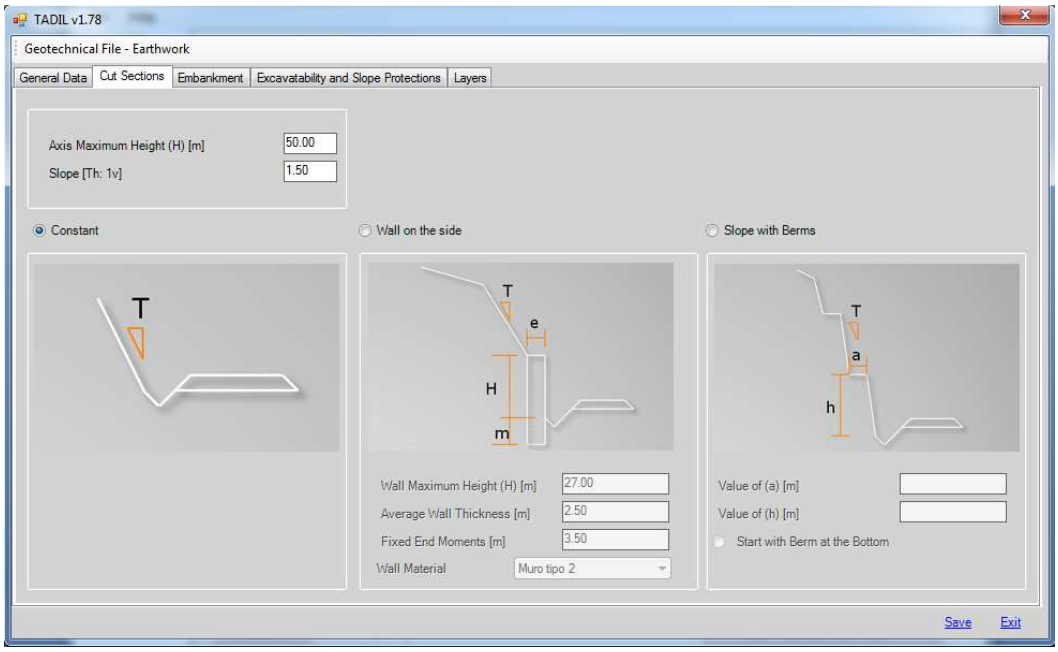


Image 41. Entering cut section scaling data.

- **Embankment**

We have also three possibilities when selecting the embankment: Embankment with constant slope, with slope over wall and with slope with berms. Likewise, by clicking on one of the three boxes, we can select the type of embankment desired according to the geotechnical area.

We can select the embankment material and the wall material from the drop-down menu offered by TADIL according to the data entered in "Construction Units and Prices".

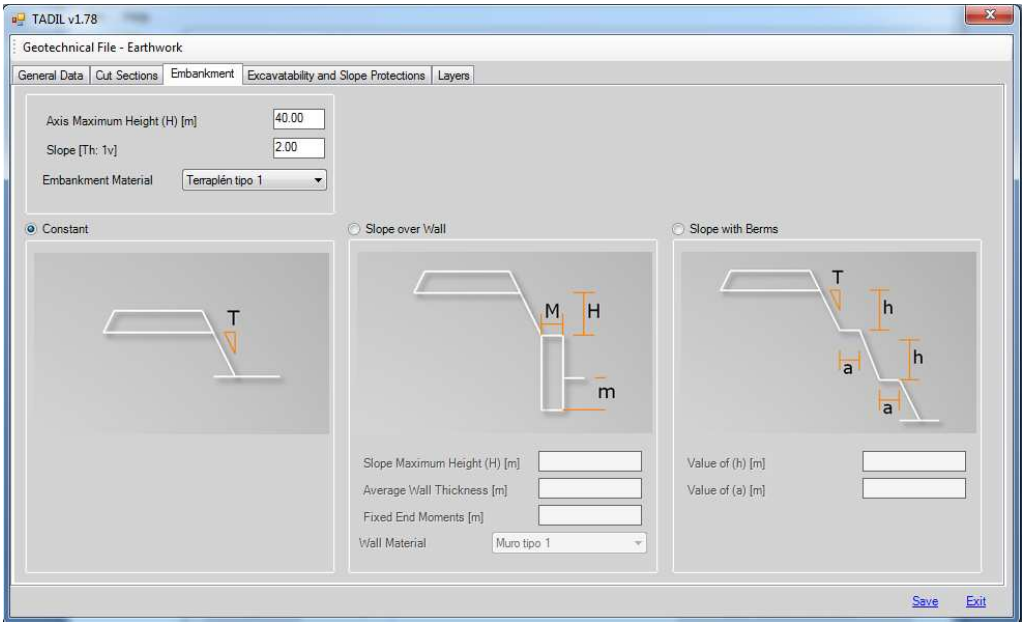


Image 42. Entering embankment data.

- **Excavatability and slope protection**

In this tab, we can assign percentages, from 0 to 100, to the different excavation methods and the slope protection depending on their adequacy to the geotechnical area. All the methods must add up to 100. The most adequate is the method, the highest must be the values. It is very important to take into account the geotechnical nature. Hence we must use mainly pneumatic hammer and/or blastings for rocky areas and depletion systems for areas of higher ground water level, and so on.

By clicking on "Save", all data are saved.

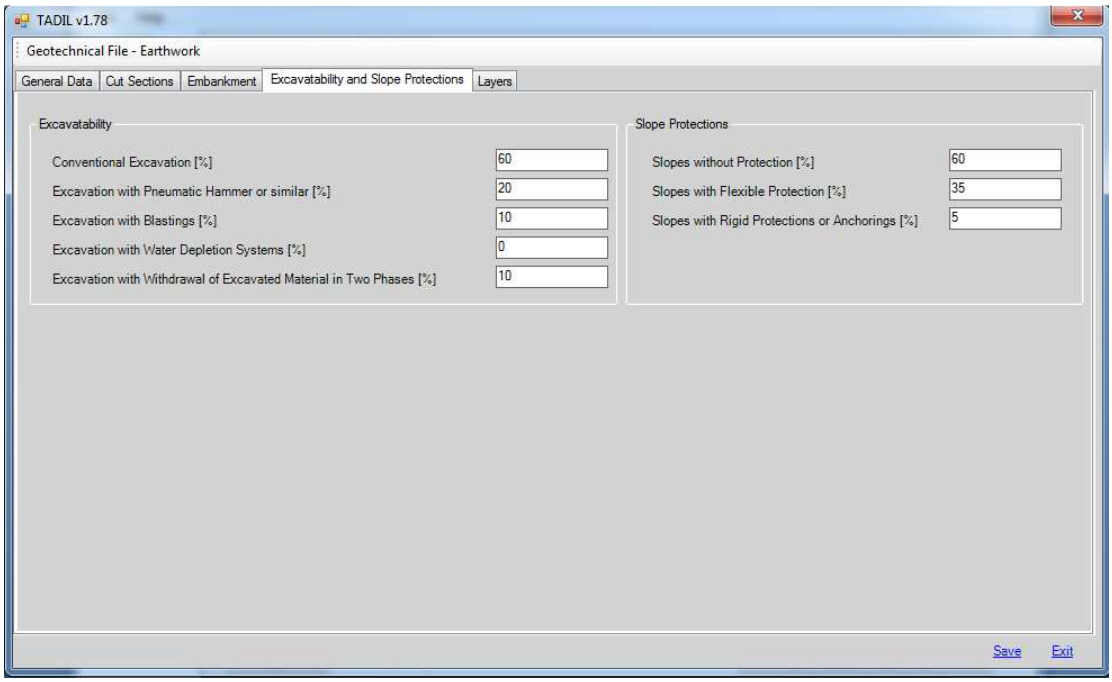


Image 43. Entering excavatability and slope protection data.

- **Layers**

Finally, we must specify the different layers our cross sections is going to consist of. First of all, we select the berm area in the drop-down menu. Every berm area has been created in "Construction Units and Prices". Once we have specified the berm area, we click on "Save" and we move on to specify the layers.

The first one is the roadbase layer. At this time, we must detail which layers, what thickness and what order we must follow to place its material. Materials have been previously defined in "Construction Units and Prices".

For the hard shoulder layers we have two options: entering data just as we have done with the roadbase layers or by clicking on "Copy Roadbase Layer to Hard Shoulder Layer".

We make the same for the basecourse layers.

We click on "Save" and we have fully defined this geotechnical area. This lithological group can be edit as many times as required or removed just by clicking on "Edit" or "Remove".

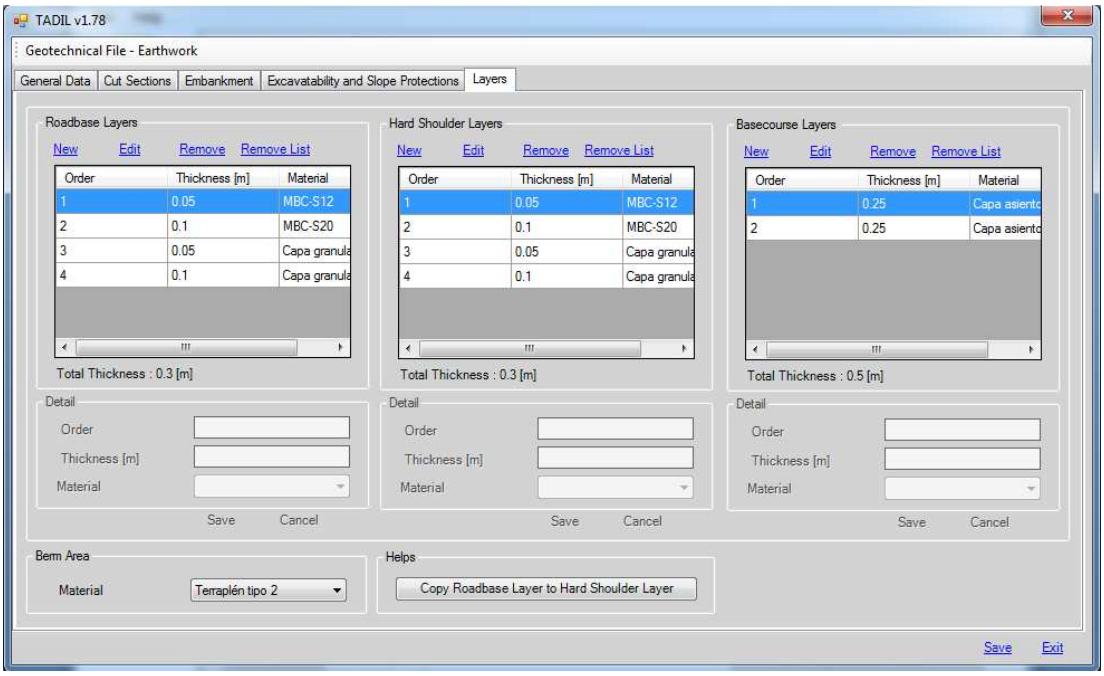


Image 44. Entering layers data.

- **Link polyline to GIS area**

Once we have fully defined the geotechnical area, we must associate it to the cartography. First of all, we must draw a polyline (closed) on the cartography. Then, we click on "Link Polyline to GIS area" and we select the polyline.

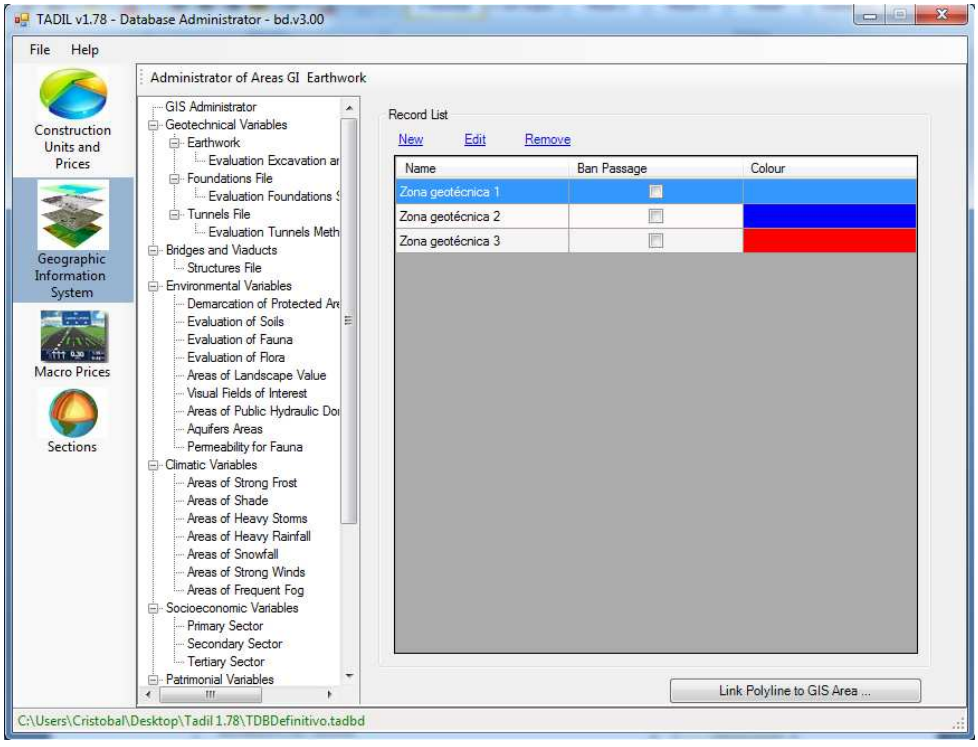


Image 45. Link polyline to GIS area.

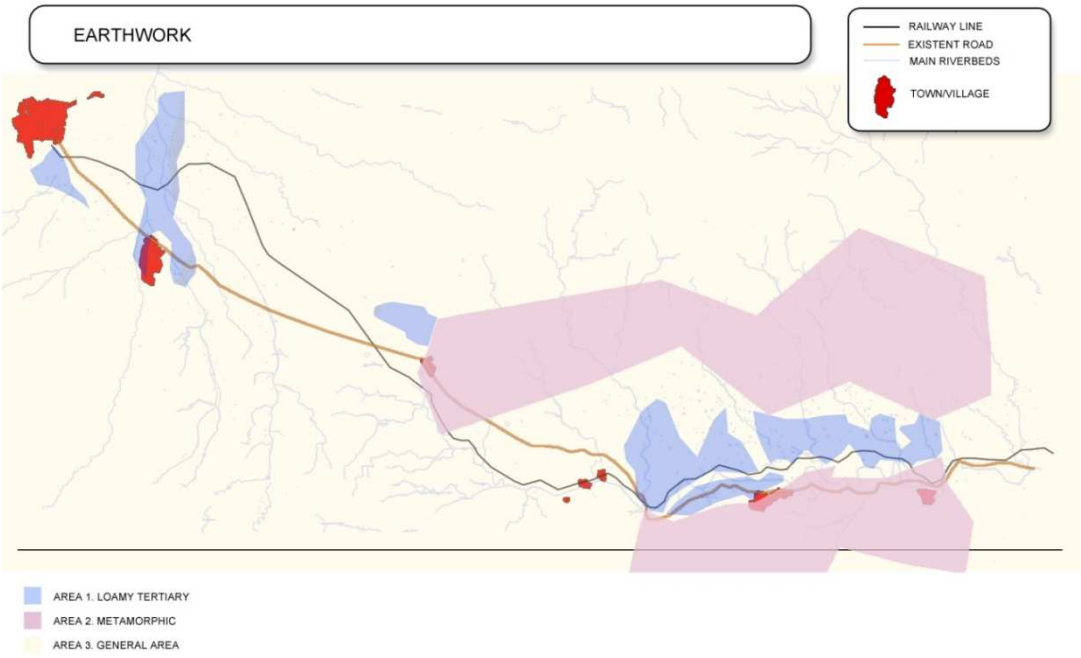


Image 46. Areas linked to the different geotechnical areas.

- **Evaluation of excavation and slope method**

In this section, we must enter a subjective evaluation of the excavation and slope methods. Zero is the most favourable value and ten is the least favourable. We save the values and move on to the next section.

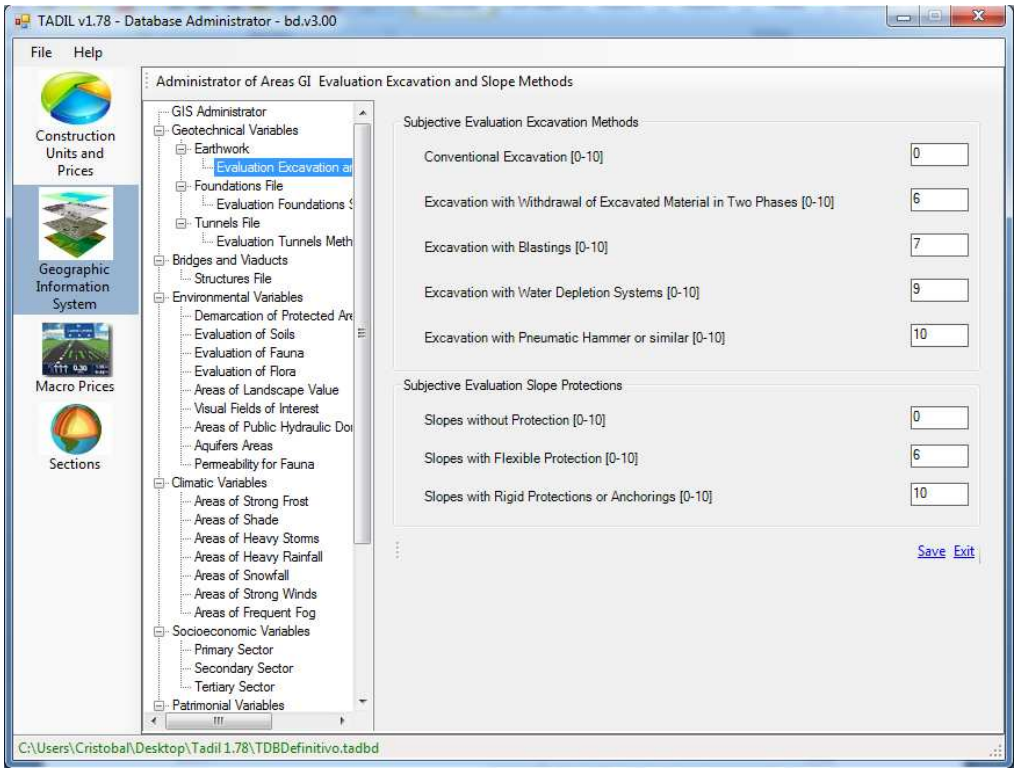


Image 47. Entering excavation and slope evaluations.

9.2.2.1.2. Structure Foundation File

In the foundation file we give the foundation features of a geotechnical area in particular. So, we must specify the typology of foundation in structures and crossing methods for each geotechnical area by filling the box "Geotechnical File, Foundation", just as we have done previously. Afterwards, we link the cartography and the polyline to the GIS area, as we have done in the previous section.

By clicking on "New" we can create new foundation areas, which can be edited and removed later by clicking on the homonym buttons.

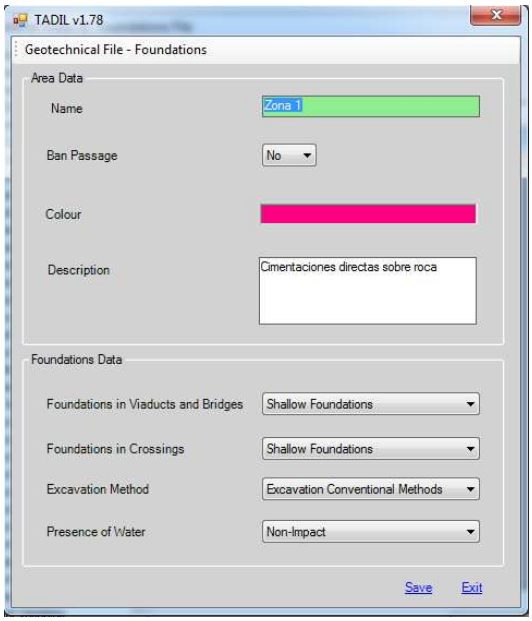


Image 48. Entering foundation data.

Next we show the different foundation areas created in our example.

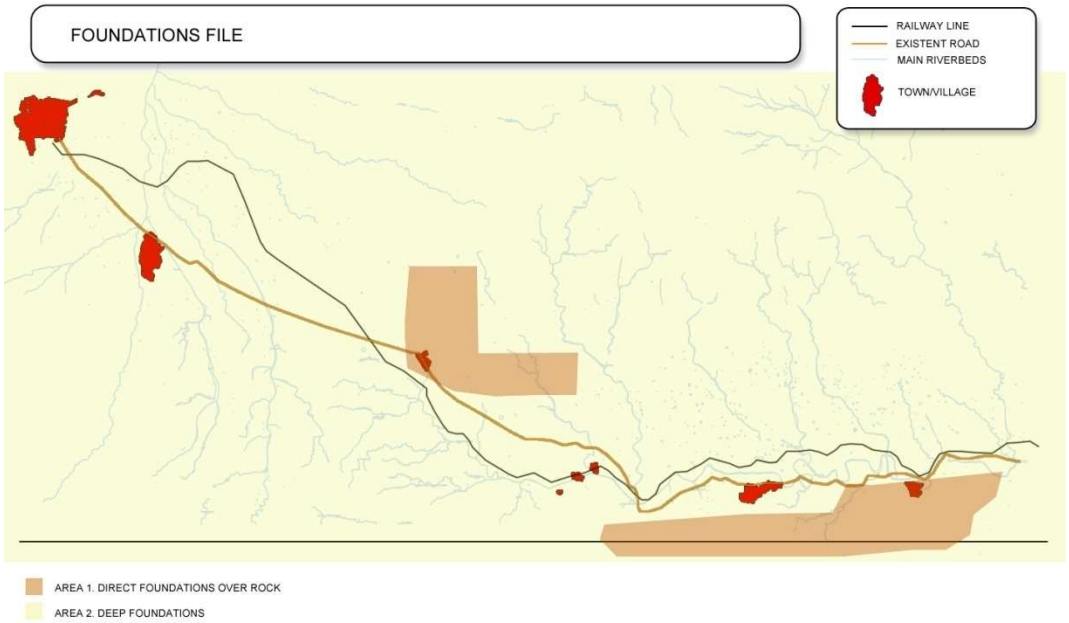


Image 49. Areas linked to the different foundation areas.

- **Evaluation of foundation, structures and walls**

Likewise, we must enter a subjective evaluation about structure foundation and crossings methods, and excavation and presence of water methods. Zero is the most favourable value and ten is the least favourable. Then we click on "Save".

9.2.2.1.3. Tunnels File

The first step is to specify if we allow or not tunnels for the draft in a particular area, by clicking on Yes or No in the box "Ban Tunnels".

As help, we can use the tab next to the entering data tab. There we can see, according to the RMR data (Beniawski 1989), data related to the setting up of support and actions in the tunnel section.

By filling the tunnel and clicking on "Search Section", TADIL selects from its database the tunnel complying with all the specified conditions.

We can also create our own tunnel sections in a .dwg file and load them into the software. To load our own sections, we must save the file into the same folder where the software is saved, by opening the folder "cad" (inside the folder "sec") and copying the file into the folder "tun".

We can also choose the tunnels construction methods and the specific treatments we need.

We save the data. We can modify them by clicking on "Edit" and removed with the button "Remove".

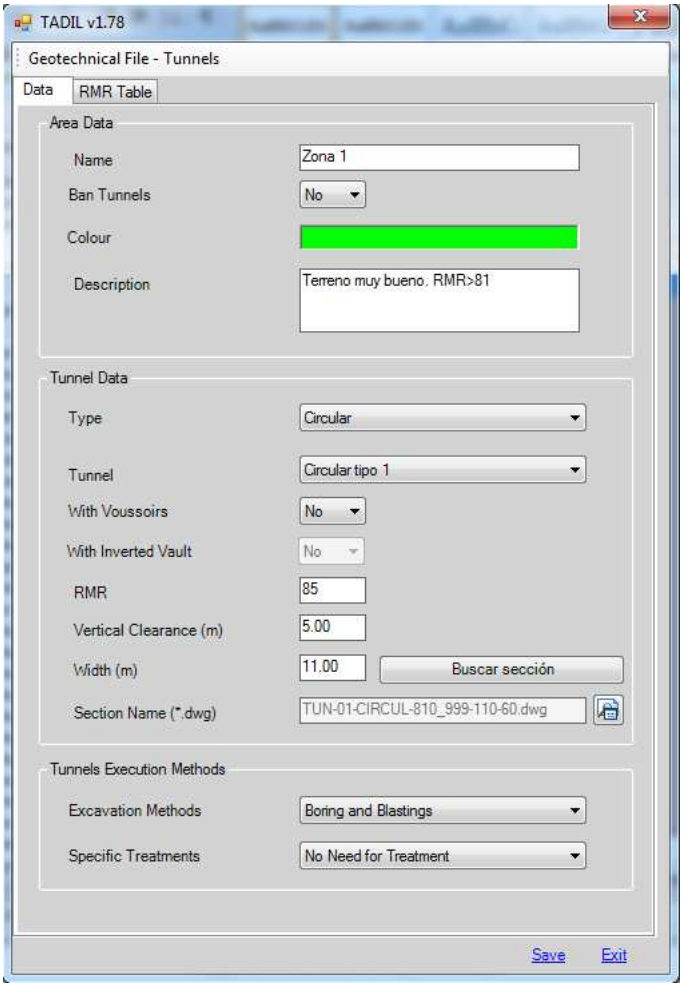


Image 50. Entering tunnels data.

To fully define the area, we also need to link a closed polyline on the cartography.

These are the areas we have specified in our study.

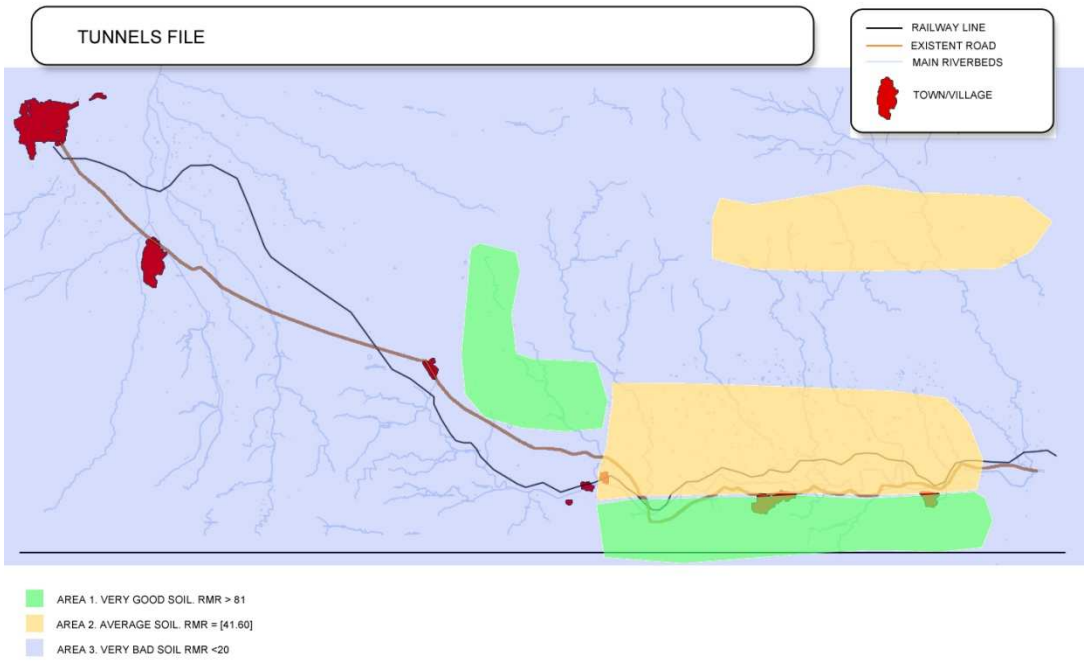


Image 51. Areas linked to the different tunnels areas.

- **Evaluation of tunnels method**

We evaluate the excavation methods and specific treatments used for building the tunnel from zero to ten, being zero the best and ten the worst.

9.2.2.2. Bridges and viaducts

- **Structure File**

We make the same for the structure file. We name the are and we define if we ban or not the structures.

We can select the structure type and, inside the menu "Structure", we choose one of the prices defined in "Construction units and prices".

After having the typology, the maximum width of deck and the distance between piers, we click on "Search selection" and TADIL selects from the default sections the one that better fits to the conditions.

Just like in the tunnels file, we can enter our own bridges sections. To load our own sections, we must save the file into the same folder where the software is saved, by opening the folder "cad" (inside the folder "sec") and copying the file into the folder "tun".

Once we have filled out the required gaps, we click on "Save". We can also edit and remove any area previously defined.

Finally, we draw a closed polyline and we link it to the area by clicking on "Link polyline to GIS area". Like that, the structures file is totally defined.

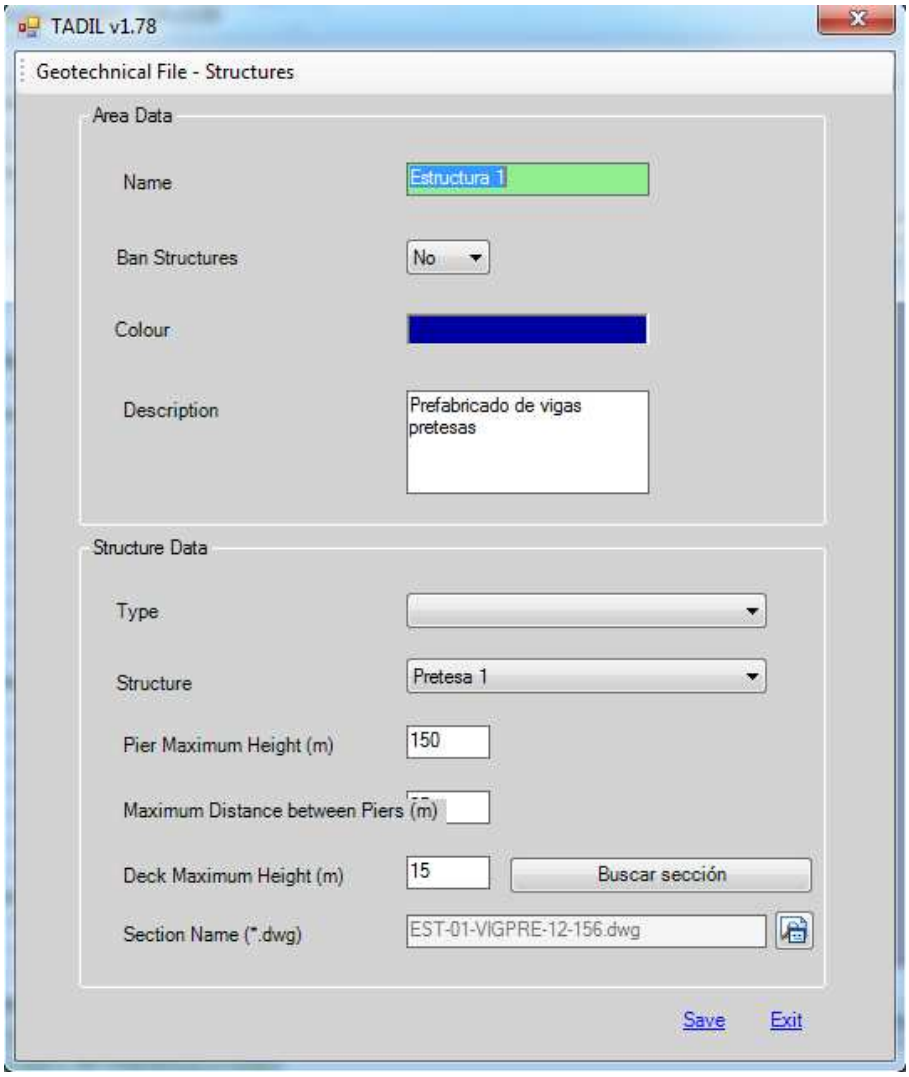


Image 52. Entering structure data.

9.2.2.3. Environmental variables

From this menu on, all the sub-menus are the same except for some aspect we explain independently. Therefore, once we explain one sub-menu, the remaining ones are also explained.

9.2.2.3.1. Evaluation of fauna

This menu is divided into two different parts: "Classifications" and "Records for Classifications".

For making the classifications we click on "New" , we name the classification, we make a brief description and we save it. As always, we can edit or remove these values.

Next we develop out example. We make two classifications for the animal kingdom: lepidoptera and protected bird species. The records for classifications are the different species grouped under this classification. So, under the lepidoptera classification, we have introduced the species parnassius apollo, and under the protected bird classification, the falco naumanni and the aquila chrysaetos.

For entering new records for classifications we need to click on "New", finally, we name and describe it. We can ban an area where these species live by activating the box "Ban Passage". We give an evaluation to the species depending on its importance. Zero is the biggest value and zero is the smallest.

We can link a photo to each record for classification. For that, we must have a file in .jpg format, save it into the same folder where the software is saved, open the folder "img" and copy our .jpg in the folder "gis".

Finally, we must link each record for classification to a polyline following the same steps as in previous sections.

When the record for classification is completely defined, we save it. This record can be edited or removed afterwards.

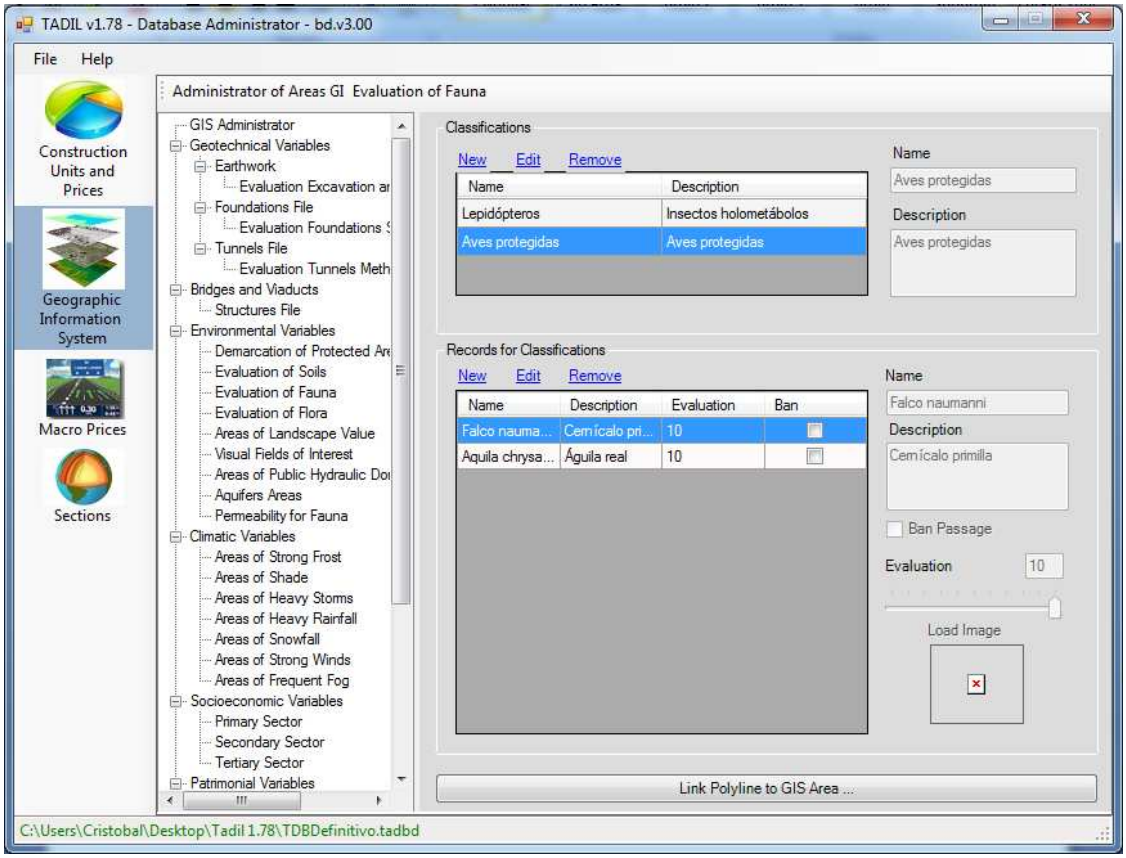


Image 53. Entering fauna data.

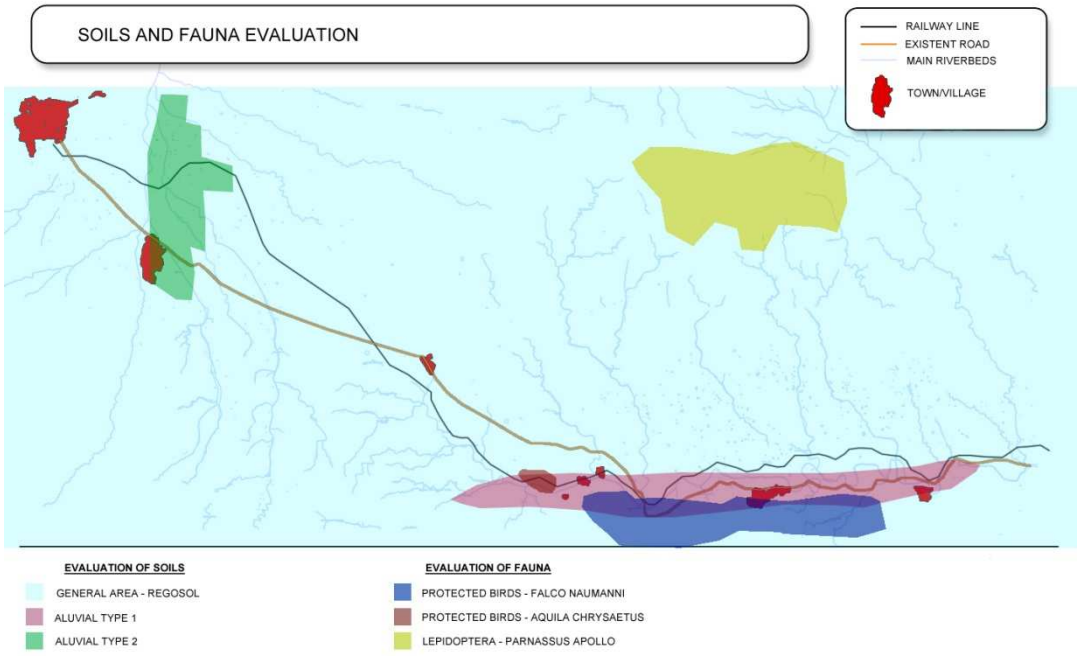


Image 54. Areas linked to the different fauna areas.

9.2.2.3.2. Areas of public hydraulic domain

In this section, we define the conditions for the different possible areas or public hydraulic domain in our cartography. We can create a new area by clicking on "New".

Once we have named the area, the software must know if we want to ban the passage or not. After that, we must decide if this area passes with structure (we select "Yes") o with crossing (we select "No").

The evaluation, as in previous sections, determines if the area is considered as important or just modest. Zero would go with the least important ones and ten with the most important.

Once we have saved these data, they can be modified by clicking on "Edit" or removed by clicking on "Remove".

Finally, we must link this area to the cartography. In this case, we can link it in two ways: by linking it to a polyline created by the user like in previous cases, or by liking the polyline to watercourse.

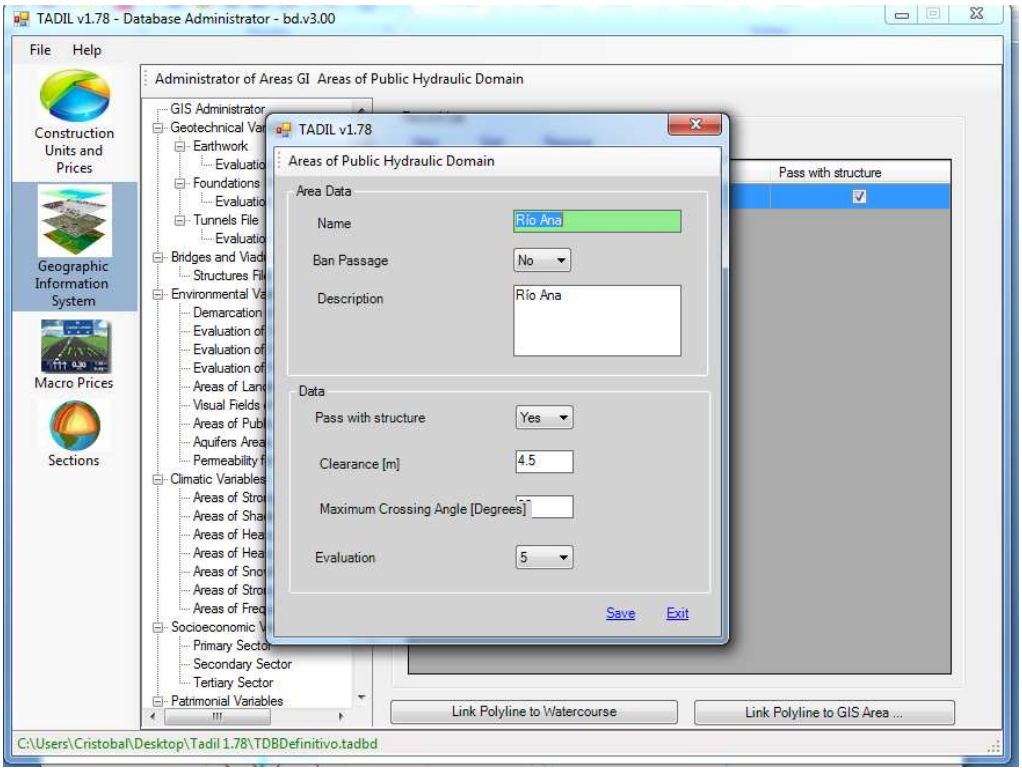


Image 55. Entering areas of public hydraulic domain data.

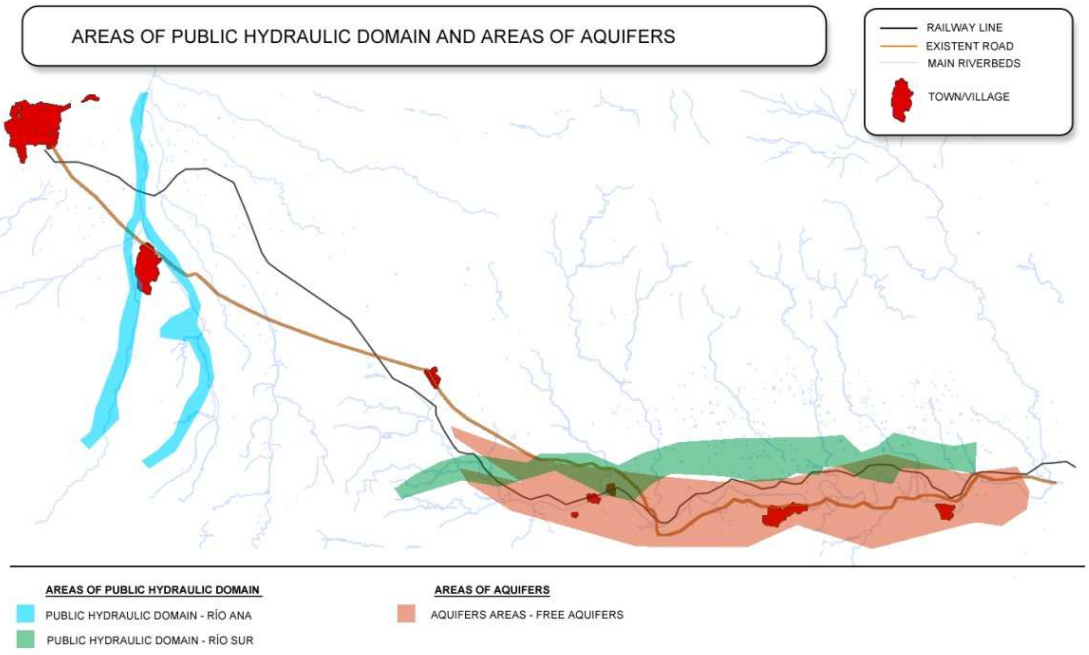


Image 56. Areas linked to the different areas of public hydraulic domain areas.

9.2.2.3.3. Example of widening of road stretch Villa Ana – Pueblo Viejo

Next we show the areas defined with TADIL when we link polylines to each environmental variables.

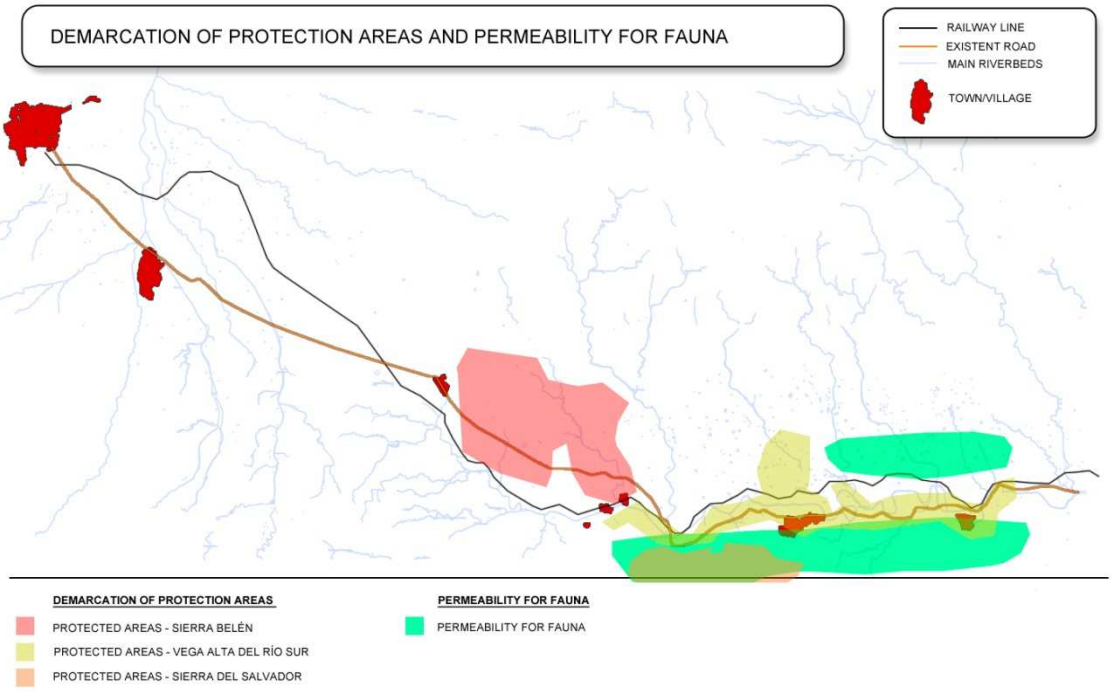


Image 57. Areas linked to the different protection and permeability for fauna areas

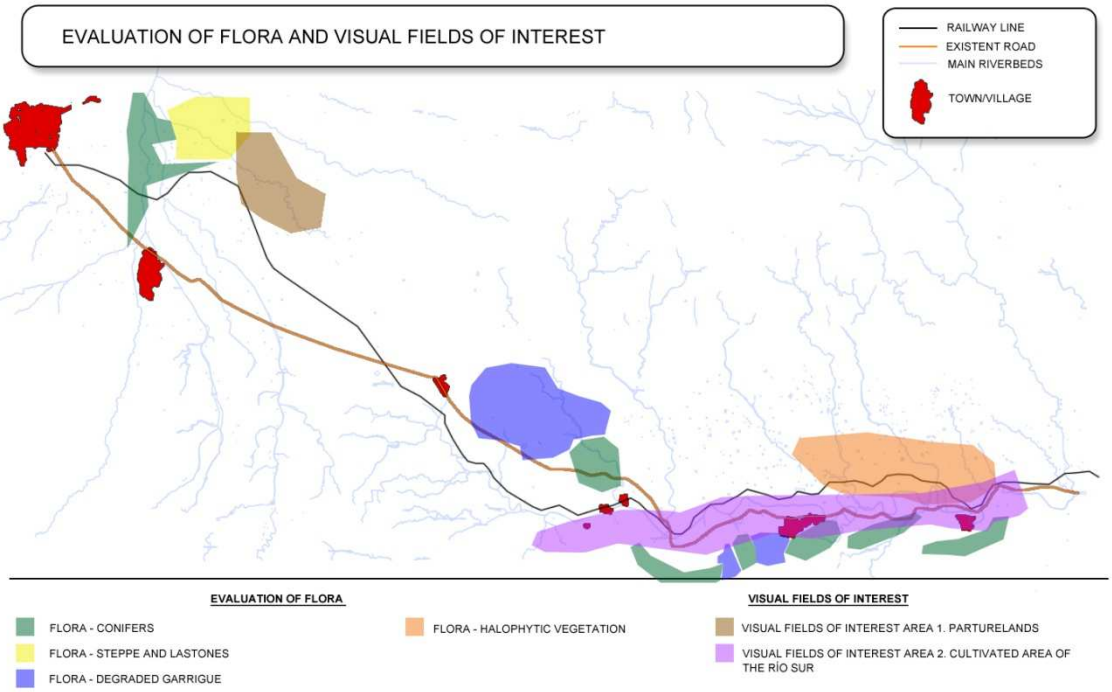


Image 58. Areas linked to the different flora and visual fields of interest areas.

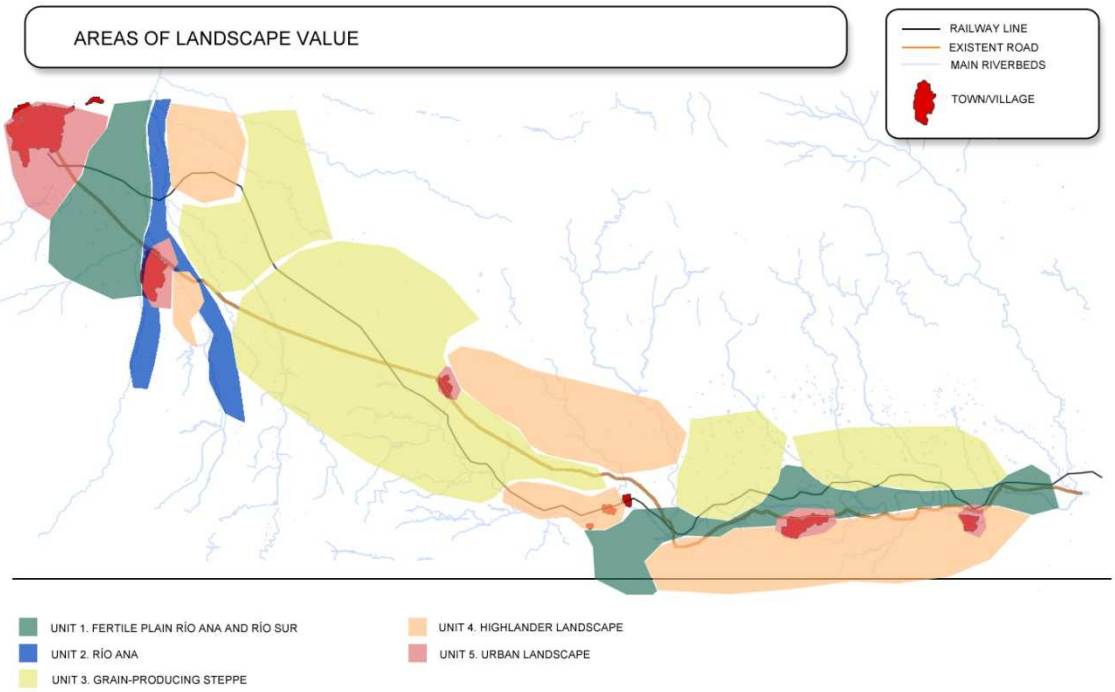


Image 59. Areas linked to the different landscape value areas.

9.2.2.4. Climatic variables

All these variables are defined as we did in the evaluation of fauna.

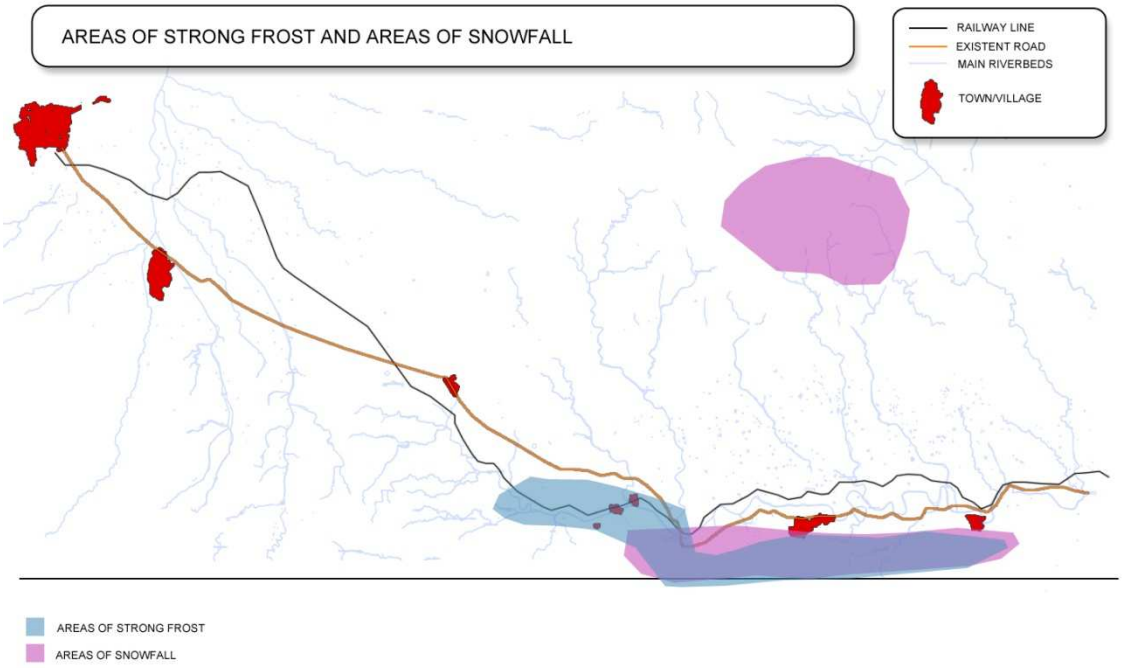


Image 60. Areas linked to the different strong frost and snowfall areas.

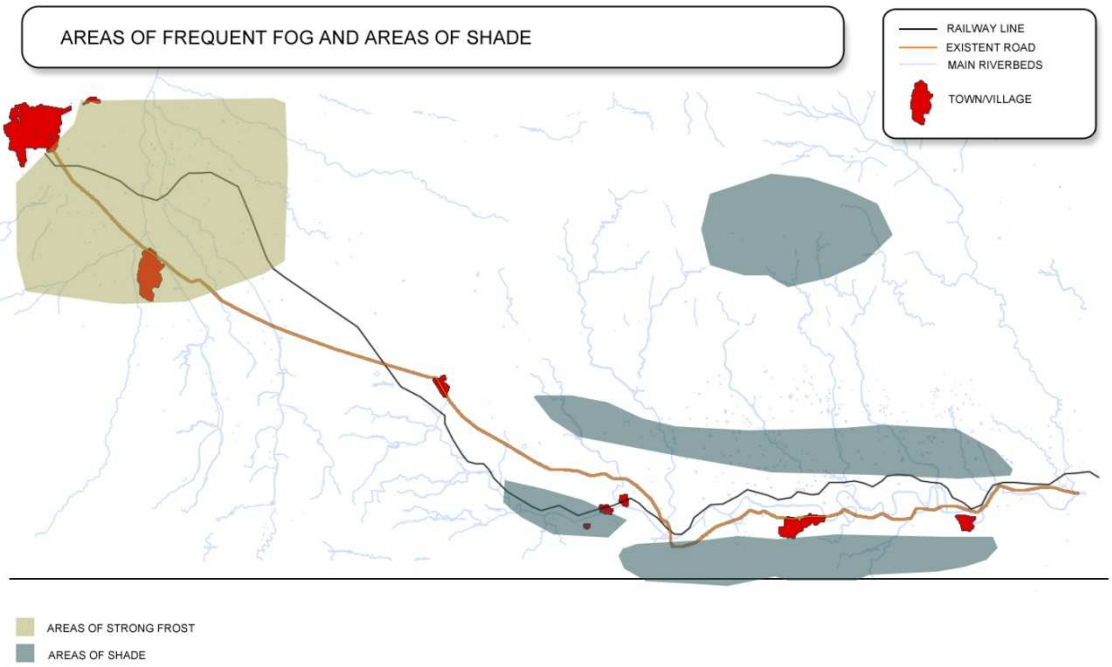


Image 61. Areas linked to the different strong snowfall and shade areas.

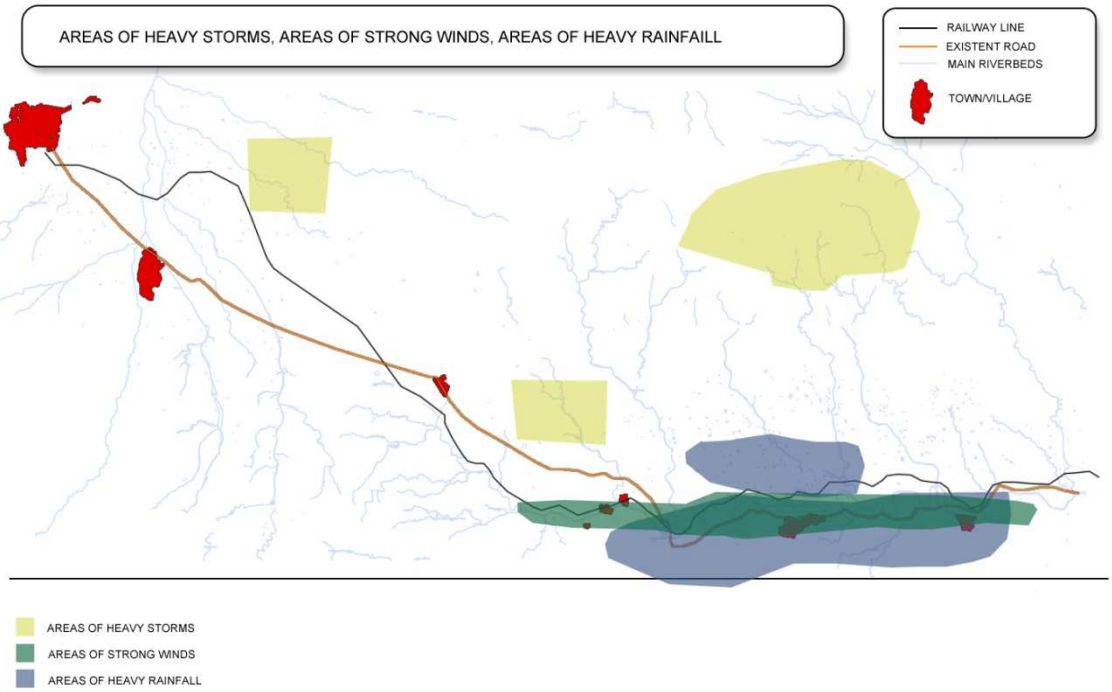


Image 62. Areas linked to the different heavy storms, strong winds and heavy rainfall areas.

9.2.2.5. Socioeconomic variables

The socioeconomic variables are defined in the same way as we did for the primary, secondary and tertiary sector (see below).

9.2.2.5.1. Primary sector

We click on "New" and we create an area corresponding to the primary sector. We choose between banning or not the passage in this sector. We make the area evaluation following the same criteria as followed previously. Finally, we select the evaluation of land production from the drop-down menu. This evaluation has to be with the price of economic performance of land. Previously, we have defined the different evaluations of land production offered by TADIL in "Construction units and prices". We save it and exit.

Finally, we need to link this area to a polyline of the cartography to totally delimit this area of the primary sector.

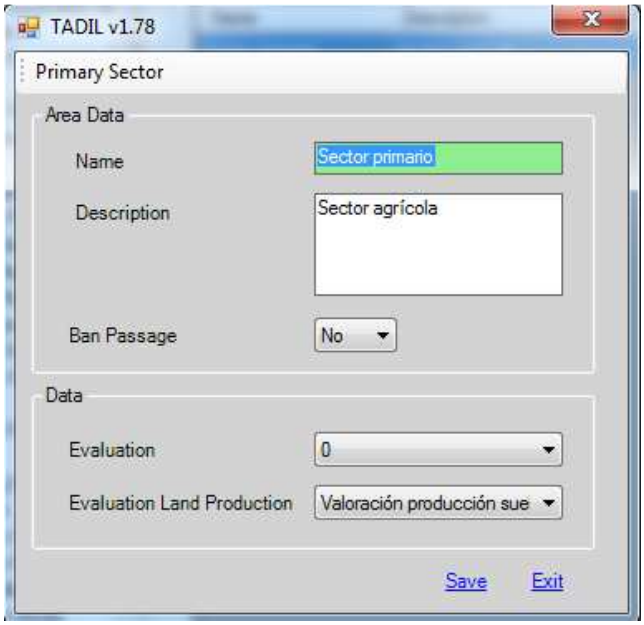


Image 63. Entering primary sector data.

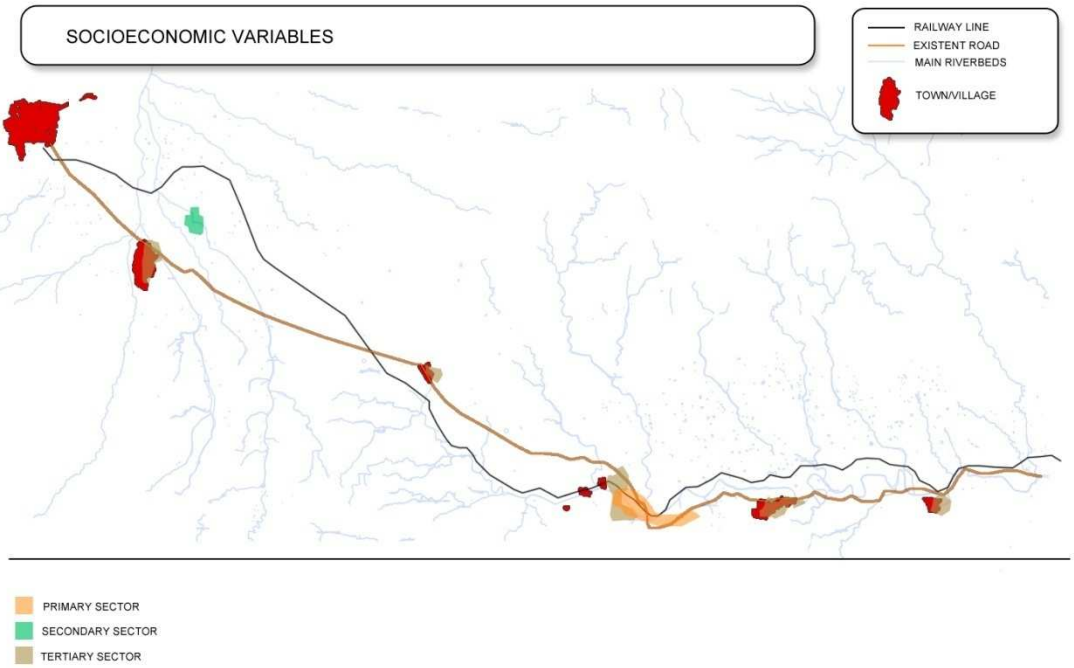


Image 64. Areas linked to the different socioeconomic sectors.

9.2.2.6. Patrimonial variables

All these variables are defined as we did in the evaluation of fauna, except for the following:

9.2.2.6.1. Building land

We make the same for building and non-building lands.

First we click on "New" to create a new entity of building land. We name and describe it. After that, we choose between banning or not the passage in this area. We make the evaluation just as we did in previous sections, giving higher evaluations to those areas of greater interest and vice versa.

In the drop-down menu "Patrimonial evaluation of land" we can select the type of expropriation that this area of building land is subject of. Previously we have defined in "Construction units and prices" both for the expropriations and prices. We save the data and exit.

Finally, we link this polyline to this new category of building land.

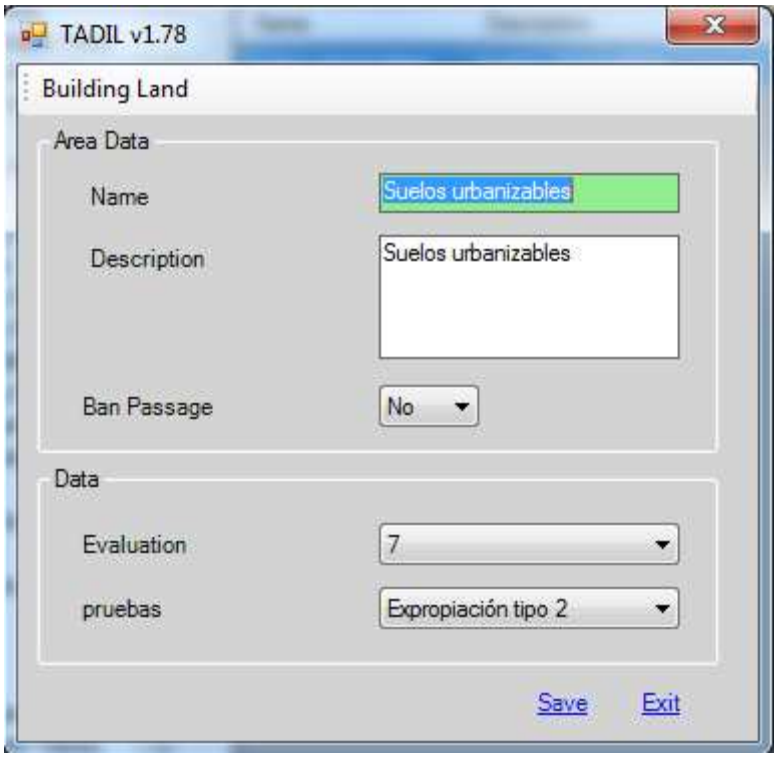


Image 65. Entering building land data.

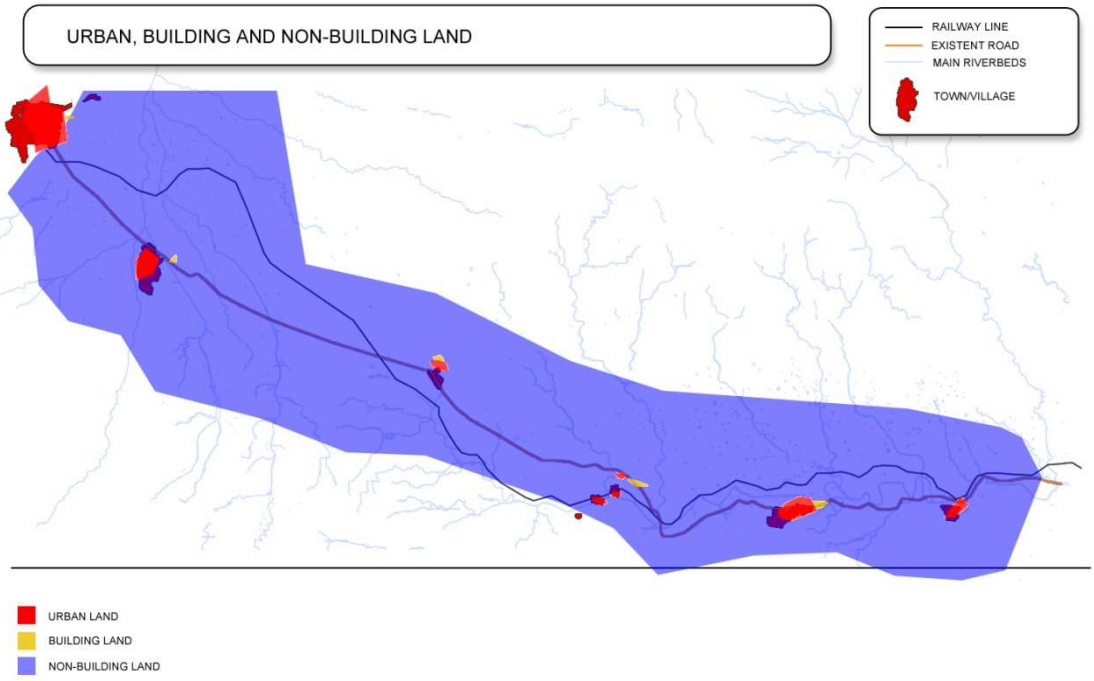


Image 66. Areas linked to the different urban, building and non-building land areas

9.2.2.6.2. Crossing of linear infrastructures

For the study to be complete, we must take into account that a road is not an isolate entity by a part of a network and that this network will define in many aspects the geometry and the cost of the future road. Therefore, we have to specify the pre-existing linear infrastructures and how they affect our project.

Future versions of TADIL will allow us to incorporate algorithms of artificial intelligence which implement the flyover crossings of infrastructures. For the time being, we can define and see them in the cartography and provide a subjective evaluation.

We add linear infrastructures to our cartography by clicking on "New". We name them and specify if we ban or not the passage, just in case the infrastructures cross our own road. If we choose not to ban the passage, we should specify if they cross level or flyover. If we find ourselves before a high capacity road, we are expected to choose flyover and we must specify its vertical clearance.

We must evaluate the area that the pre-existing linear structure occupies and then, we save and exit.

Finally, we link a polyline to any linear infrastructure that can be crossed with our road.

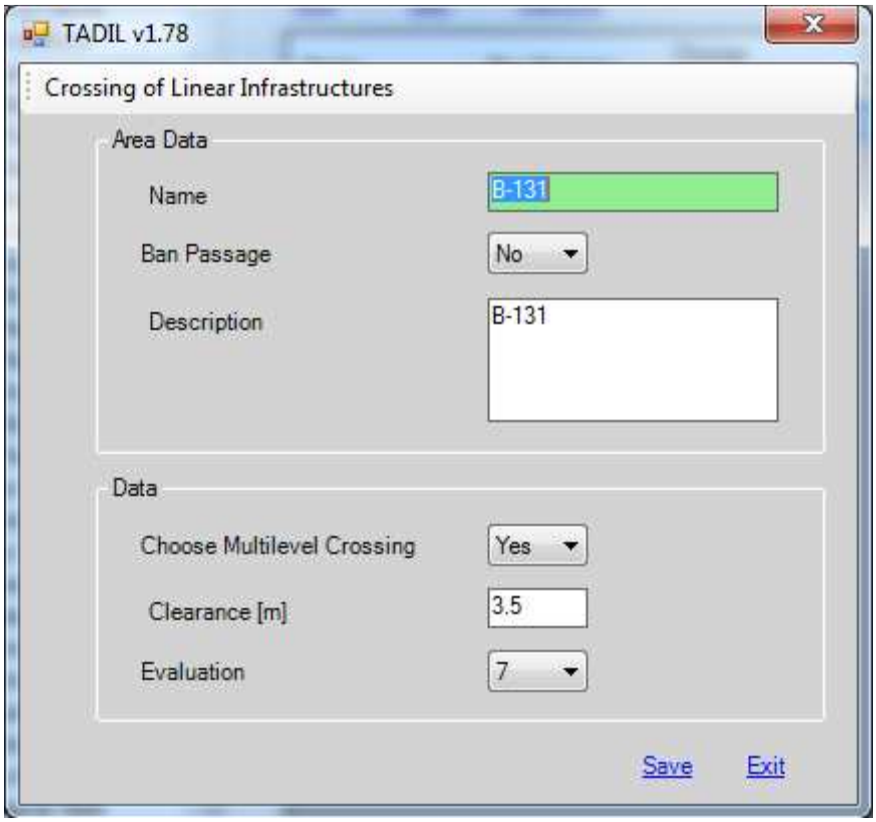


Image 67. Entering crossing of linear infrastructures data

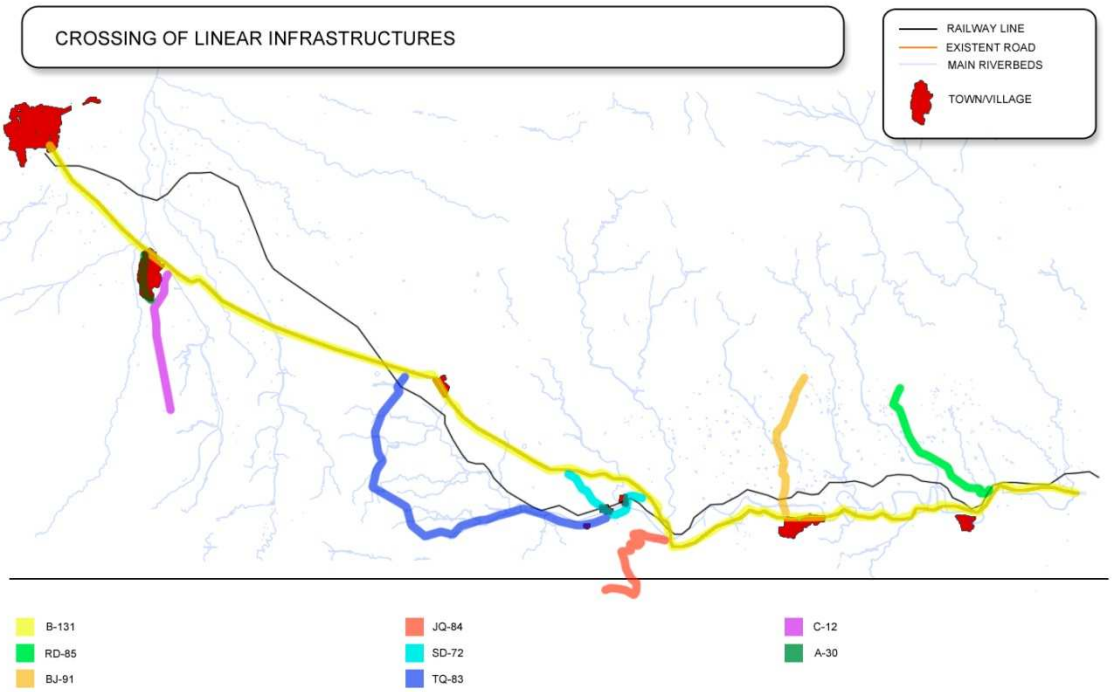


Image 68. Areas linked to the different crossing of linear infrastructures areas.

9.2.2.6.3. Example of widening of road stretch Villa Ana – Pueblo Viejo

Next we include the remaining patrimonial variables we have considered in our example.

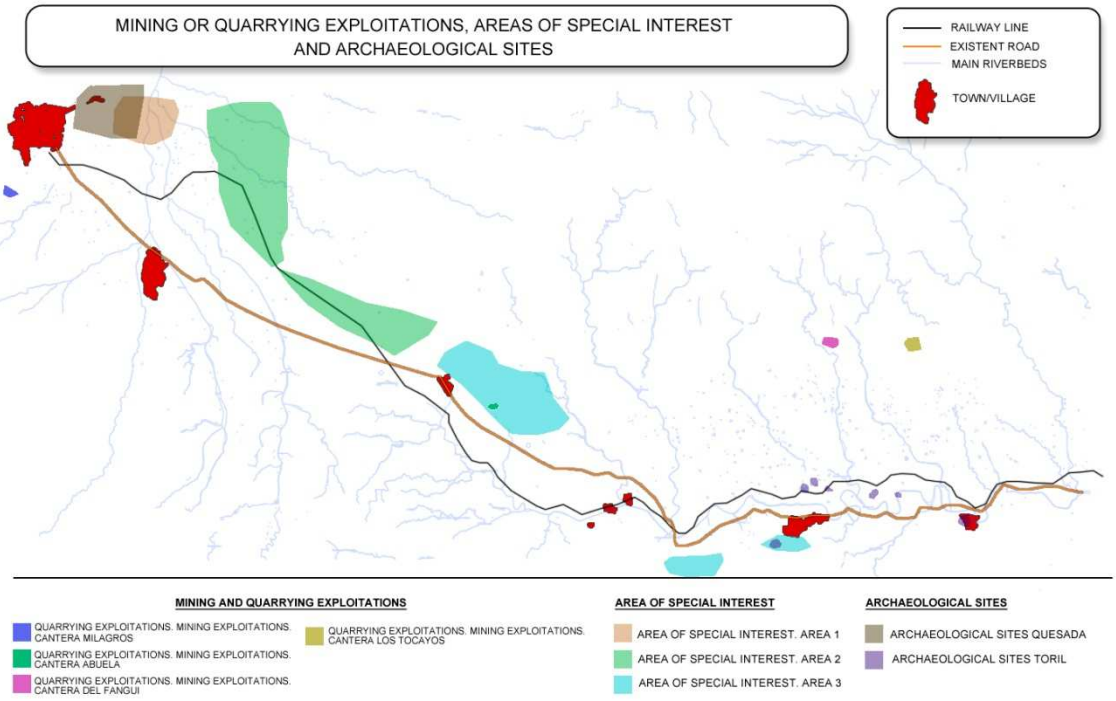


Image 69. Areas linked to the different mining or quarrying exploitations, special interest and archaeological sites areas.

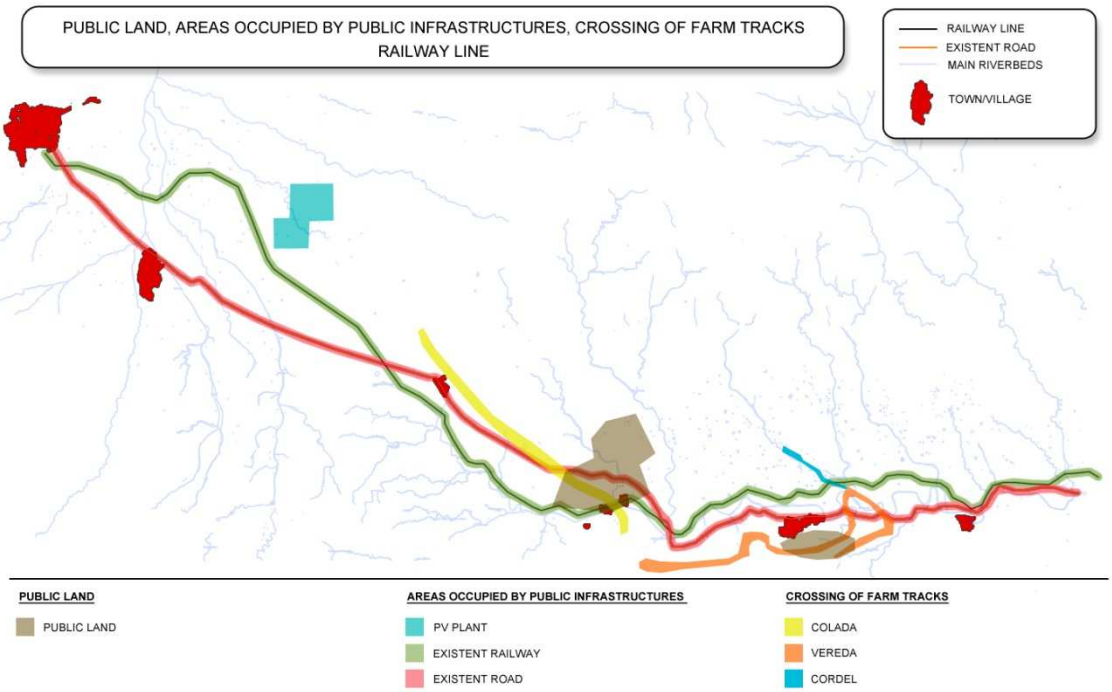


Image 70. Areas linked to public land, areas occupied by public infrastructures and crossing of farm tracks areas.

9.2.3. MACRO PRICES

In this section we must specify the group of macro price of the type section of our road. As type section we can consider simple road or double road and under the category of double road, we can choose between dual carriageway, controlled-access motorway or dual carriageway without central reservation. In each section we can create different records of groups of macro-prices, according to the intrinsic features of the land. That is, each record is a combination of macro-prices which must be in line with the infrastructure type and the land features we have. So, for example, it will not be the same if we create a road in a very rainy area, where more important drainage works are required, than if we do that in a drier area.

It must be noted that the concept of macro-price includes every construction unit comprised in the corresponding section. In general, these prices are given by the draft length unit and we must confine ourselves to the experience in the project and construction of infrastructures to give these costs. The macro-price of Health and Safety is measured as a percentage in the budget of material execution of the work.

9.2.3.1. Macro-prices for simple road

- **General type**

To add a new record of macro-prices appropriate for the type section of simple road, we click on "New". Afterwards, we can edit or remove this record by clicking on "Edit" and "Remove".

Then, we move on to select the macro price of the longitudinal and transversal drainage, of the signalling, beacons and traffic barriers, of the replacement of services, of the geotechnical corrections, of the provisional diversions, of the complementary actions, of the corrective measures and of the health and safety. Previously we have defined the macro prices in "Construction units and prices". Once selected, we obtain a new record of macro-price. We click on "Save" and we exit.

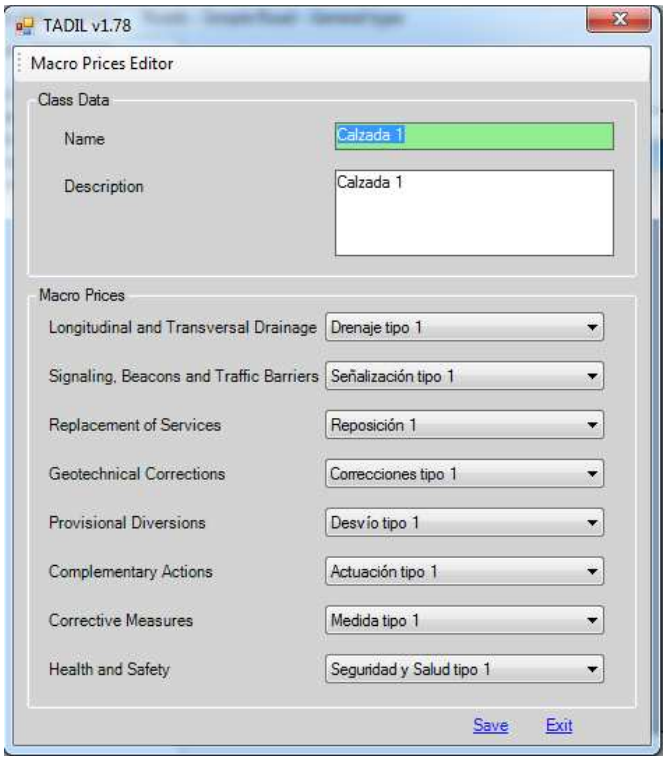


Image 71. Entering macro-prices for simple road data.

9.2.3.2. Macro-prices for double road

We follow just the same steps as we have done in the previous section; the costs must be in line with this type of infrastructures.

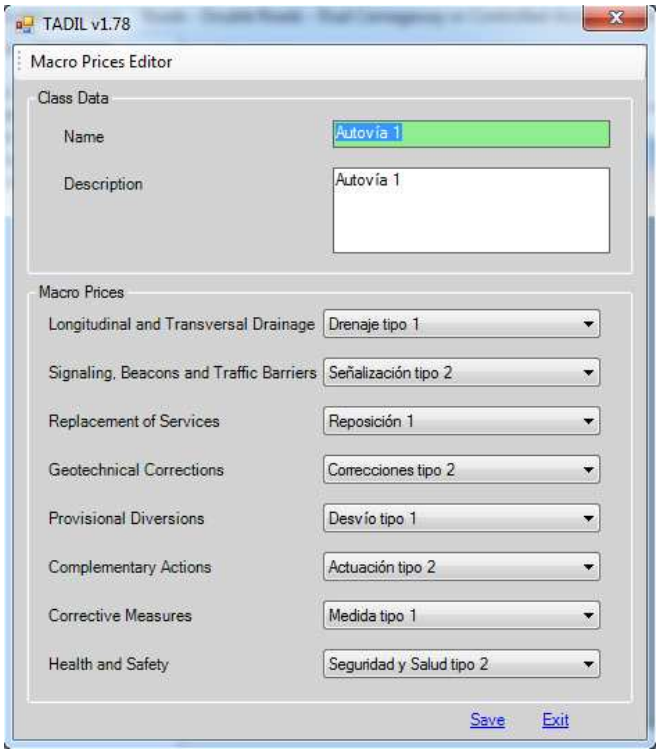


Image 72. Entering macro-prices for double road data.

9.2.4. SECTIONS

This last section of TDB addresses to specify the geometry of the section of the ditches and the section of the road.

9.2.4.1. Ditches

- **Triangular ditches**

To create a new type of ditch we click on "New". In this menu, we name and describe the ditch and, afterwards, we define its geometrical conditions. Finally, we save it and exit.

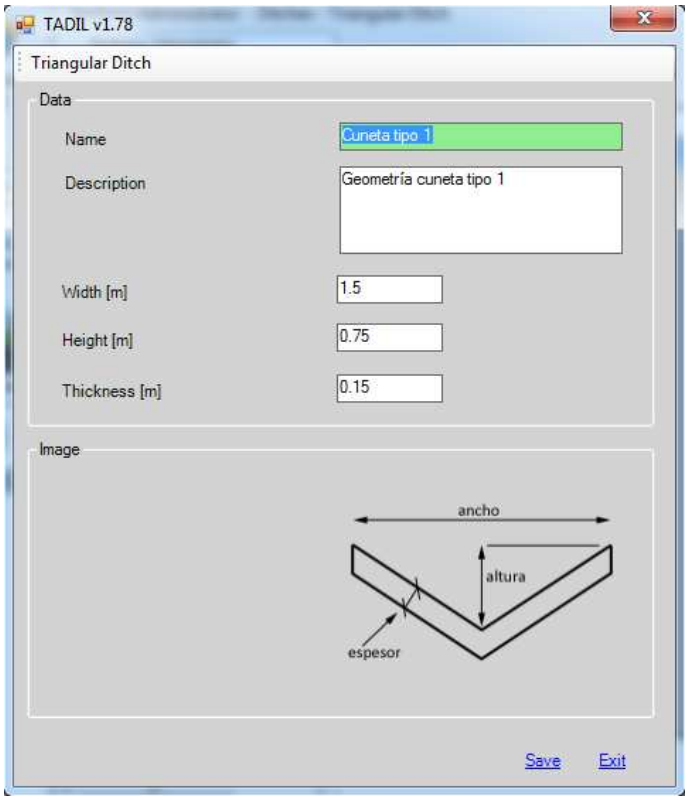


Image 73. Entering ditch data.

- **Trapezoidal ditches**

We follow the same steps as in the triangular ditches.

9.2.4.2. Roads

9.2.4.2.1. Type Section of Simple Road

- **General type**

We create a new record of simple road by clicking on "New". This new record can be edited or removed.

The first thing to do when creating a new type of section of simple road is to name and describe it.

The next step is to define its ditch. We can choose if the ditch is triangular or trapezoidal. Once we have chosen the type of ditch, we can move on to specify its geometry. We have previously created the different geometries of ditches in the section "9.2.4.1. Ditches".

Likewise, we have previously fixed the variety of prices for the ditches that TADIL offers now in "Construction units and prices". At this point, we should highlight that the price given must be consistent with the type of ditch selected.

Finally, to complete the ditch data of our section of simple road, we need to choose its location, at the level of the berm or at the starting level of the roadbase layers.

After that, we specify the road geometry. Generally, the geometry values correspond to the criteria specified by the administration or the regulations as well as to the traffic capacity study, which determines the number of requested lanes.

We can also display a section scheme.

After having introduced all the data, we click on "Save" and exit.

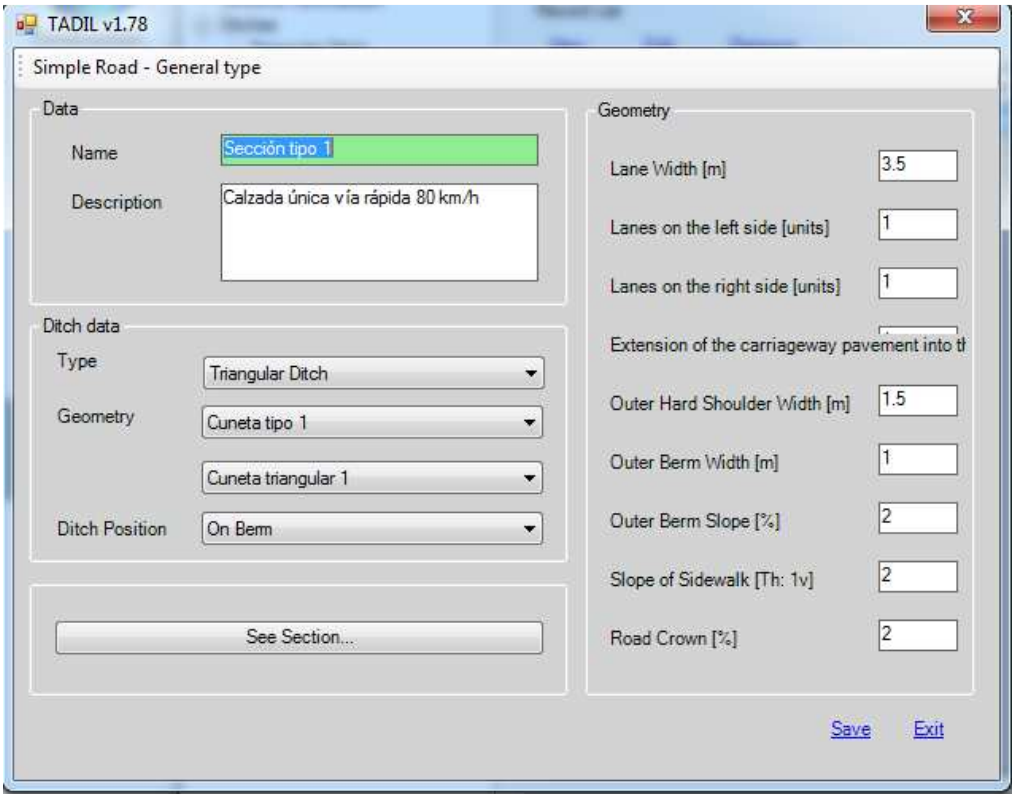


Image 74. Entering type section of simple road data.

9.2.4.2.2. Double road

- **Dual Carriageway or controlled-access motorway**

We enter the values following the same steps as in the simple road.

The main difference is that in this case there are two directions of traffic separated by a central reservation with internal ditch. We cannot choose the location of the internal ditch because it is placed in the central reservation.

Once we have determined all the data, we save them and exit.

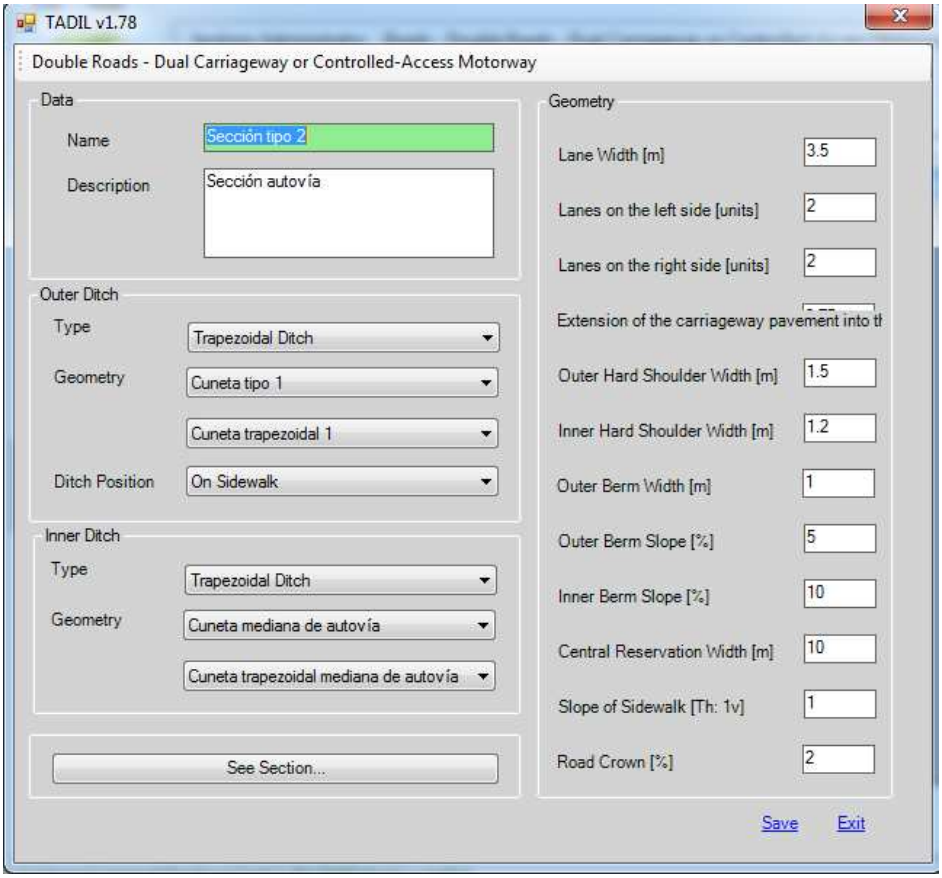


Image 75. Entering type section of double road data.

- **Dual Carriageway without central reservation**

We find ourselves before a particular case of the previous one. This type does not have central reservation, so we put a barrier between both lanes as traffic protection and division. This barrier is defined by default in the software. If we want to propose another type of barrier, we must save it in .dwg format and save the file into the software folder, inside the folder "cad", inside the folder "sec", inside the folder "bar".

After filling out all the gaps, we save and exit.

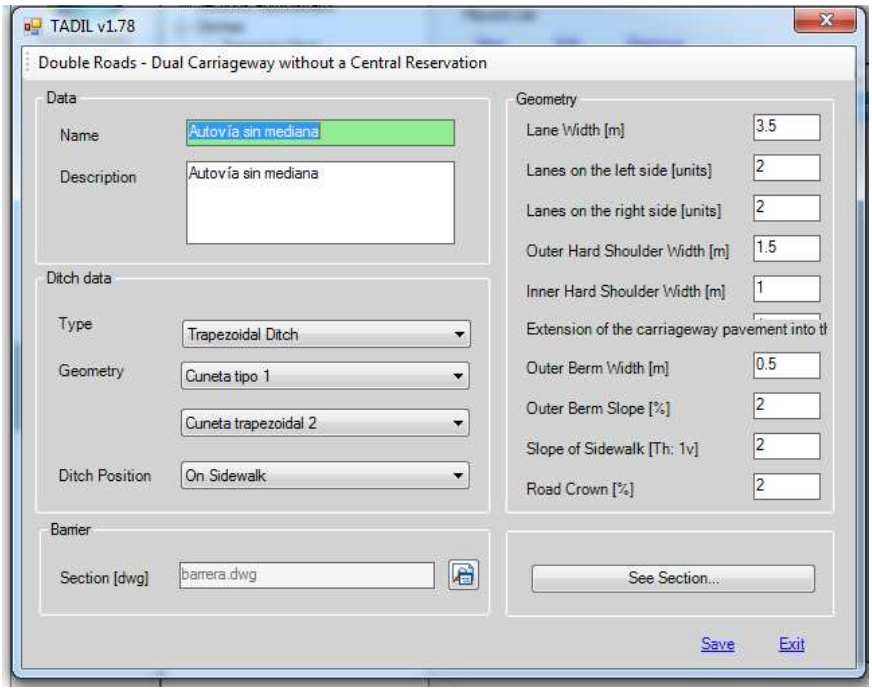


Image 76. Entering dual carriageway without central reservation data.

9.3. TDI IMPLEMENTATION – GENERATING DESIGN IN INFORMATIVE STUDIES

When we have completely defined the database of our project, we can move on to develop a full informative study. In this section we are going to see how the design of different alternatives is generated.

9.3.1. GENERATING THE INFORMATIVE STUDY

The first step is to name the informative study. We select "New Informative Study" and in the emerging menu we write the name of our file; for our example, we choose the name "Valle Villa Ana.tadil".

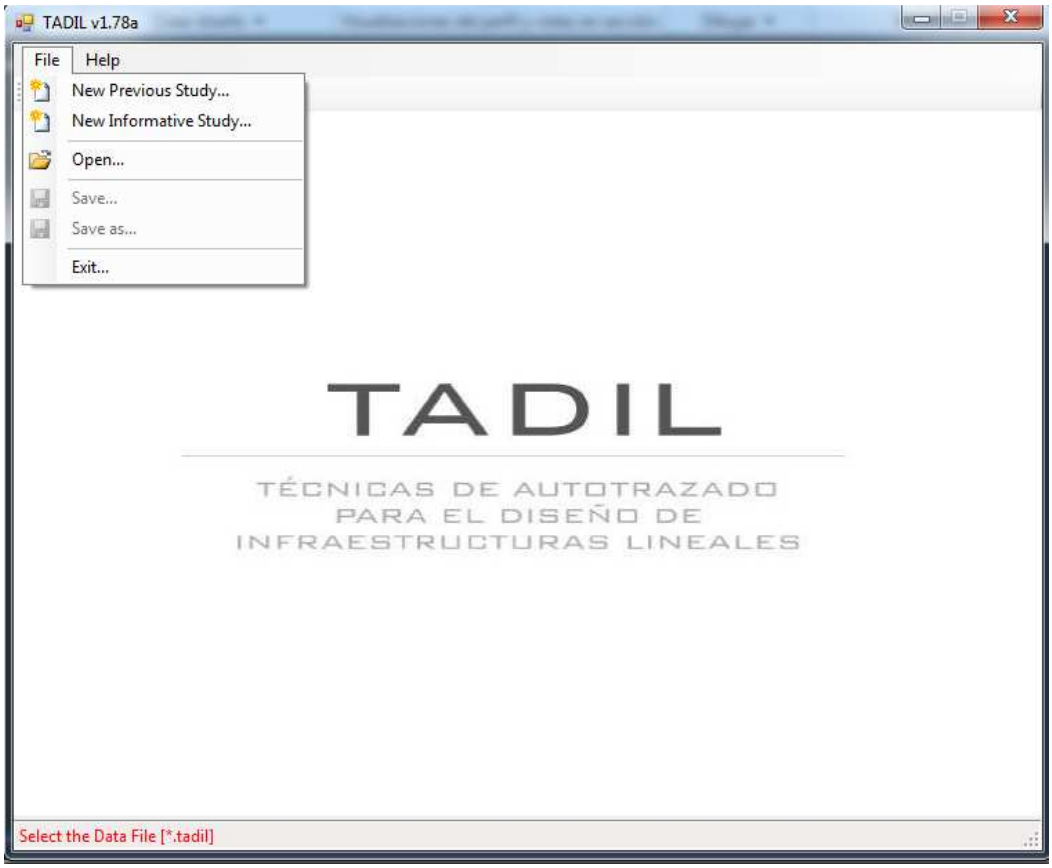


Image 77. Creating a new informative study.

9.3.2. SETTING

- **File Paths**

First we must specify which regulation and database we are going to use for carrying out the informative study.

TADIL comes by default with the Spanish Regulations but the user will be able to enter the convenient regulations at any time.

In our example, we will use the default one. Therefore, we push the "Select" button. Then, a window opens and, in the Software Folder we open the folder "dat". Finally, we open the folder "regulations", select the regulation and save.

Next we must load the database TDB that we want to use. In our case, we load the database we have just created. We click on "Select" and we look for the file we have just created.

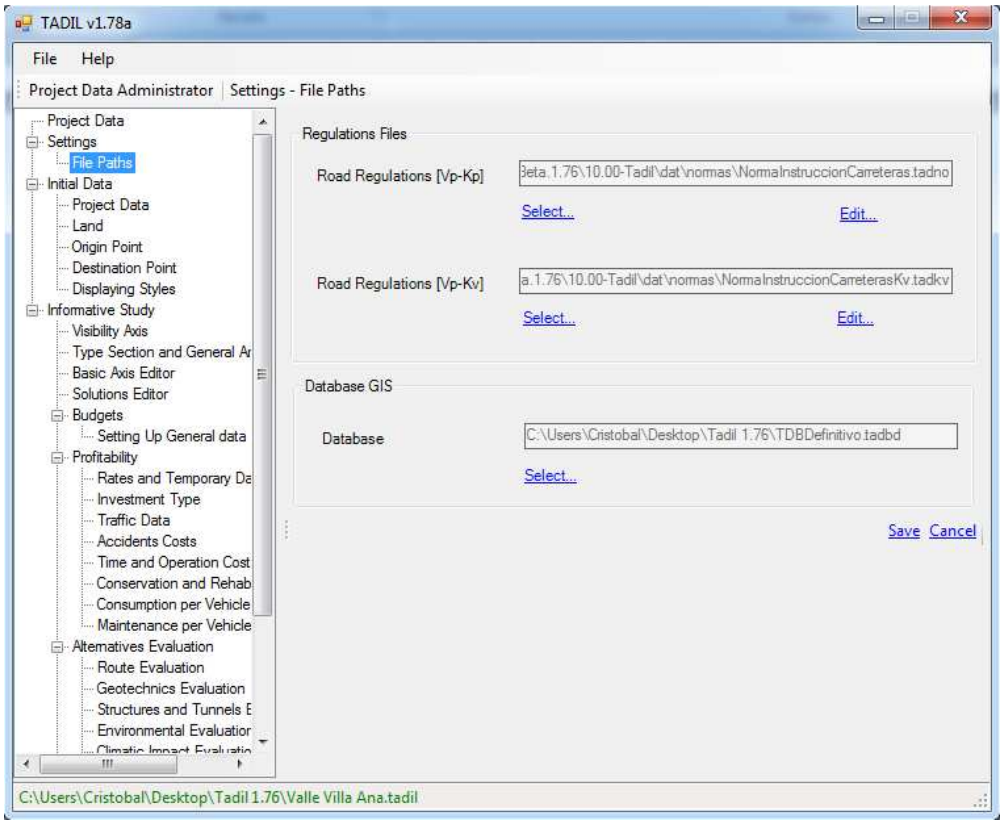


Image 78. Entering regulation and database.

9.3.3. INITIAL DATA

9.3.3.1. Project data

In the menu "Project Data" we enter the name of the study and its description. The interval of sections is greatly important in the study of the design to develop as it conditions the gap between the cross sections to obtain and, in consequence, the measure accuracy and the work budget. When we expect great accuracy, we must set the interval of 20 or 25 m. However, we must take into account that the nearer between sections, the slower the calculation time and obtaining of results. In general, we recommend elaborating calculations every 100 m for roads longer than 10 km (for all the alternatives), allowing the comparison between them and finally, carrying out the study with a lower distance (25 m for example) for those two or three solutions with better punctuation.

On the other side, the plan of earthwork will be also more accurate if they are nearer.

In our example, we have considered a gap of 100 m, which we apply to every alternative of the study. We click on "Save" and our conditions are defined.

Once we have evaluated the alternatives, we obtain again the results with 25 m gaps for the two solutions better evaluated.

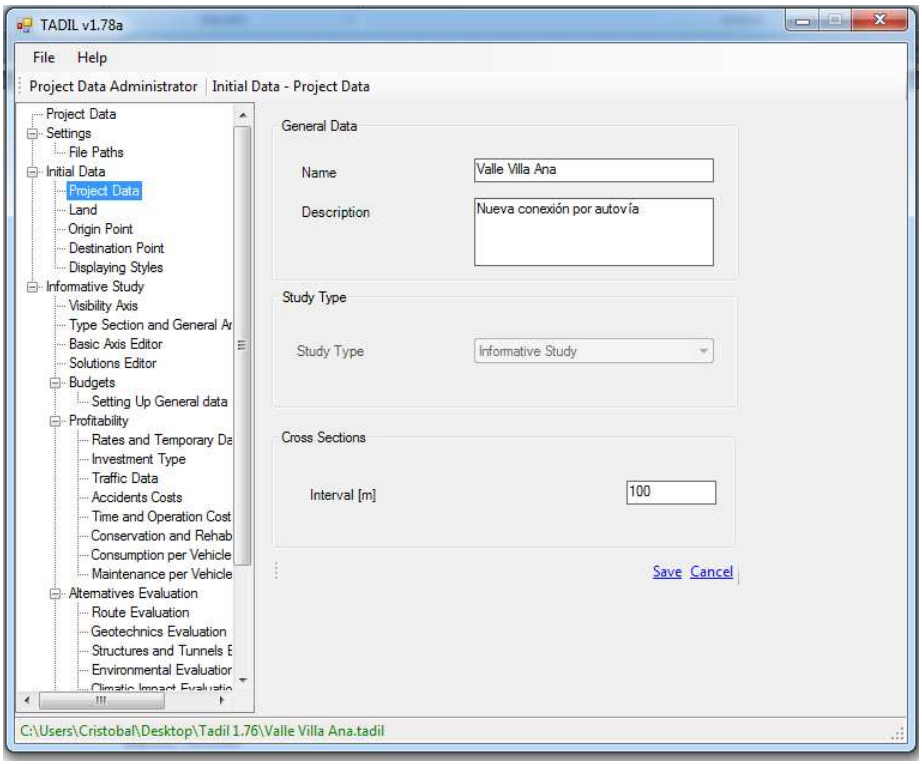


Image 79. Entering the name, the description and the interval between cross sections.

9.3.3.2. Land

We can enter additional banned areas to those created in the Geographic Information System. We can also remove areas with important natural slopes or areas according to our criteria.

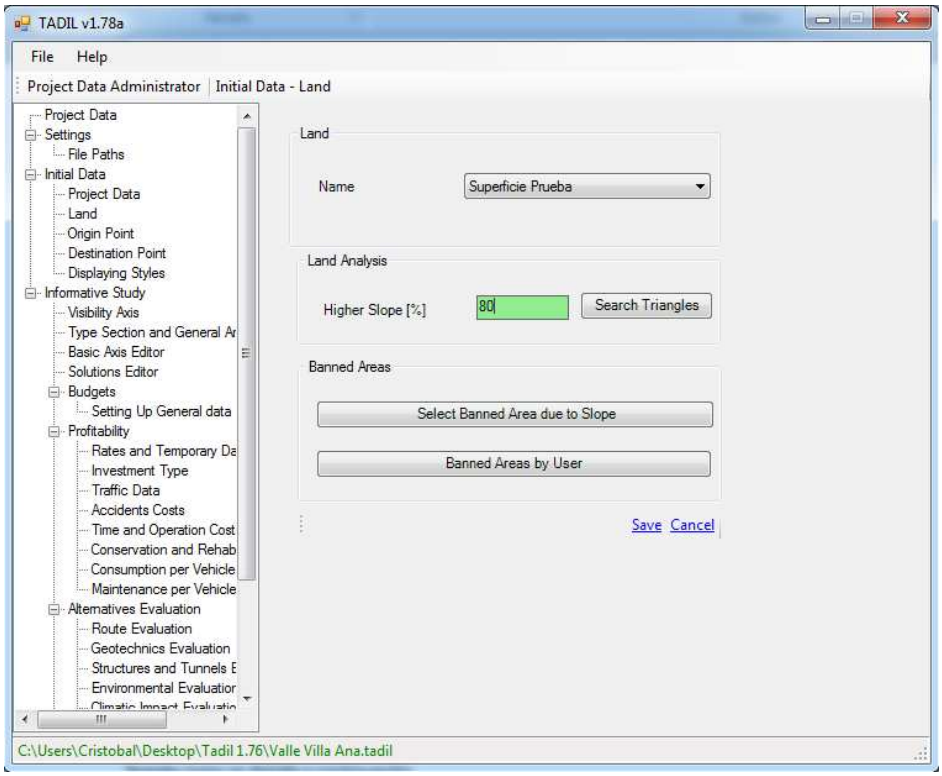


Image 80. Entering the cartography and the banned areas not defined in the TDB.

9.3.3.3. Origin and Destination Point

We consider the same data as in the previous study. See below.

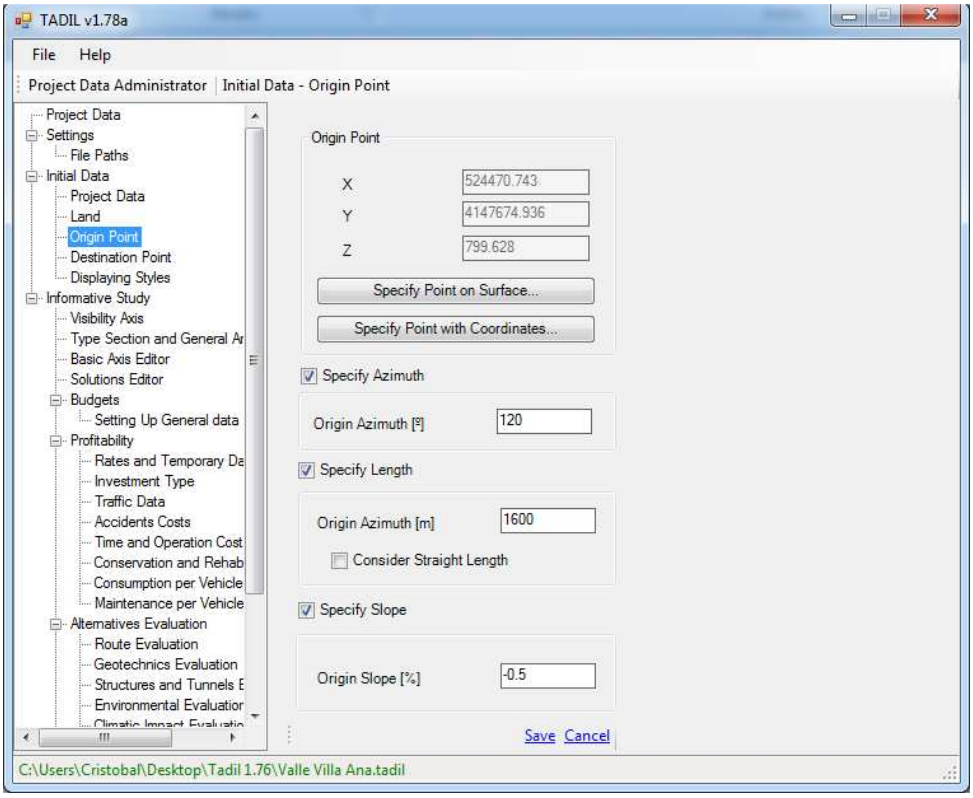


Image 81. Entering origin points data.

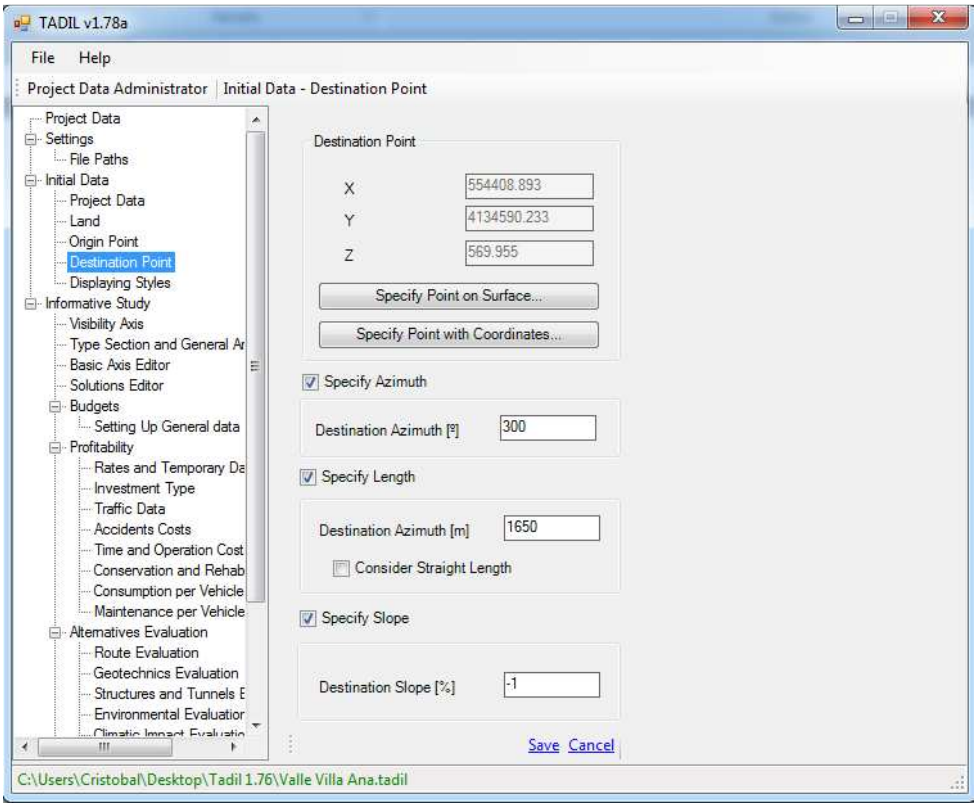


Image 82. Entering destination points data.

9.3.3.4. Displaying styles

In this section we must use the displaying styles we have or have generated in AutoCad CIVIL 3D. For more information about this issue, please go to the User Guide of the aforementioned software. Notwithstanding, as we will see at the end of this Guide, we may enable the labelling methods in cad, for alternatives whose plan and profile we want to draw.

To load the displaying styles that TADIL includes, we should follow these steps:

- We open the file with the cartography to be used.
- In the tab "Administer" in AutoCAD 3D, we click on "Import".
- We go to the folder where TADIL is located and we select the file "PLANTILLAS ESTILOS TADIL.dwt". We click on "Open".

Up to here, we have loaded all the styles. We must note this process has to be taken only for the first time we work with the cartography. The following times, the aforementioned styles would have been already loaded.

If we had opened the TDI and the displaying styles had not been loaded, we recommend closing and opening it again.

Afterwards, we just need to load the styles in TDI by selecting them from the drop-down menu. TADIL's own styles are recognisable when we include the word TADIL in them.

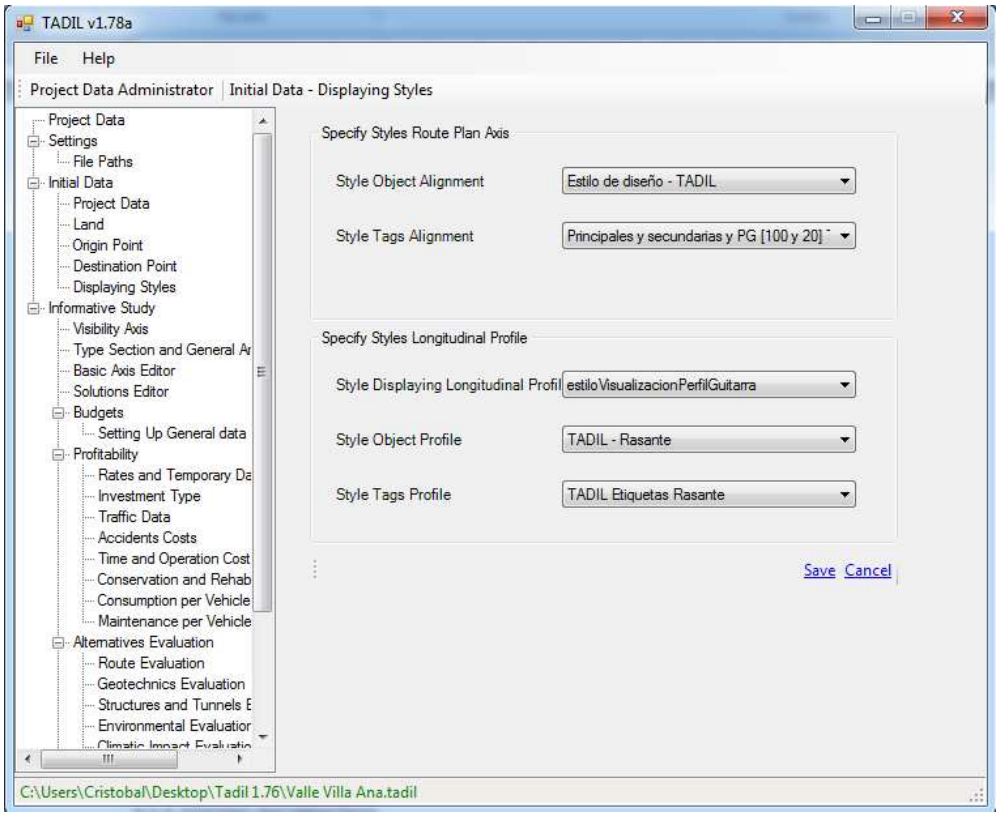


Image 83. Entering displaying styles by TADIL

9.3.4. INFORMATIVE STUDY

9.3.4.1. Visibility axis

At this point, we can calculate the automatic visibility axis between the end of the origin alignment and the start of the destination alignment.

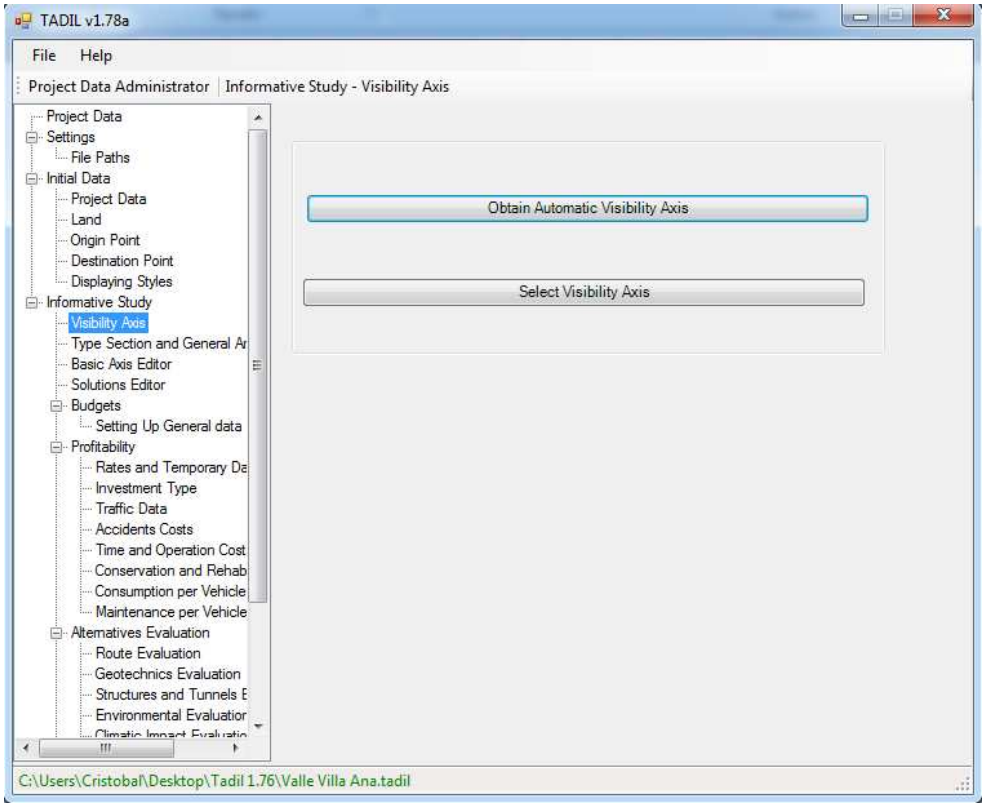


Image 84. Visibility axis

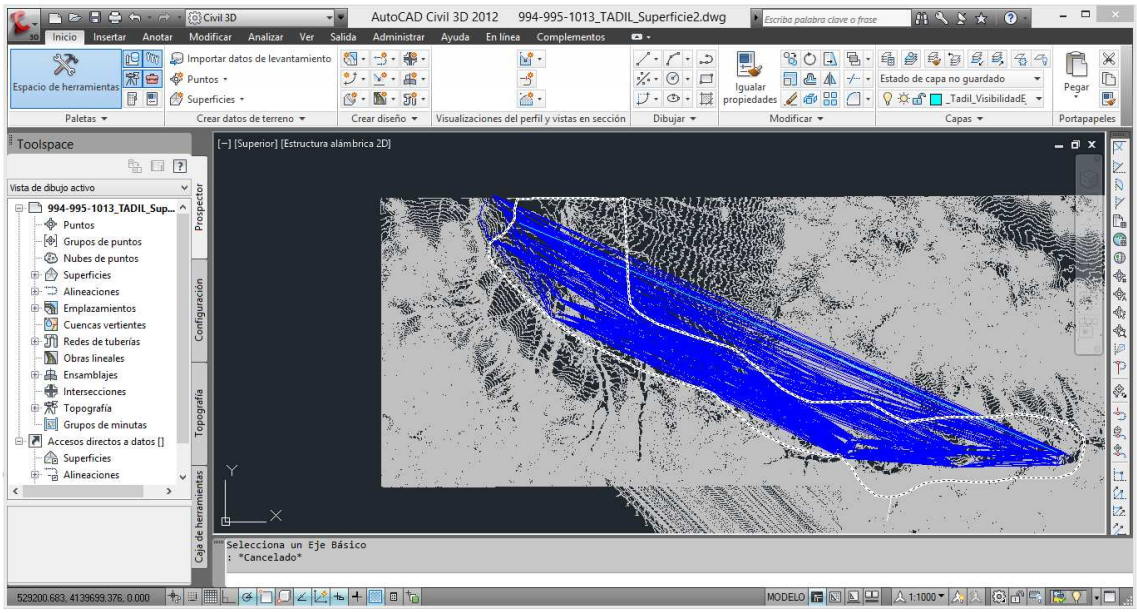


Image 85. Creating the automatic visibility axis.

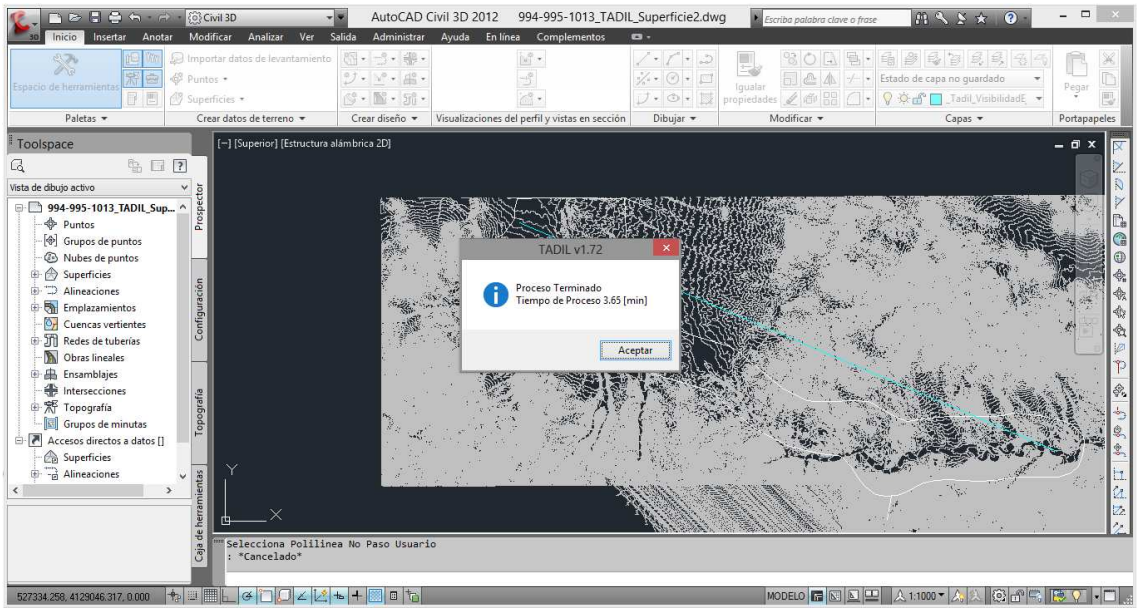


Image 86. Creating the automatic visibility axis and the invested time.

9.3.4.2. Select section, macro-prices and general areas

In this menu we can select, from the basis of prices, the group of macro prices which best fits with the the type of infrastructure we intend to develop. This will allow to complete the construction budget.

Likewise, we can select the general area for earthwork, foundation, structures and tunnels. The general area represents the dominant area in the studied sector, so that when a point does not belong to the a specific sector of earthwork, foundations, structures or tunnels, a general area is assigned. This process avoids problems from incorrect assignment of polylines and makes the calculation of homogeneous areas easier.

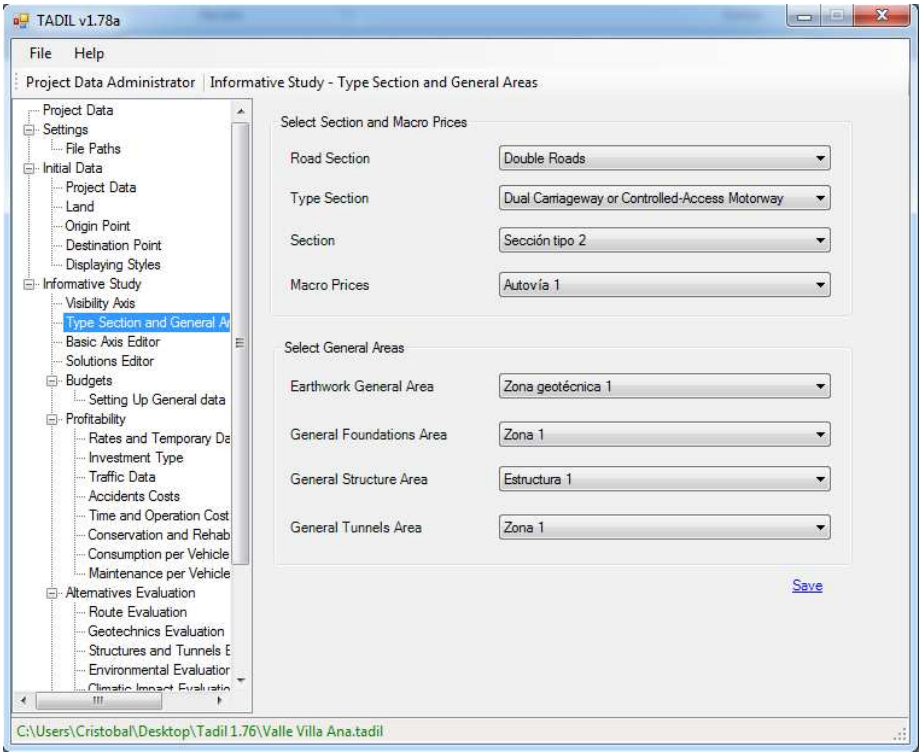


Image 87. Entering the section, macro-prices and the general areas

9.3.4.3. Basic Axis Editor

In this section we introduce the features of the infrastructure to plan. Unlike the previous study, we can see that in this case the tab "Geometry and Costs" does not appear. This is because in the informative study, data come from the Geographic Information System and from the construction units we have entered.

For our example, we have considered the same features than in the previous study, 120 km/h dual carriageway in the Class 1 and we allow isolated speed reductions and minimum kv. In the remaining menus, we have considered maximum slopes of 7% in roads and 5% in structures. We apply a 0.85 reduction coefficient to these values entered in the last tab.

For the dynamic evaluation we have also considered the same percentages of evaluation for distance, cost and orography.

Finally, we consider default values for calculating in the section Advanced Options 1.

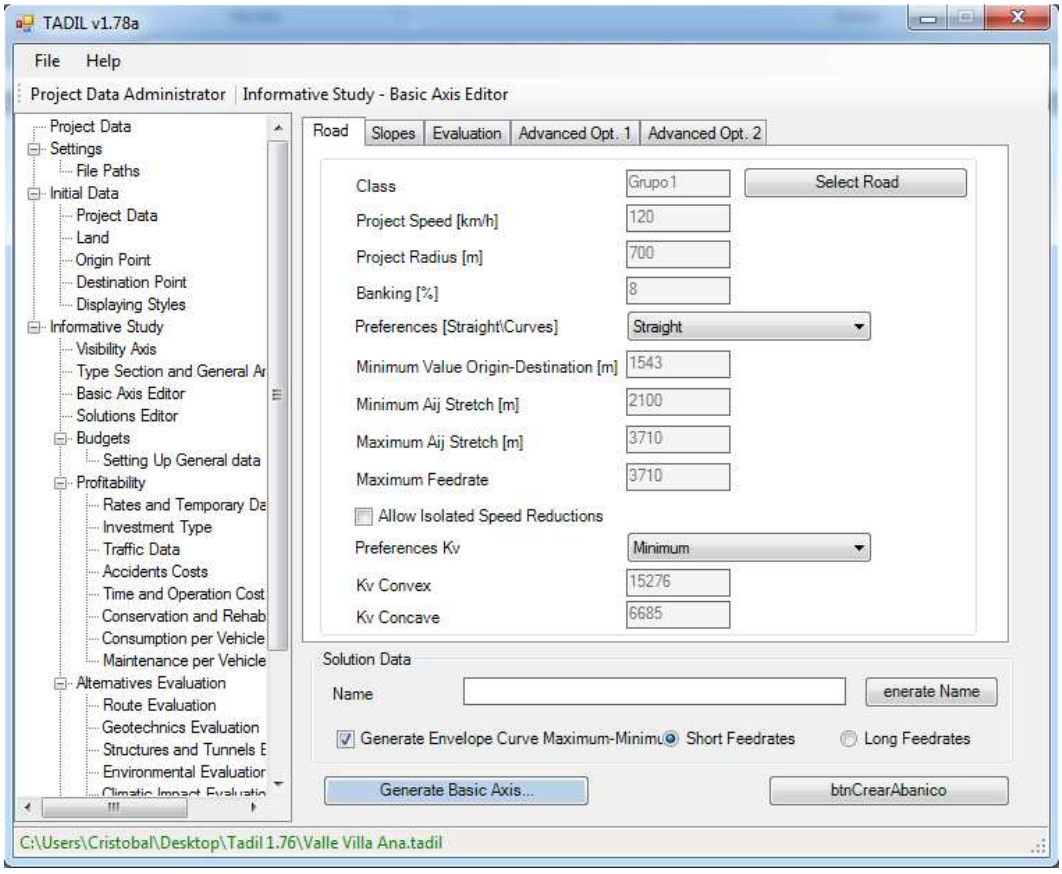


Image 88. Selecting the road.

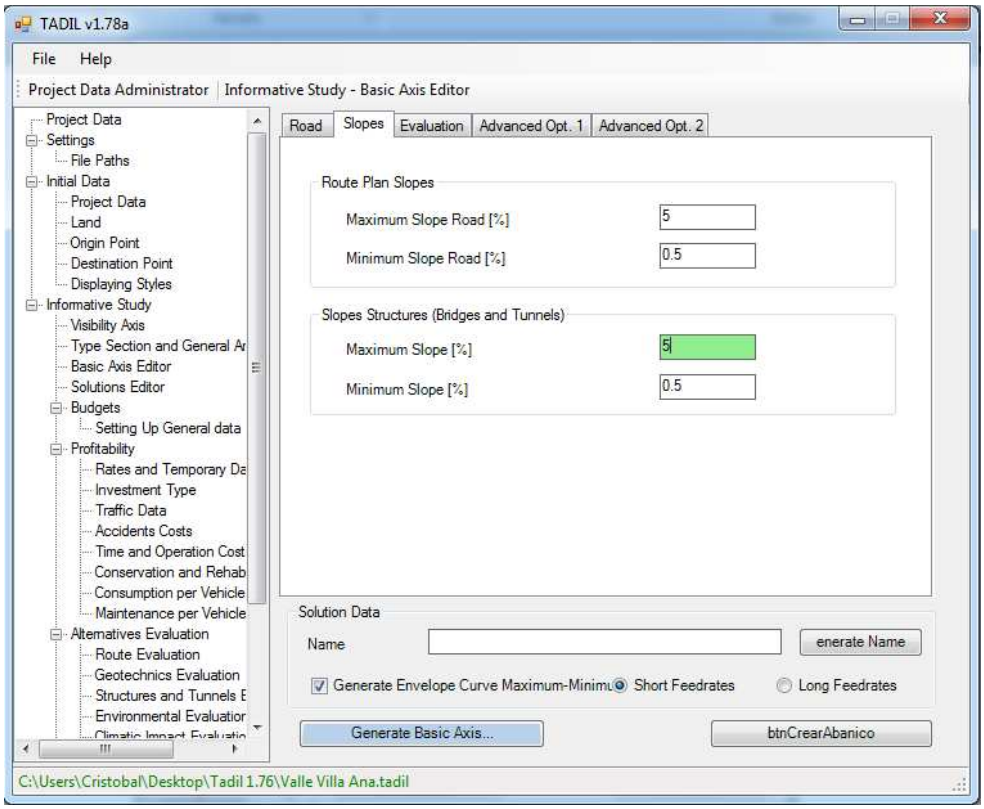


Image 89. Entering slopes.

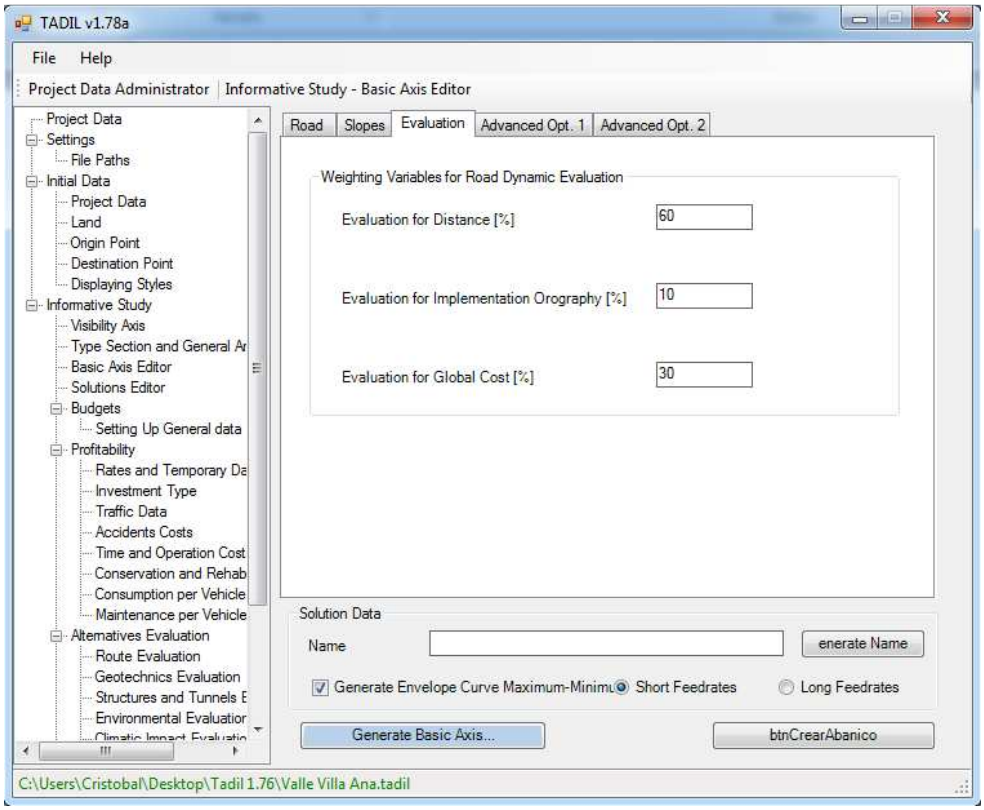


Image 90. Entering evaluations.

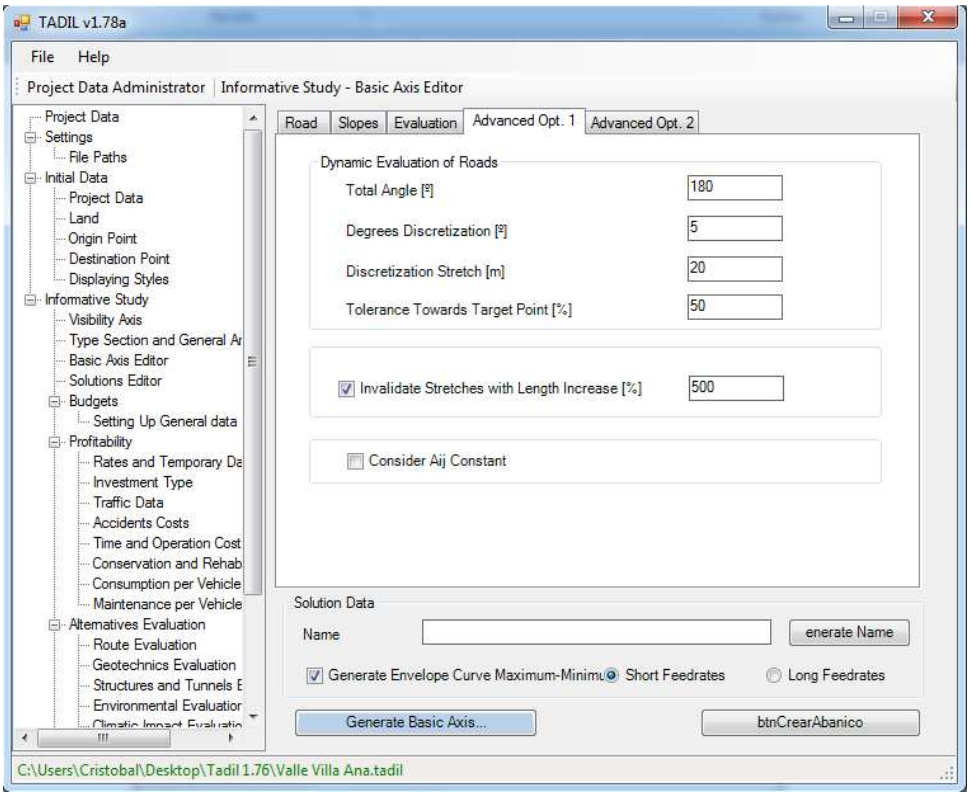


Image 91. Entering advanced options 1.

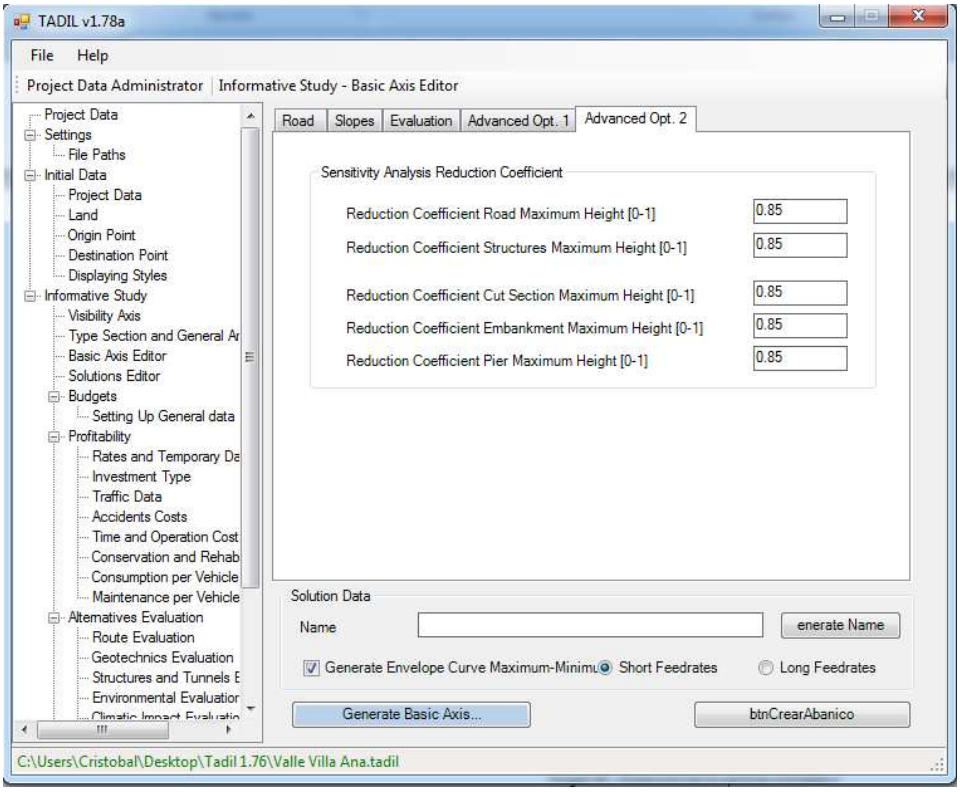


Image 92. Entering advanced options 2.

Then, we calculate the basic axis of the alternative itineraries.

First, we calculate the basic axis with two minimum and maximum envelope curves so generating three alternatives. Likewise, we calculate a fourth alternative by implementing long feedrates.

To carry out a meticulous study, we can also create manually a visibility axis, which would allow us to create more basic axis and, therefore, more alternatives. In our informative study we use the same visibility axis created in the previous study, by drawing the same polyline, clicking on "Select visibility axis" and clicking on the polyline. So, we have another visibility axis.

We generate three more alternatives with this new visibility axis, with short feedrates and generating minimum and maximum envelope curves. Therefore, we have a study with seven alternatives.

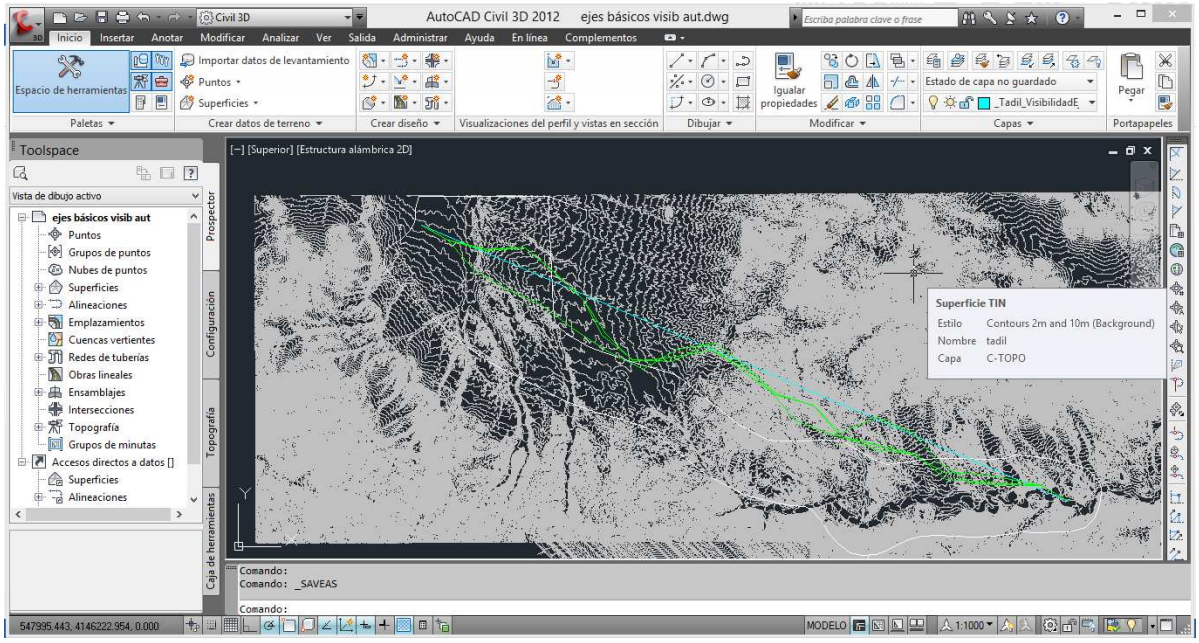


Image 93. Generating the three first basic axis

9.3.4.4. Solutions editor

Firstly, we calculate the basic axis related to the primary solution of the automatic visibility axis and its minimum and maximum envelope curves. The basic axis of the three alternatives will appear ticked as calculated in the solution editor.

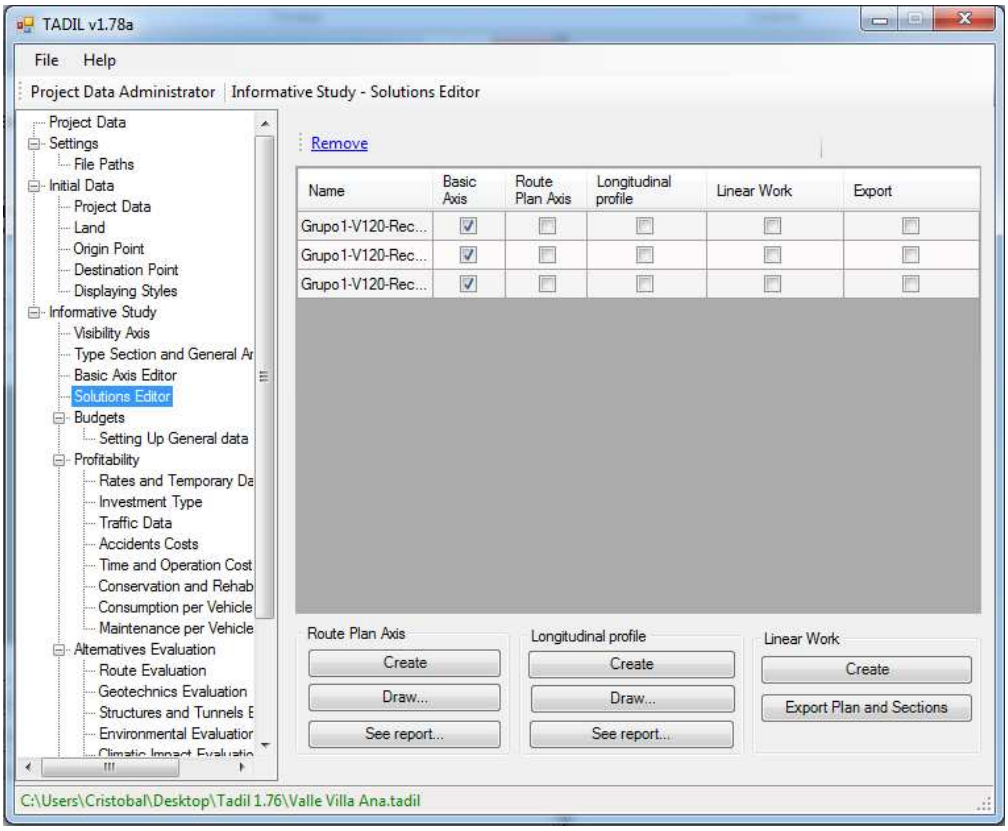


Image 94. Solutions editor.

- **Route plan**

Therefore, we can calculate the route plan axis solution by solution.

After doing that, they will appear ticked in the solution editor.

We can see the straight lines are coloured in red, the clothoids in green and the curves in yellow.

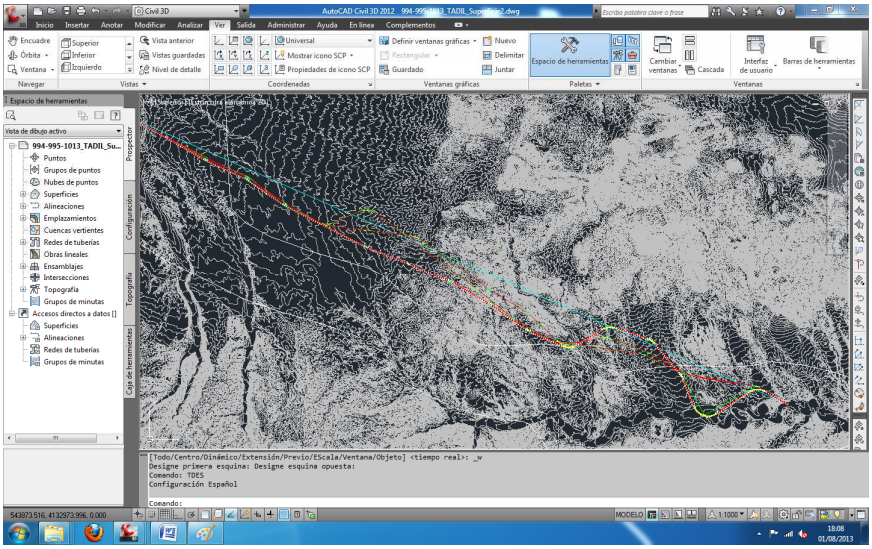


Image 95. Route plan axis of the primary solution.

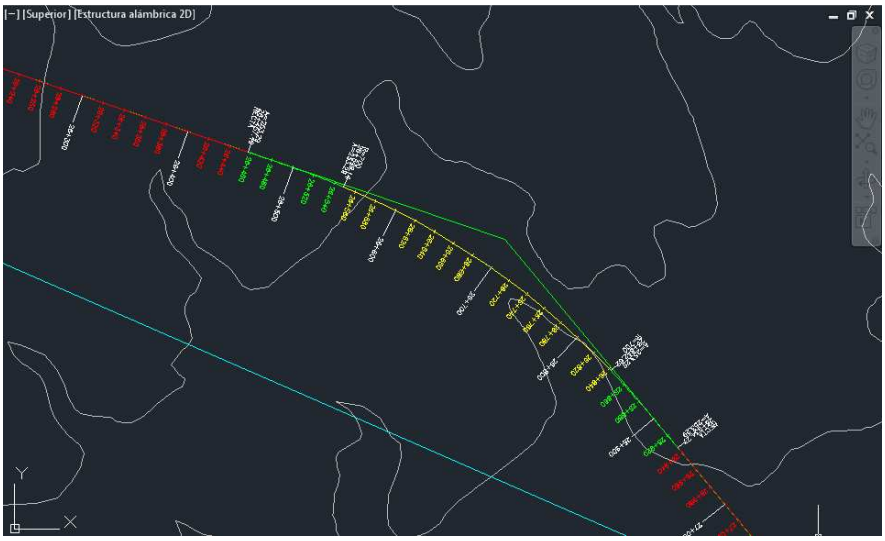


Image 96. "Route plan axis".

- **Longitudinal profile**

Next we calculate the longitudinal profile of the route, alternative by alternative. TADIL asks us to insert a point in the profile plan, we select a point out of the cartography and the longitudinal profile is placed in this location.

- Work Longitudinal Profile

To load the longitudinal profile, we should follow these steps:

a) In the tab "Home" from AutoCAD 3D we enable the "Toolspace"
b) In the tab "Prospector", we open "Alignments" and, inside this menu, we open "Axis Alignments".
c) We will get a number of names which are the solutions of the projects we are calculating. We open the menu of our solution and, inside it, we open the menu "Profiles Views".
d) We select the name of our solution, we right-click and we click on "Properties". Then, we can see the dialogue box "Properties of Profile Views".
e) Over the tab "Information", in the drop-down menu "Object Style" we select the file TADIL - Perfil. We click on "Apply" and we save.
f) In the tab "Bands", in the table we go to "Cota de rasante", "Cota roja - Desmonte" and "Cota roja - Terraplén", in the box "Perfil 2" and we select the name of our solution, which finishes with the word "rasante". We click on "Apply" and we save.
g) To load the data of vertical transition curve on undulating track, we must select the grade line of our project, we right-click and we click on "Edit labels". Then, the box "Profile Labels" will appear. We click on "Import Label Set" and we select the default label set of TADIL or the set created by the user. We click on the drop-down menu "Type" and we select which data we want to represent in our work longitudinal profile. In our example, we have just selected convex and concave transition curve on undulating track.

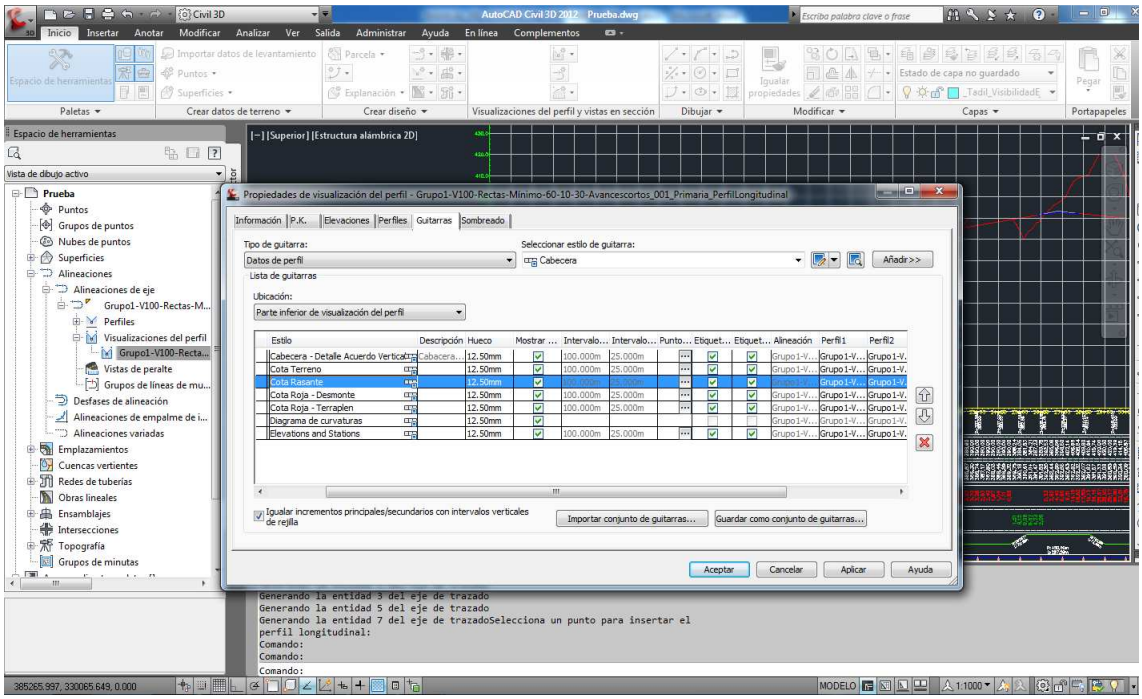


Image 97. Loading the work longitudinal profile.

- Labelling longitudinal profile TADIL

TADIL also includes a button which allows labelling the longitudinal profile when the linear construction calculation has finished.

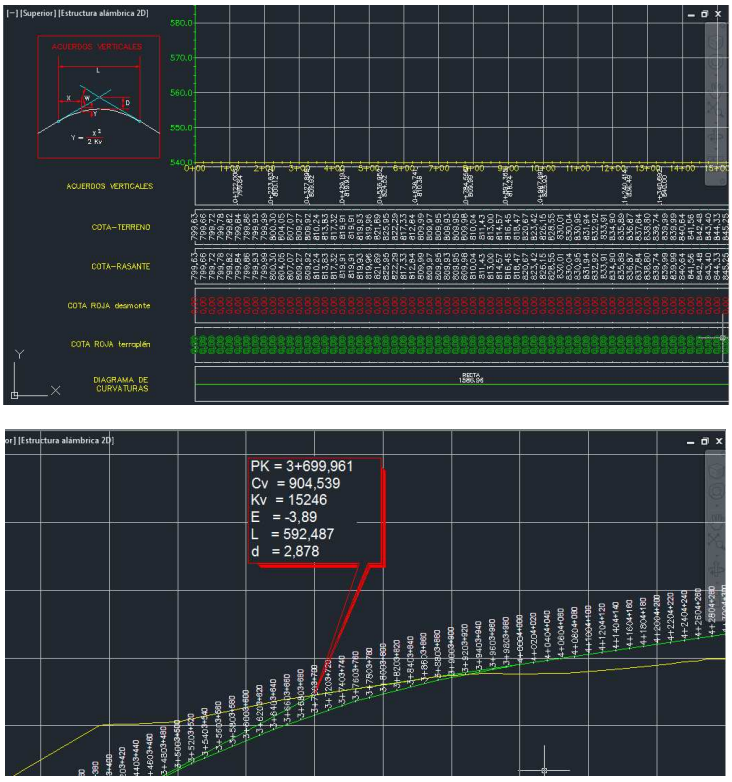


Image 98. Labelling longitudinal profile TADIL.

In the solution editor, the calculated longitudinal profiles are ticked.

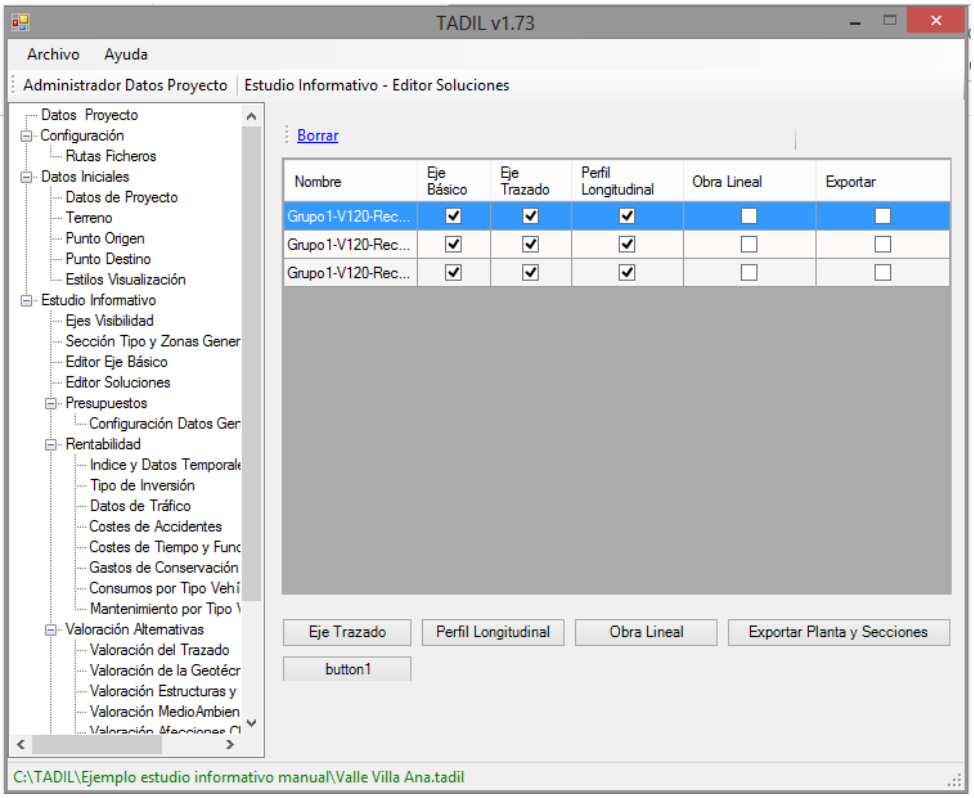


Image 99. Calculation longitudinal profile.

- **Linear Work**

Finally, we calculate the linear work. Unlike in the previous study, in the informative study we can obtain the cross sections, the earthwork plan and the measures which we will use for making the earthwork balance and the budget. At the same time, we will use the budget for obtaining the profitability and, finally, with all the information and the GIS information we can evaluate the alternatives and select the solution.

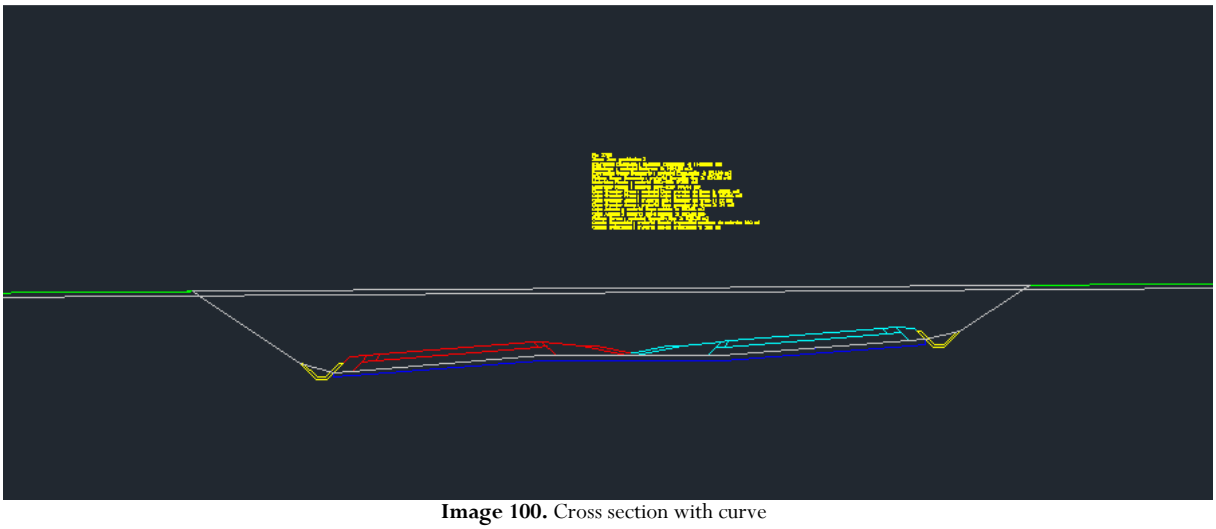


Image 100. Cross section with curve

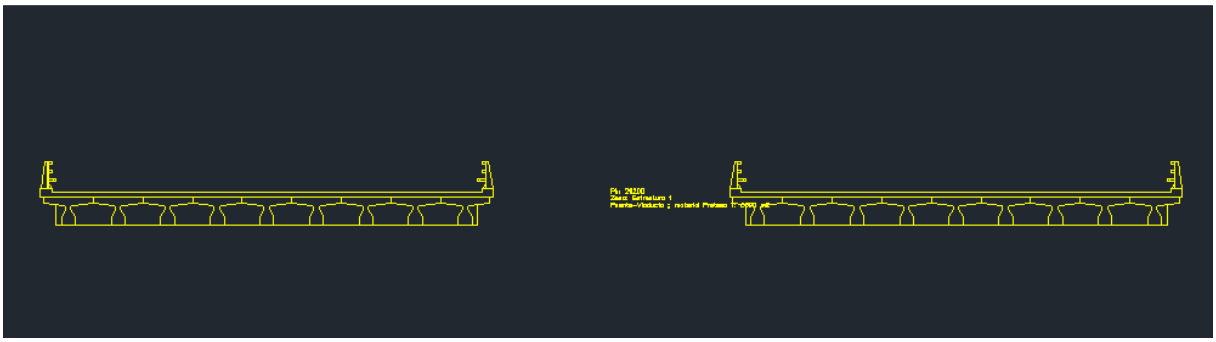


Image 101. Cross section with structure

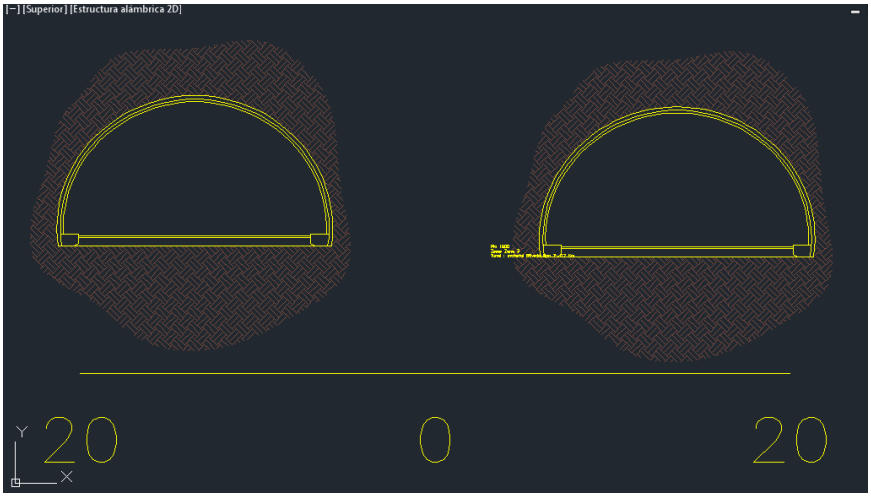


Image 102. Cross section with tunnel

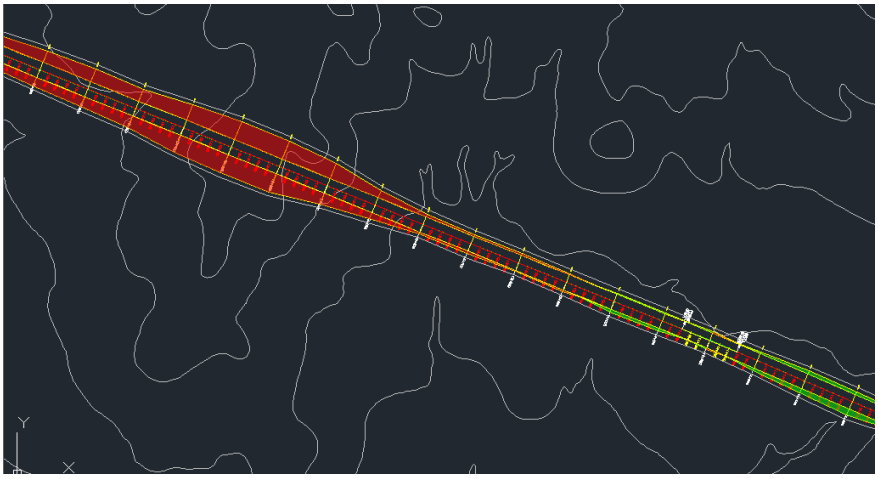


Image 103. Earthwork plan

We will make the calculation alternative by alternative; upon completing, the box of calculated linear work will be ticked in the solution editor.

With each calculation, there will appear the drawing of the cross sections and the earthwork plan, as we can see in the previous images. In sections, in addition to the pk, we can see the measure section by section.

Just like we did with these three alternatives, we make the alternatives with long feedrates and the three alternatives from the visibility axis manually introduced.

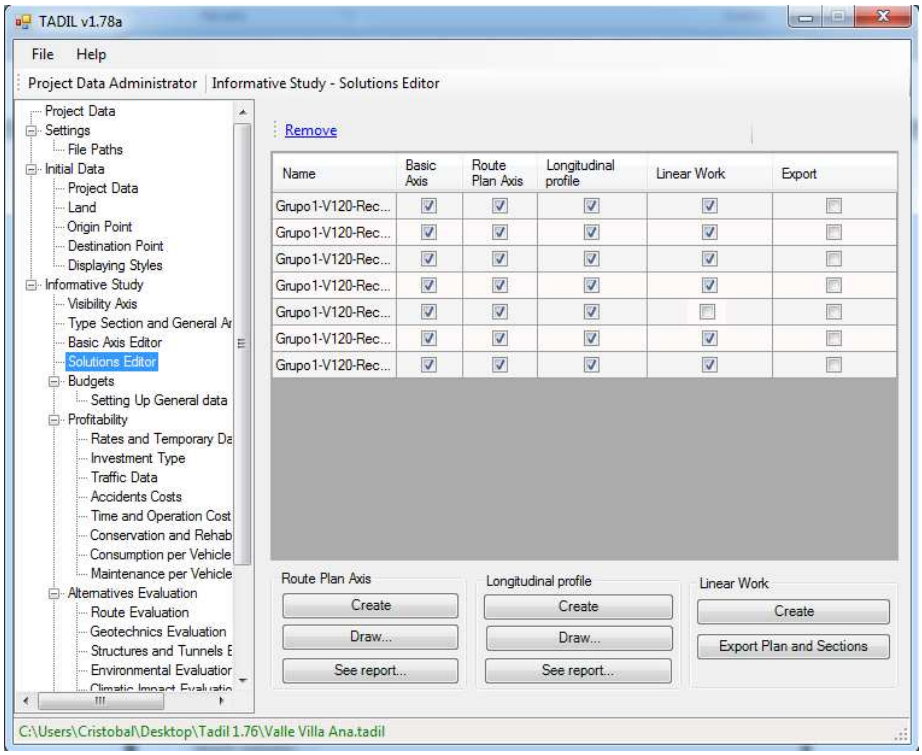


Image 104. Calculation of the seven alternatives.

TADIL warns that one the of alternatives, in particular, the minimum envelope curve of the primary basic axis from the visibility axis manually introduced, fails to comply with the conditions. Therefore, we rule out this option and we continue with six alternatives.

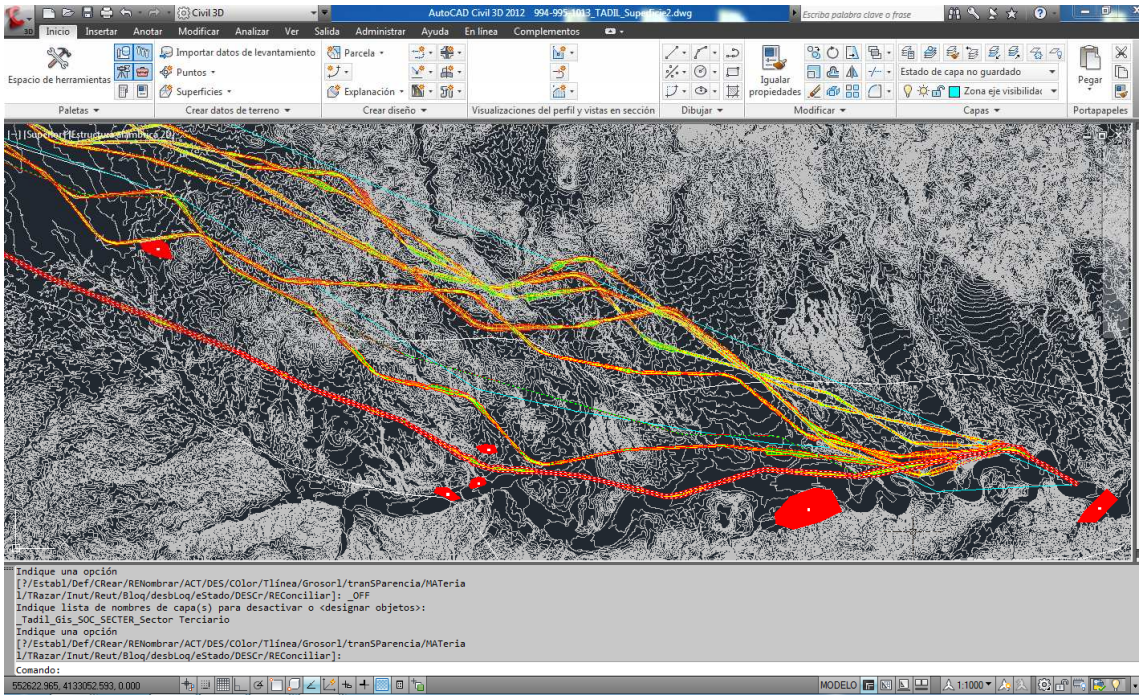


Image 105. Detail of the plan of the six alternatives which have a solution.

To download the memory to the work file, we can export both the plan drawing and the cross sections drawing to another file.

TADIL asks us to save the file of cross sections and plan and the box "Export" will be then ticked.

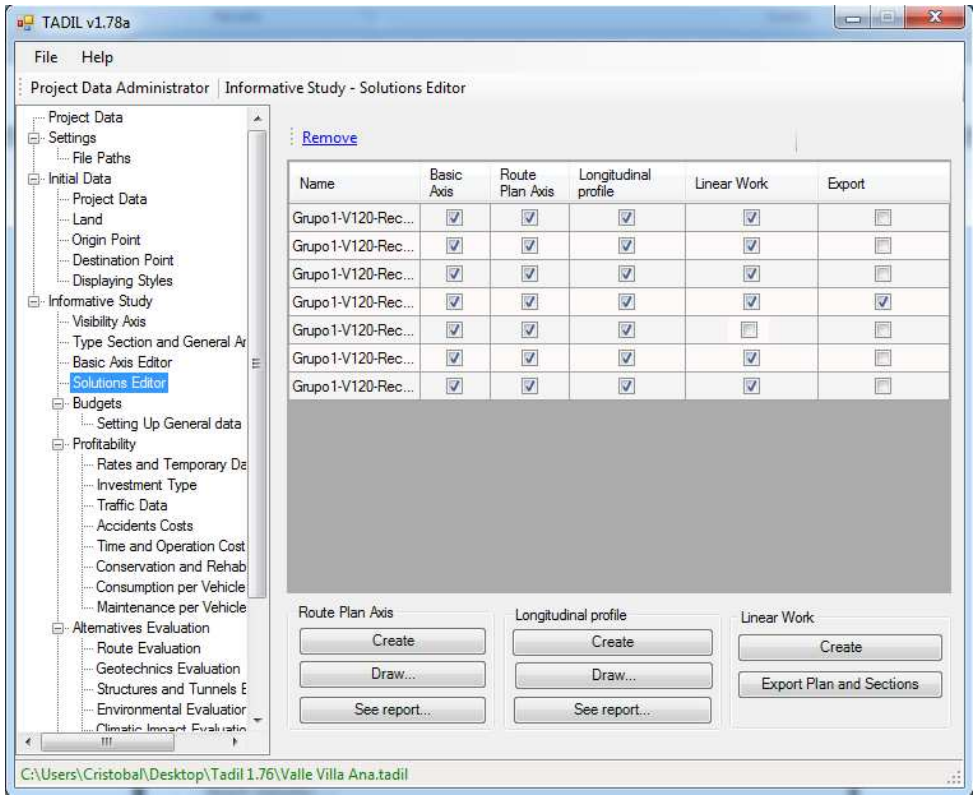


Image 106. Exporting the plan and cross sections of one of the alternatives.

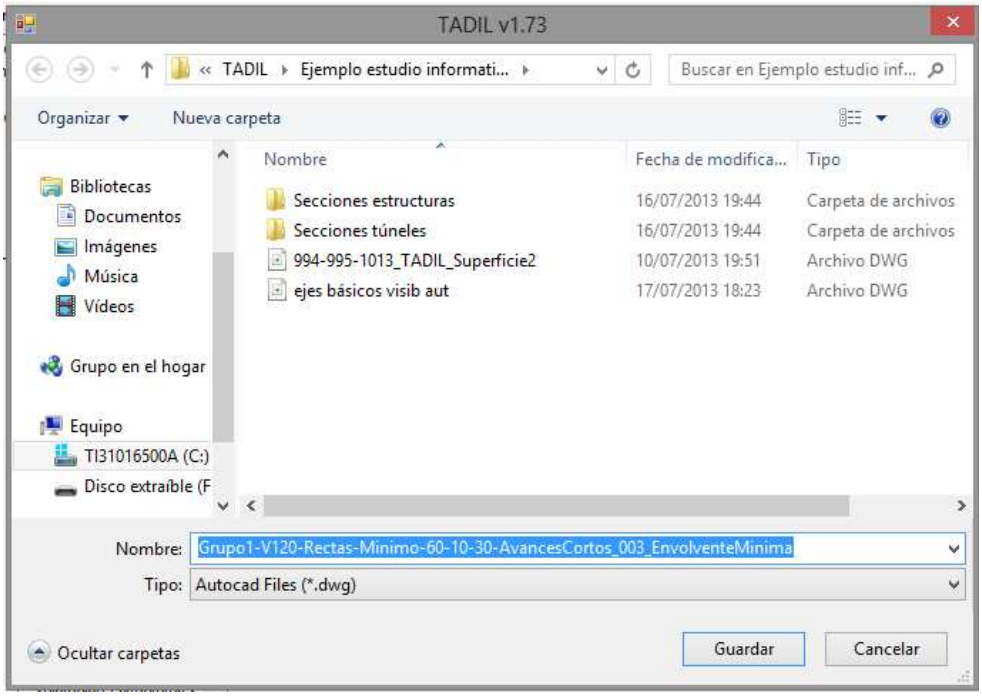


Image 107. Saving the exported .dwg

9.3.4.5. Entering budget data

Once we have calculated the linear work, we can obtain the budget of every alternative, after entering some data though.

These data allow to specify the budget of material execution and the bid budget. That is, the general costs, the industrial benefit, the quality control, the patrimonial conservation, landscape restoration and so forth. We enter the material execution as percentage (See the Methodological Guide). Finally, the VAT will allow us to determine the tax part in the budget.

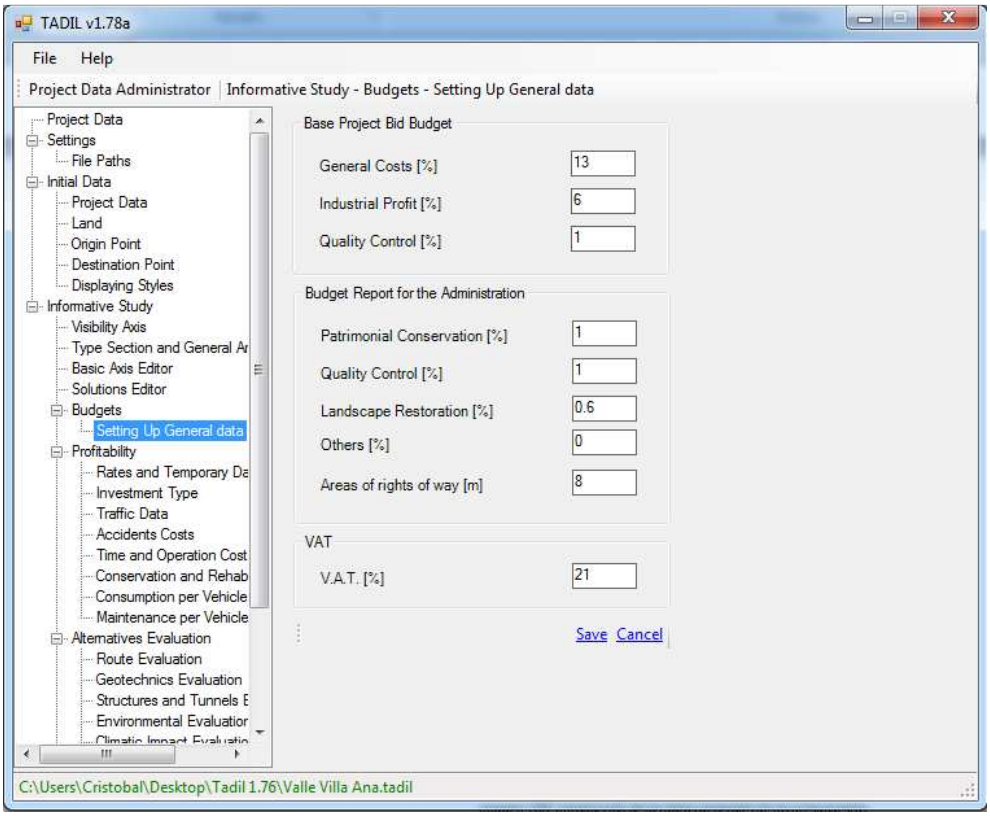


Image 108. Entering general data of budgets.

With the aforementioned values, we calculate the Budget Material Execution, the Base Project Bid Budget and, finally, the Budget Report for the Administration of every alternative.

Once we have calculated the budgets, we can move on to know the profitability of every alternative.

9.3.4.6. Entering profitability data

Here we are going to analyse the profitability of the investment. We recommend reading the Methodological Application Guide to face more clearly the profitability study.

- **Rates and Temporary Data**

To carry out the profitability study year by year, we need to specify the exploitation period, the duration years of the infrastructure construction and the rates: update rate, CPI and the coefficient of review of construction prices (increase of construction prices during the construction period). (See Methodological Guide).

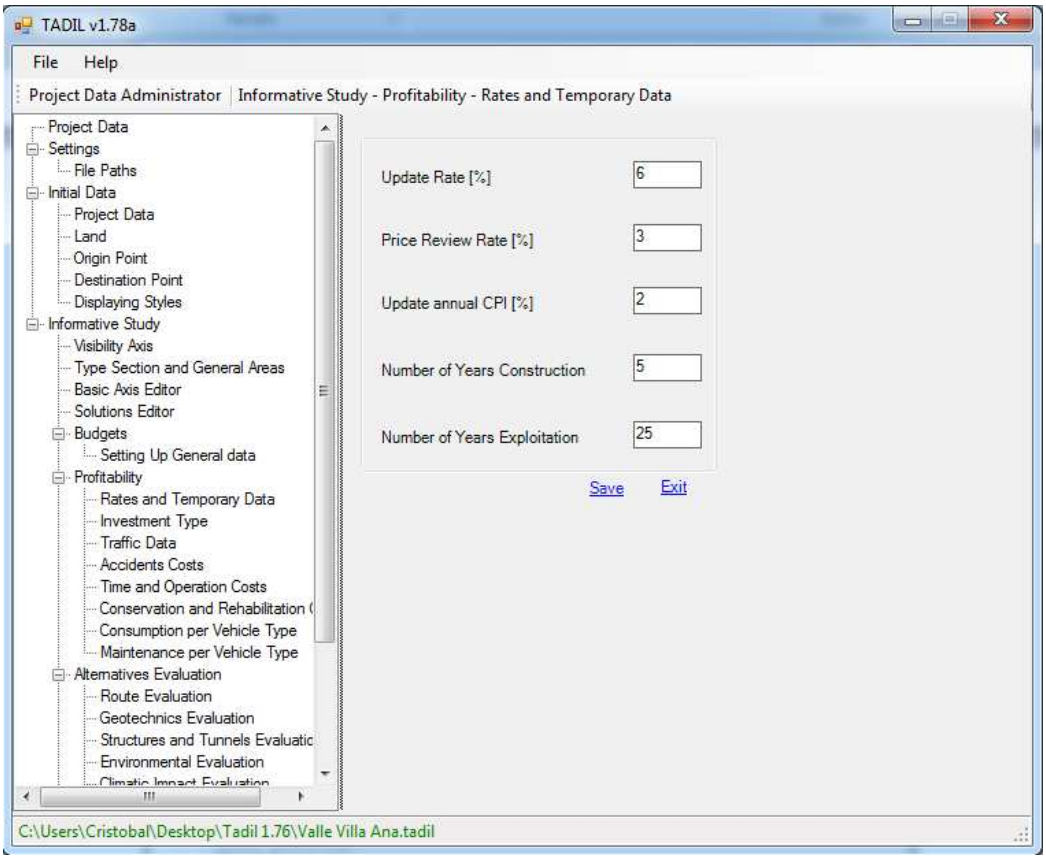


Image 109. Entering the rates and the temporary data.

- **Investment Type**

The second step is to specify the kind of investment; that is, if we are before a public or private investment or, if appropriate, a mixed one.

For the example, Valle Villa Ana we have firstly considered public investment. Subsequently, we will carry out the analysis for a private development with public collaboration.

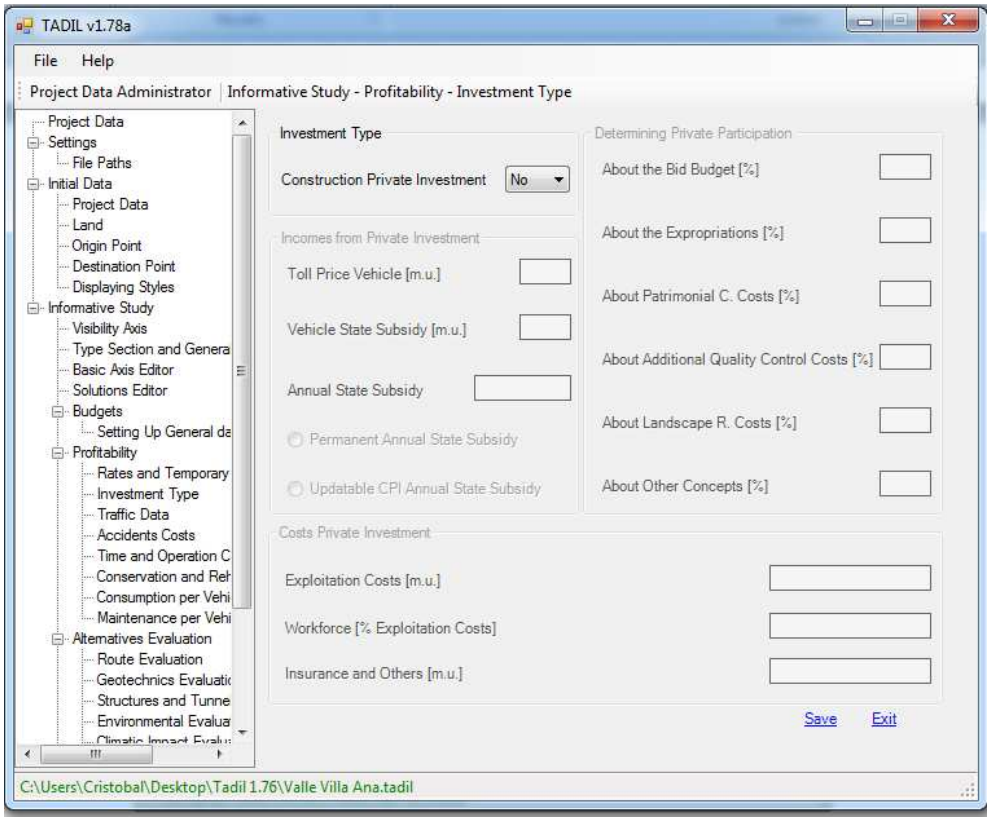


Image 110. Entering the investment type data.

As we can see, those data related to private investment are disabled.

- **Traffic Data**

The next step is to specify the traffic data related to the inherent action. We consider we should start from a traffic study made during the phase of previous study.

In TADIL we enter data of the current connection and we specify if we maintain it or not.

As well, we indicate the ADT and the foreseen growth, the percentage of heavy vehicles and the foreseen traffic absorption for the new connection; we also enter the percentage of foreseen heavy vehicles.

It should be noted that if we do not maintain any former connection, the traffic absorption percentages of the new one will be 100% and the maintenance and rehabilitation costs from the former connection will not apply during the exploitation period.

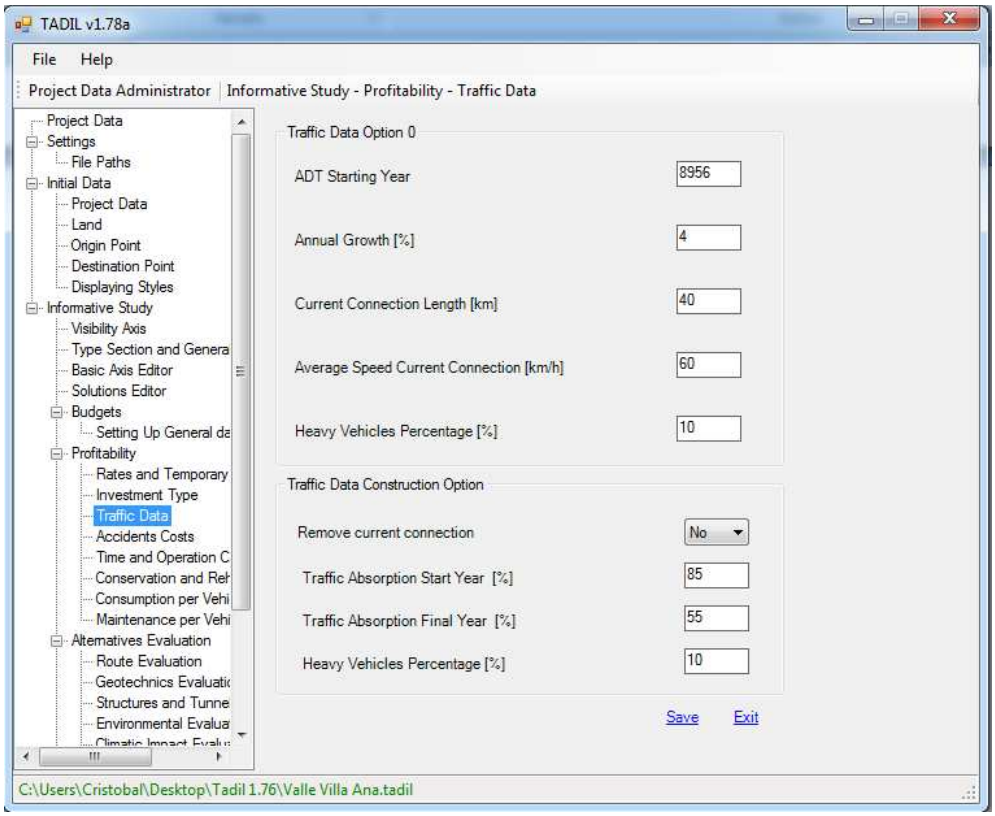


Image 111. Entering the traffic data.

Once we have entered the traffic data, we move on to specify all the remaining data regarding accident costs, time and operation, conservation and maintenance.

- **Accident Costs**

In the section Accident Costs, we enter the corresponding death and hazardousness data of the current connection and of the new one as well, the number of injured per accident, the cost per death and per injured (See Methodological Guide).

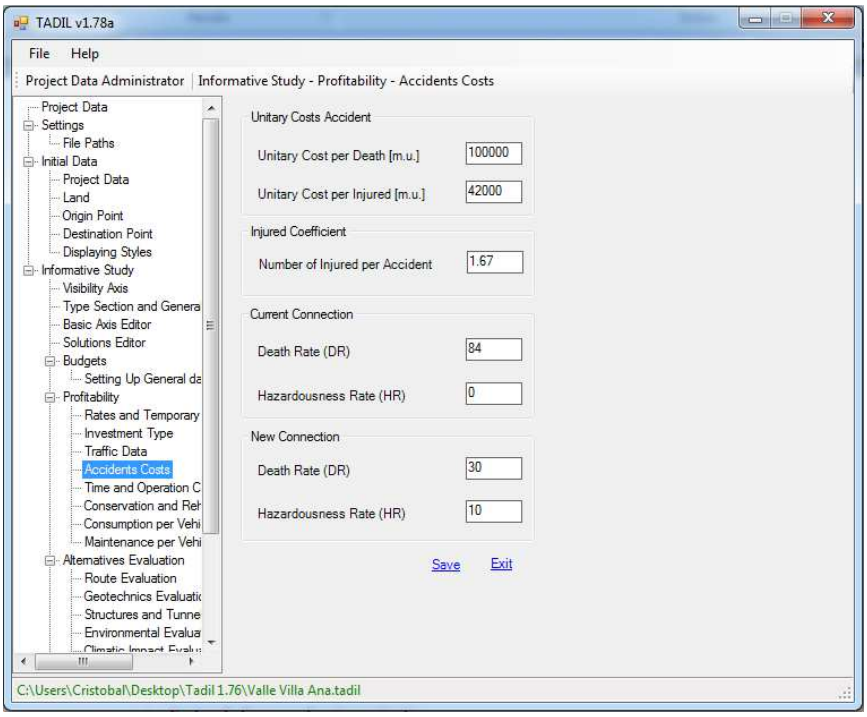


Image 112. Entering the accident costs data.

- **Time and Operation Costs**

In the section Operation Costs, we indicate the fuel and lubricant costs, the tyres costs and the vehicle pay-off cost, the time cost as well as a weighting coefficient which estimates the percentage of professional journeys , where time costs is attributable to the moving people costs (See Methodological Guide). These costs are specified for light and heavy vehicles.

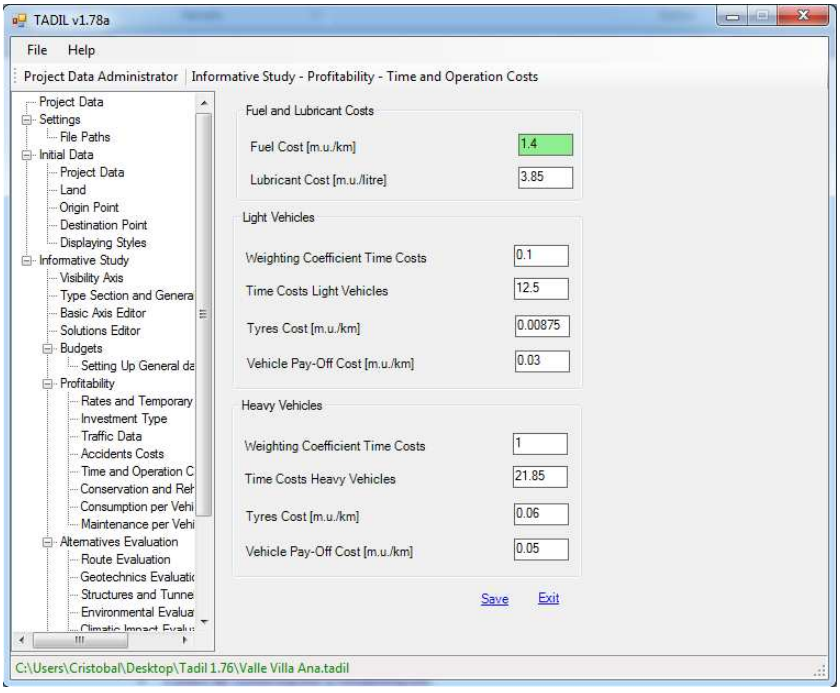


Image 113. Entering the time and operation costs data.

- **Conservation and Rehabilitation Costs**

TADIL allows entering conservation and maintenance costs of the new and the former connection.

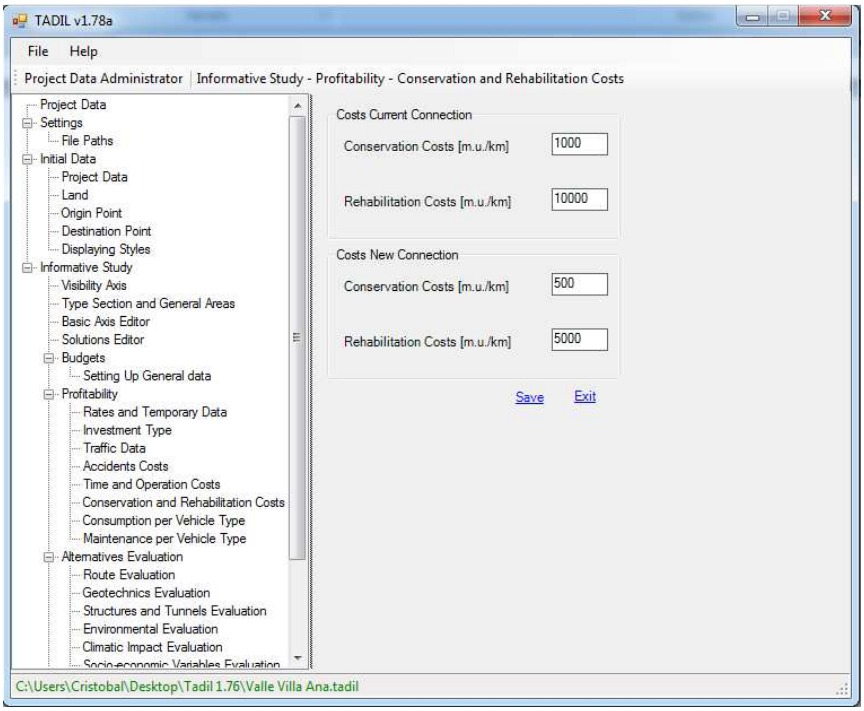


Image 114. Entering the general data about conservation and rehabilitation costs.

- **Maintenance and consumption costs per vehicle type**

The maintenance and consumption costs per vehicle, regardless it is light or heavy, can be edited in lists according to the average speed of vehicles, and saved.

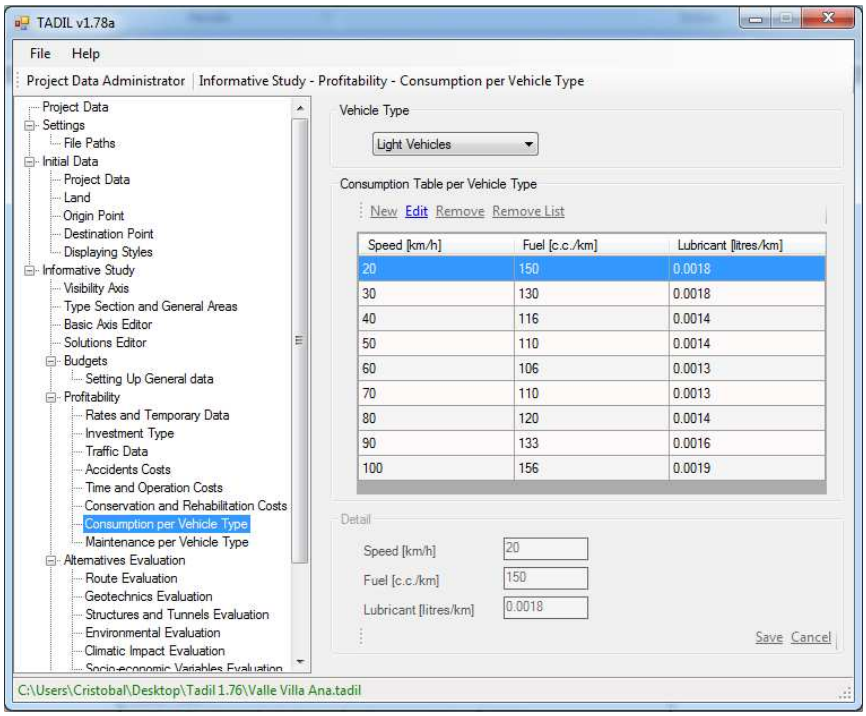


Image 115. Modifying the data related to consumption per vehicle according to speed.

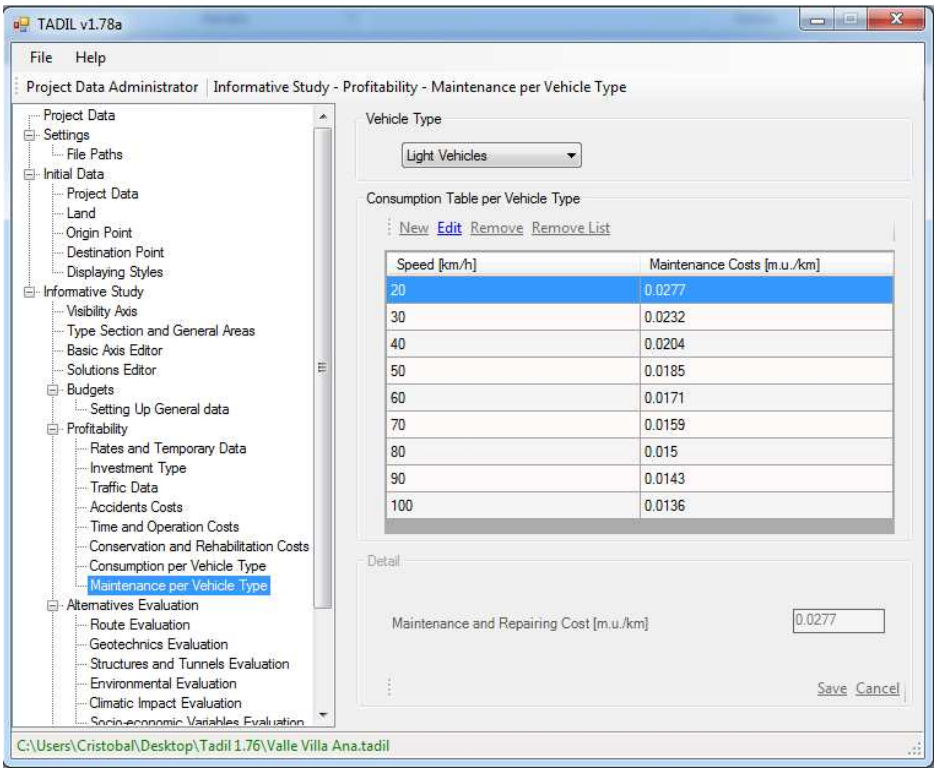


Image 116. Modifying the data related to maintenance per vehicle according to speed.

With all the aforementioned data, TADIL calculates the profitability of variables and obtains the IRR, the IRP, the relationship benefit/cost and the NPV (See Methodological Guide).

9.3.4.7. Entering data of alternatives evaluation

This is the last step in the informative study. In this section we have to evaluate the different alternatives and select the best solution.

So, we need to specify the percentage of every variable in each chapter.

We should enter the weighting percentages of next chapters:

- Draft
- Earthworks Geotechnics
- Structures, Tunnels and Walls Geotechnics
- Environmental Variables
- Climatic variables
- Socioeconomic Sectors
- Patrimonial variables
- Economic Variables

In the Methodological Guide we detail the formula we use for every variable in each chapter.

TADIL offers local and global marks. As for global marks, a final evaluation on a 10 point scale is given. For the best solution we have 0.

For each group of variables, the alternative with a 0 will be the best.

We must once again insist on clicking on "Save" after entering the data in each menu (even with default data).

The scores we have given to our informative study are the following:

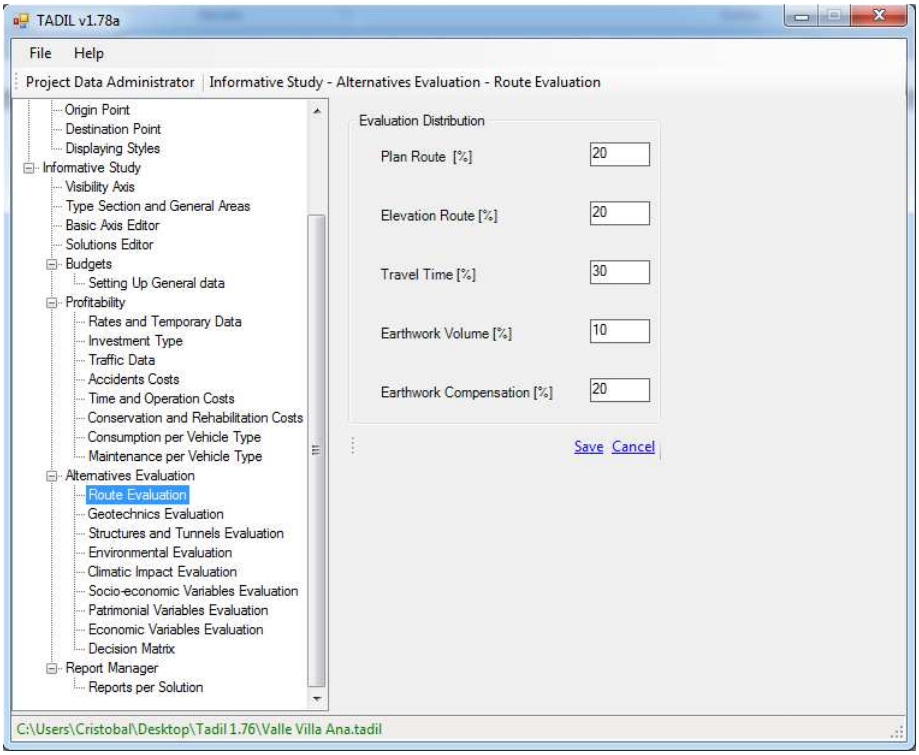


Image 117. Entering the weighting percentages of the route plan variables.

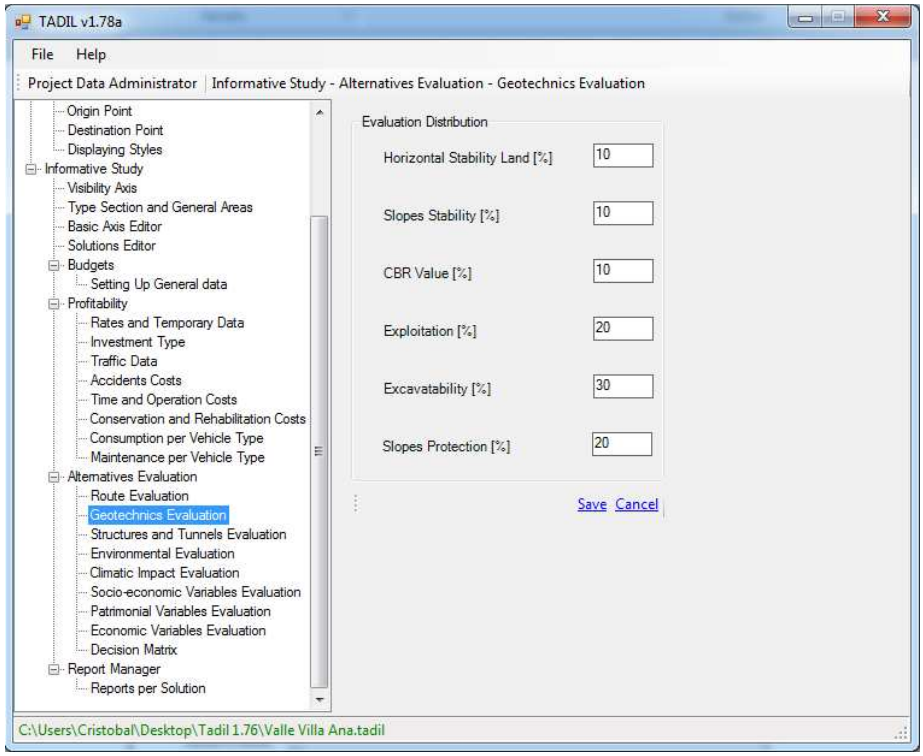


Image 118. Entering the weighting percentages of the geotechnical variables.

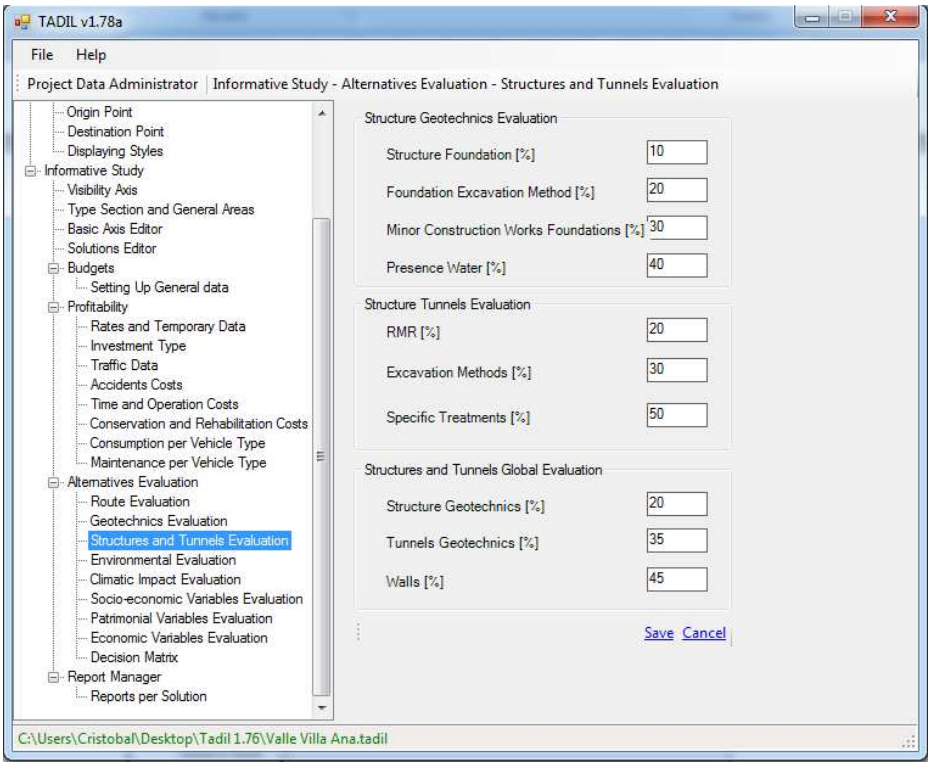


Image 119. Entering the weighting percentages of the geotechnical variables of tunnels, structures and walls.

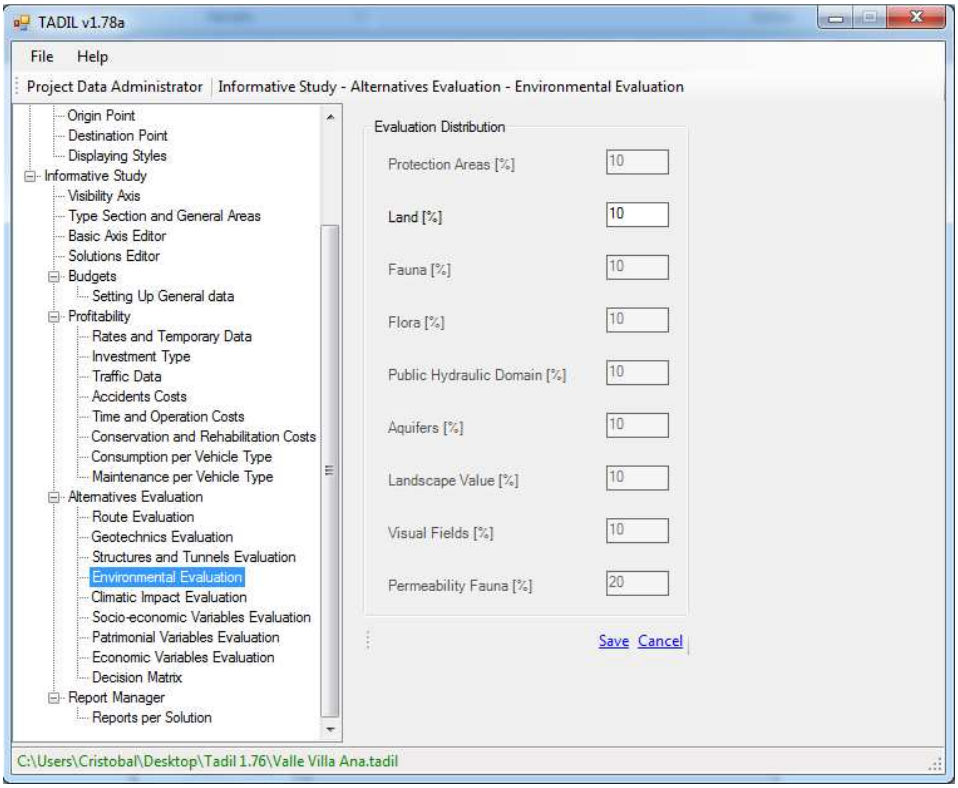


Image 120. Entering the weighting percentages of the environmental variables.

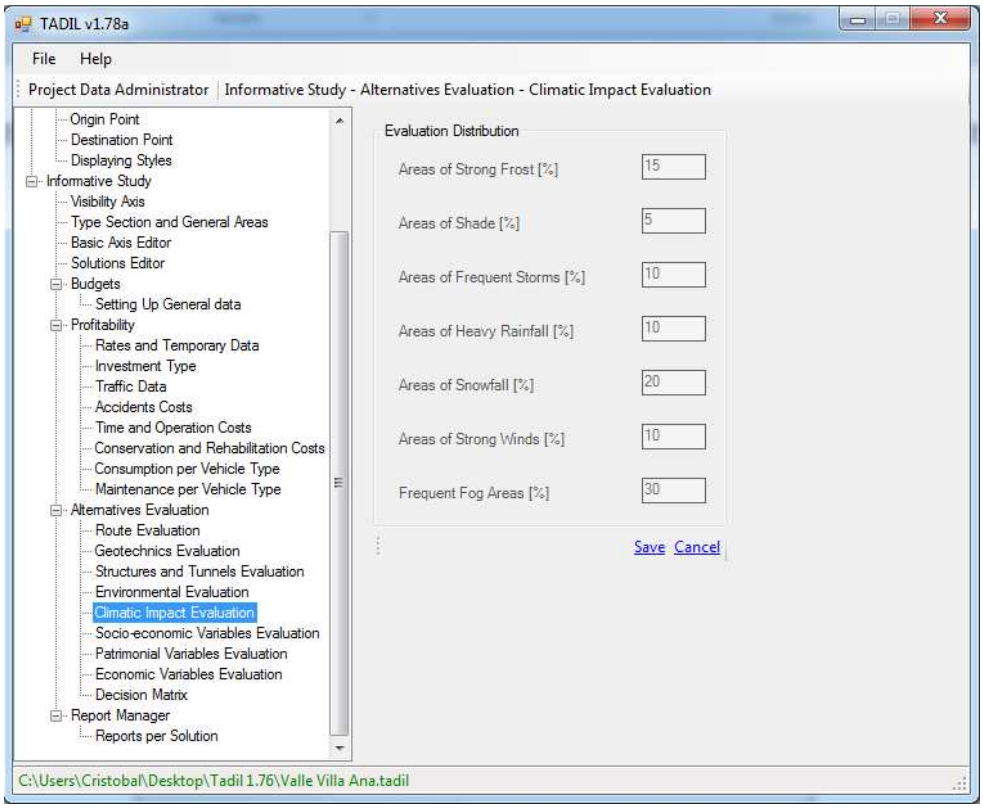


Image 121. Entering the weighting percentages of the climatic variables.

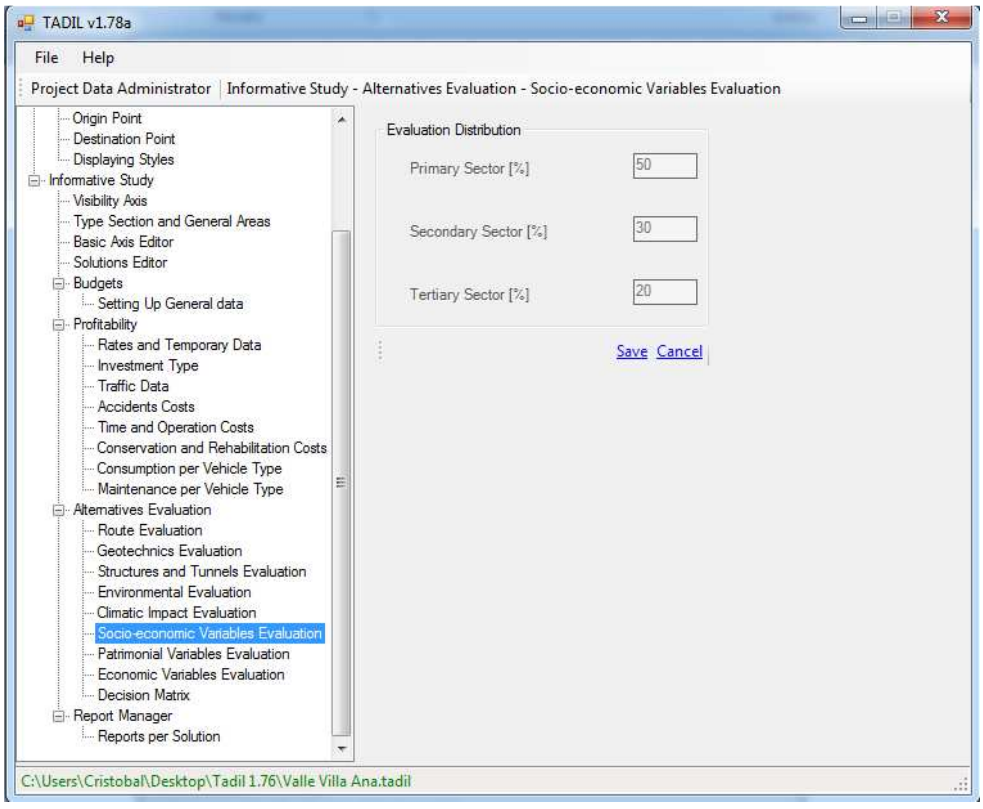


Image 122. Entering the weighting percentages of the socioeconomic variables.

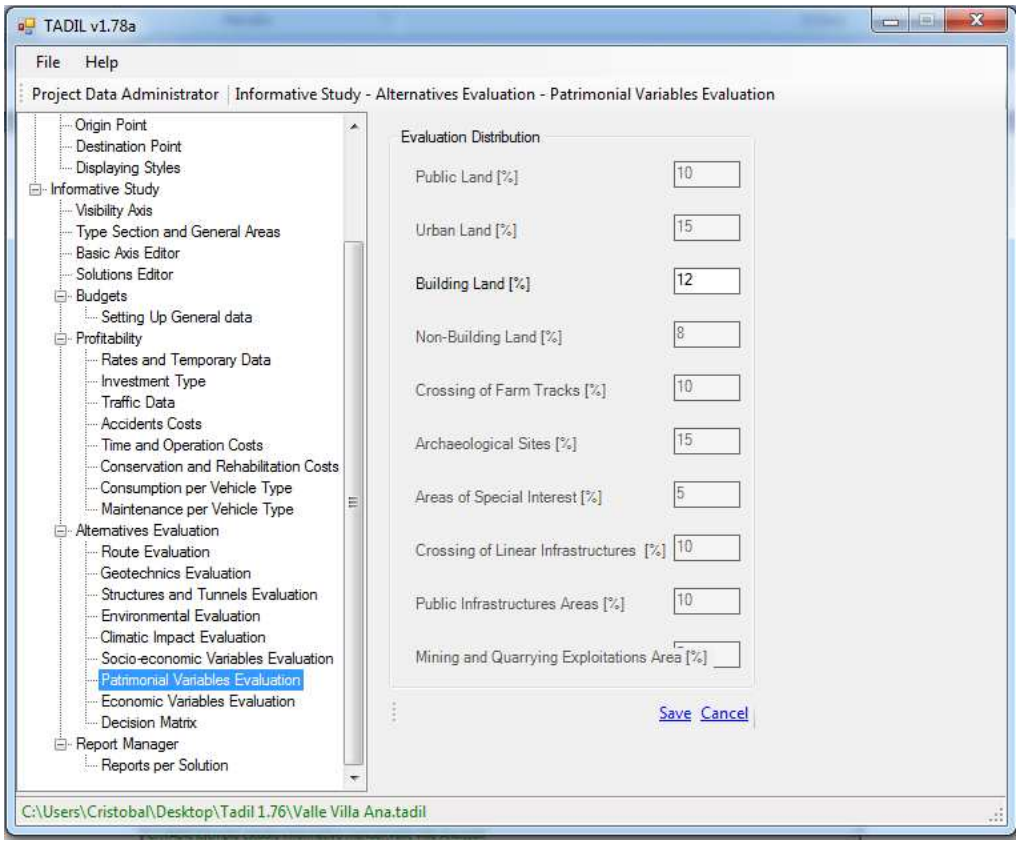


Image 123. Entering the weighting percentages of the patrimonial variables.

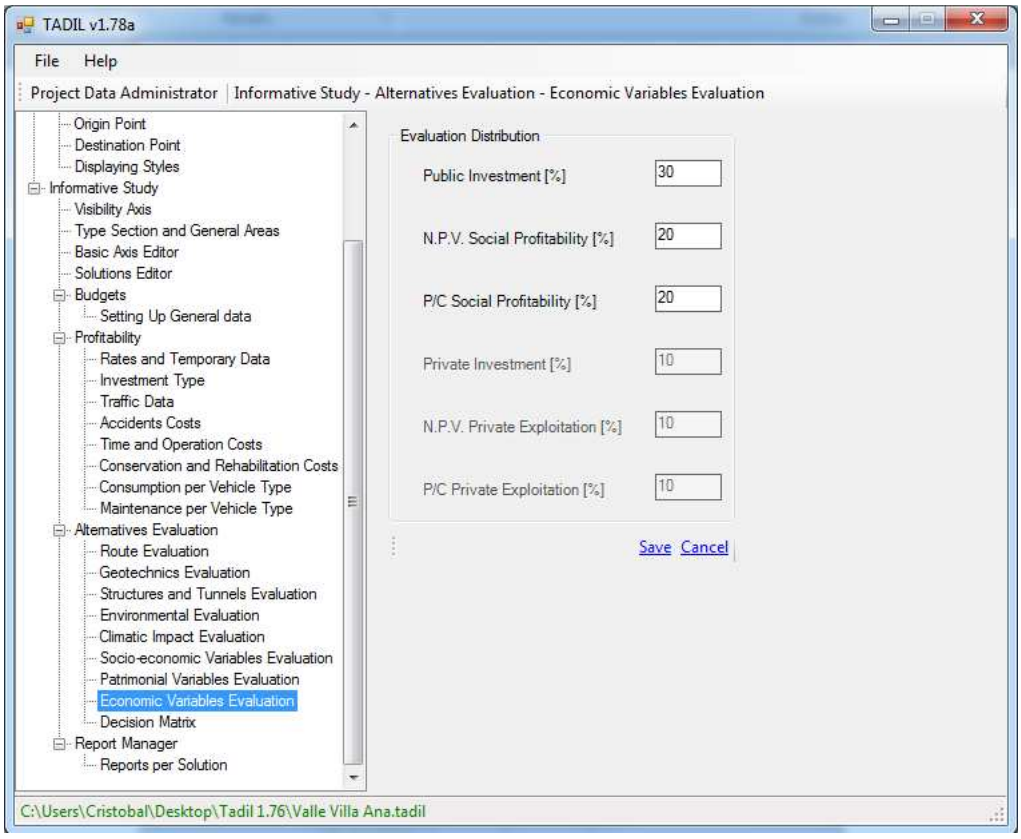


Image 124. Entering the weighting percentages of the economic variables.

- **Decision Matrix**

With the aforementioned data, TADIL move on to calculate the evaluation of all the alternatives by suggesting as solution that of less score (0, as global mark).

In the section Decision Matrix, TADIL shows the marks of each alternative; in addition, we can consult the marks chapter by chapter of every alternative and, finally, every variable of each chapter.

Previously, we should have specified which alternatives we want to evaluate and the weighting hypothesis of chapters [see Methodological Guide).

Afterwards, we click on "Evaluate Solutions for Hypothesis".

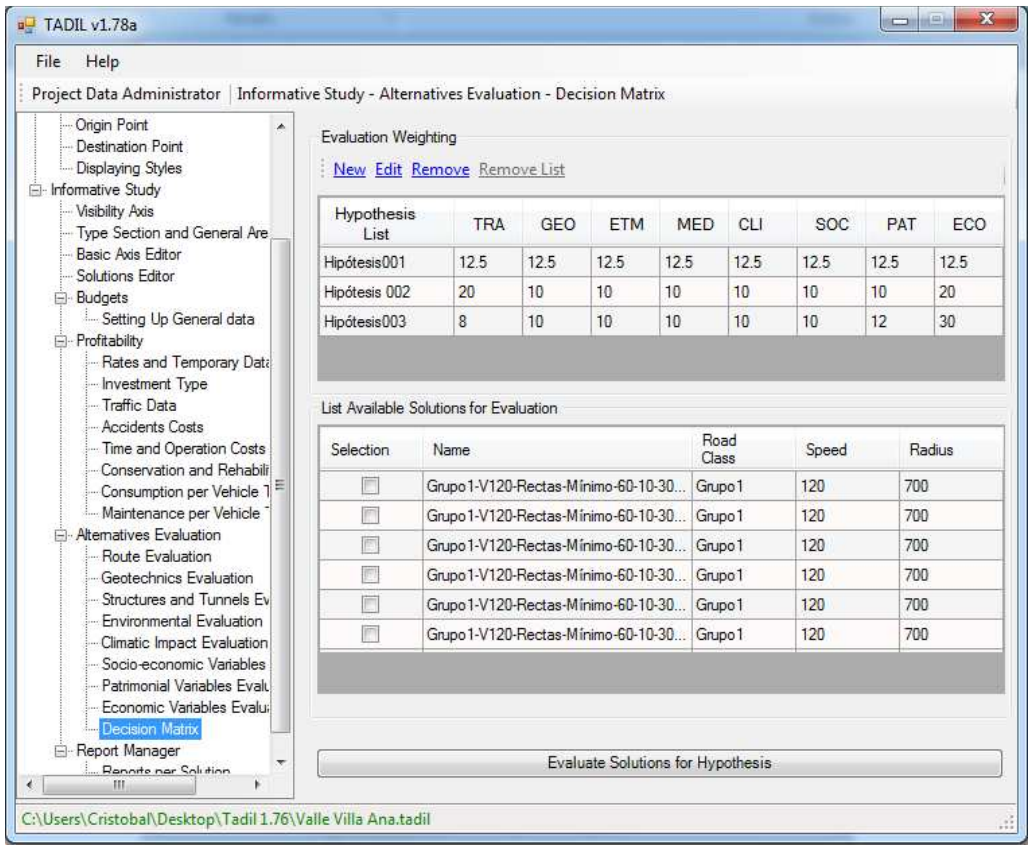


Image 125. Entering the weighting percentages in the decision matrix and selecting the alternatives to be evaluated.

Once TADIL shows the hypothesis-evaluated solutions list, we can obtain a succinct report (first button) or a detailed report (second button).

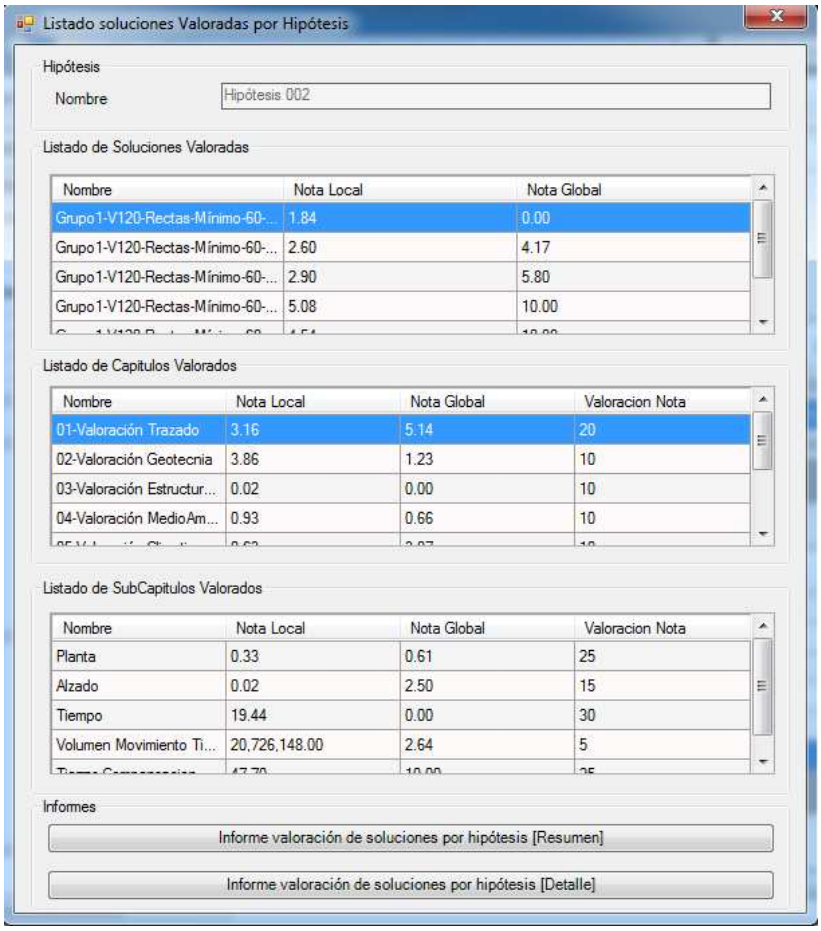


Image 126. Obtaining evaluations per alternative.

The process described previously has been made for six alternatives, which it is a quite complete study.

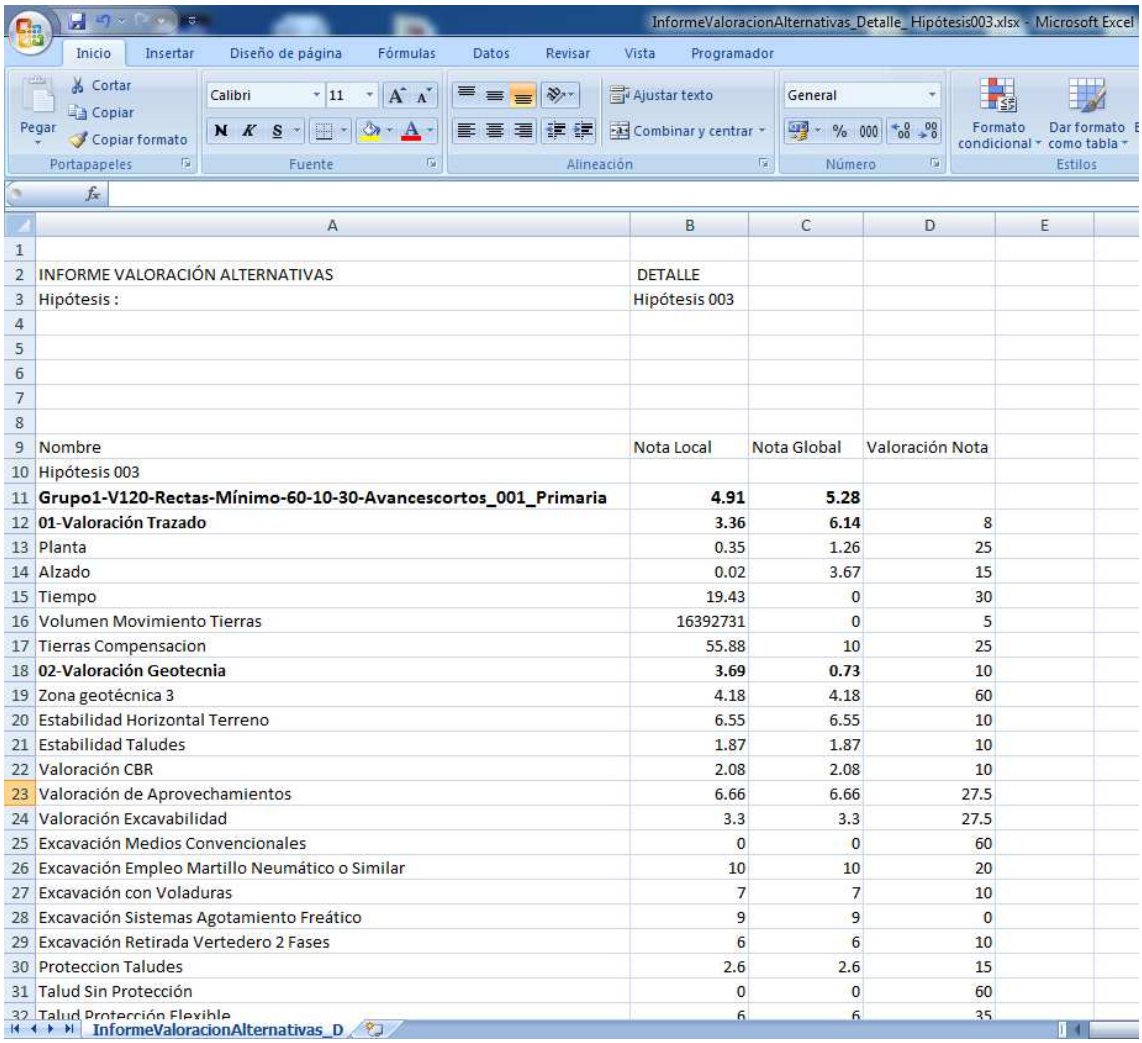
Finally, to these six alternatives, we can add some others by doing the following:

- Modify the type of investment, including private investment.
- Include long feedrates in the basic axis calculation (we have included only one).
- Modify the coefficients of reduction.

For a study of this kind, we consider the following points to be a good analysis:

- obtaining more or less 20 to 30 route basic axis.
- between 10 and 20 route axis calculated with their longitudinal profiles.
- a minimum of 6 alternatives with linear works completely calculated and ready to enter in the decision matrix.

Next we show the evaluation report for the six alternatives we have studied:



	A	B	C	D	E
1					
2	INFORME VALORACIÓN ALTERNATIVAS	DETALLE			
3	Hipótesis :	Hipótesis 003			
4					
5					
6					
7					
8					
9	Nombre	Nota Local	Nota Global	Valoración Nota	
10	Hipótesis 003				
11	**Grupo1-V120-Rectas-Mínimo-60-10-30-Avancescortos_001_Primaria**	**4.91**	**5.28**		
12	**01-Valoración Trazado**	**3.36**	**6.14**	8	
13	Planta	0.35	1.26	25	
14	Alzado	0.02	3.67	15	
15	Tiempo	19.43	0	30	
16	Volumen Movimiento Tierras	16392731	0	5	
17	Tierras Compensacion	55.88	10	25	
18	**02-Valoración Geotecnia**	**3.69**	**0.73**	10	
19	Zona geotécnica 3	4.18	4.18	60	
20	Estabilidad Horizontal Terreno	6.55	6.55	10	
21	Estabilidad Taludes	1.87	1.87	10	
22	Valoración CBR	2.08	2.08	10	
23	Valoración de Aprovechamientos	6.66	6.66	27.5	
24	Valoración Excavabilidad	3.3	3.3	27.5	
25	Excavación Medios Convencionales	0	0	60	
26	Excavación Empleo Martillo Neumático o Similar	10	10	20	
27	Excavación con Voladuras	7	7	10	
28	Excavación Sistemas Agotamiento Freático	9	9	0	
29	Excavación Retirada Vertedero 2 Fases	6	6	10	
30	Proteccion Taludes	2.6	2.6	15	
31	Talud Sin Protección	0	0	60	
32	Talud Protección Flexible	6	6	35	

Image 127. Example list of evaluation per alternatives.

9.3.4.8. Report obtaining

Once we have evaluated the alternatives, we can obtain the editable files of budget and profitability as well as the evaluation reports. We go to the last tab "Reports per Solution", where we can find three more tabs, the first one is for budgets, the second one for profitability and the third one, for geometric aspects of the work.

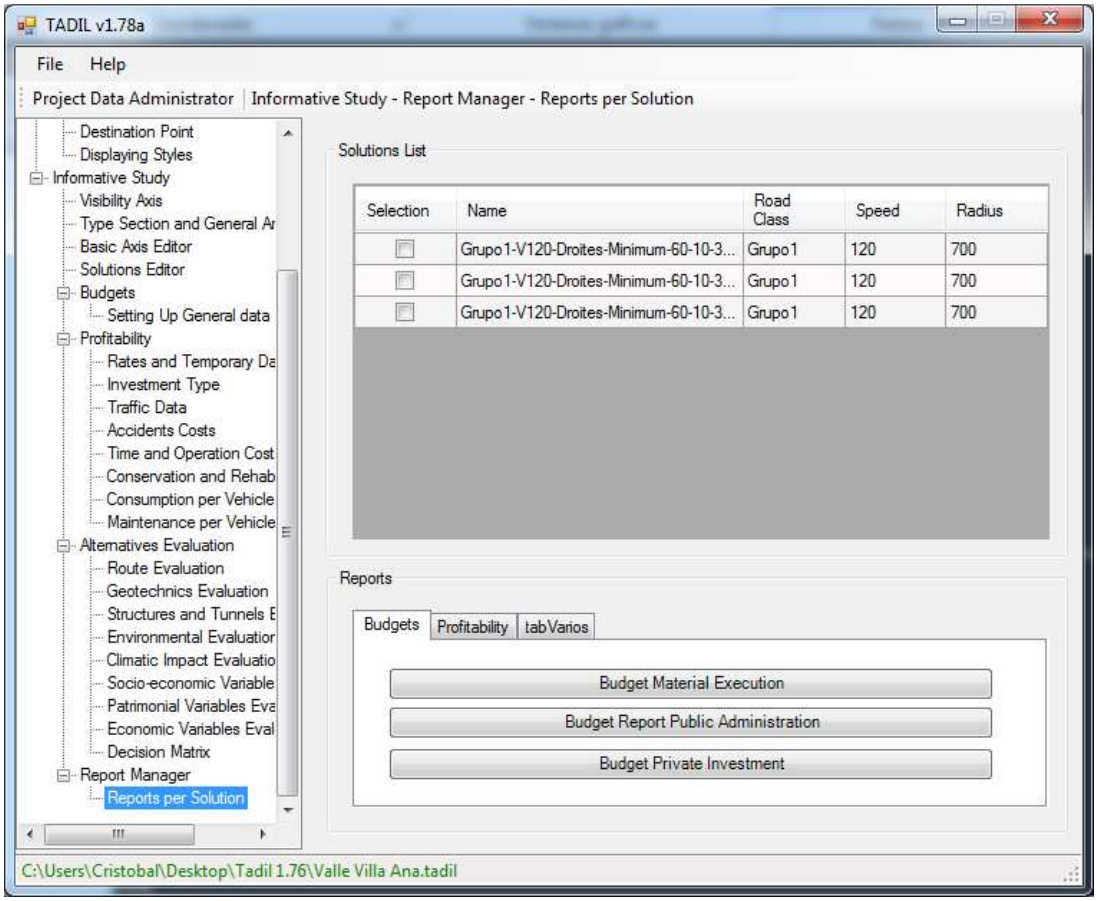
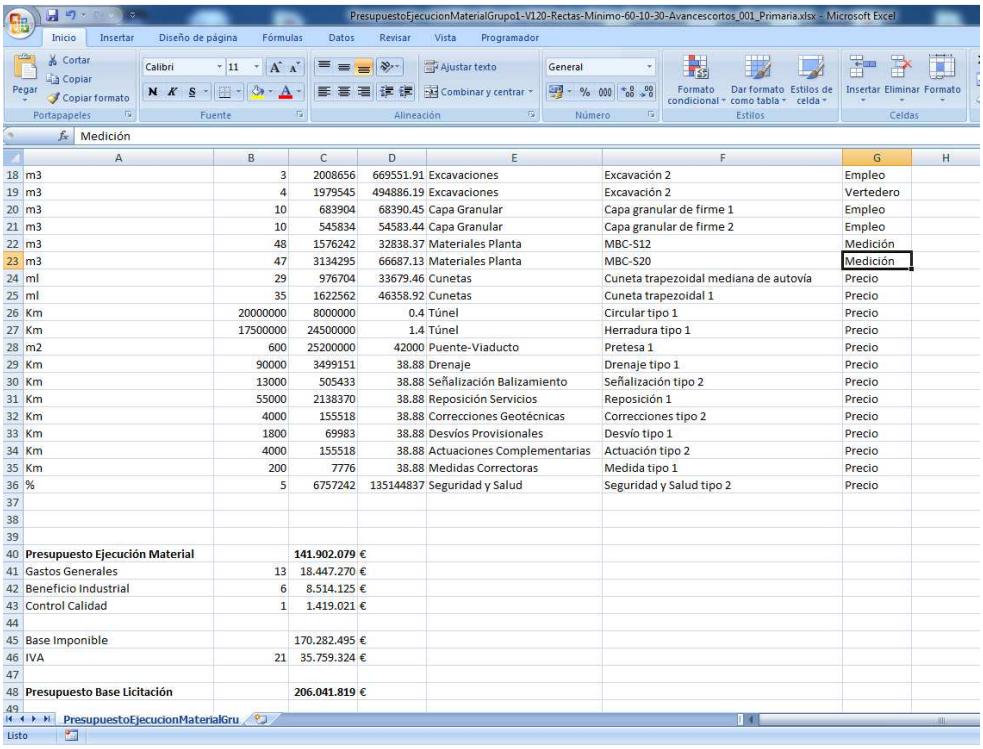


Image 128. Menu for exporting the budgets lists.

We must prove that we obtain said reports in .csv format (comma separated value). We should convert the file to .xlsx format for editing them.

Next we show some reports examples:

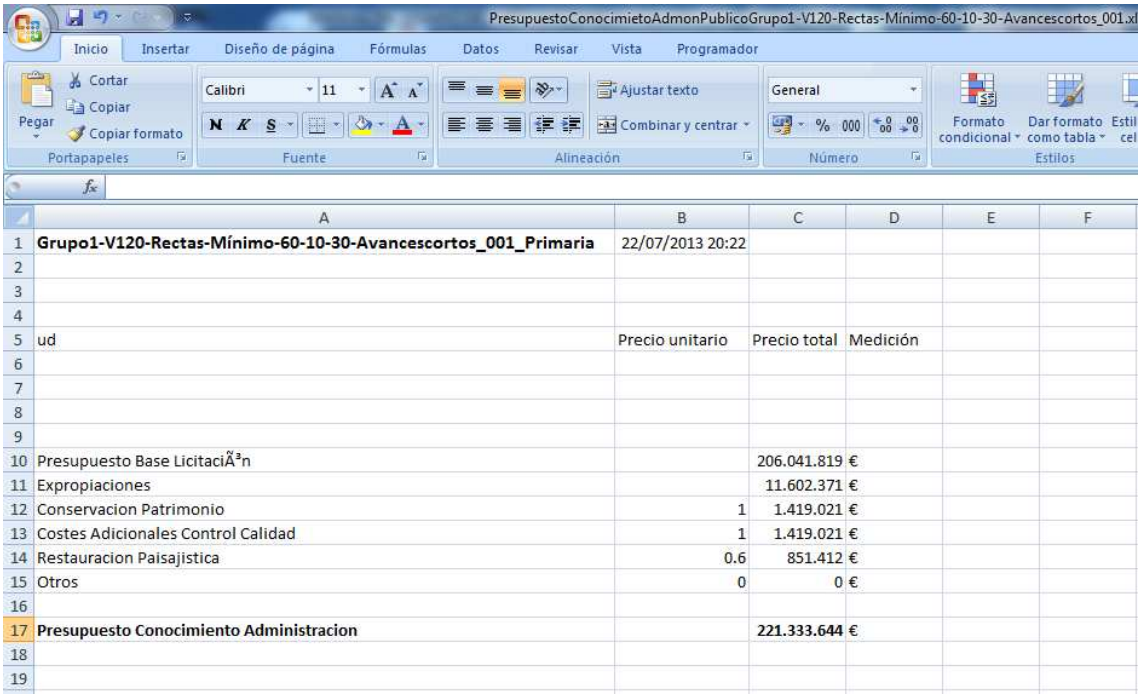
- **Budget Material Execution**



	A	B	C	D	E	F	G	H
18	m3	3	2008656	669551.91	Excavaciones	Excavación 2	Empleo	
19	m3	4	1979545	494886.19	Excavaciones	Excavación 2	Vertedero	
20	m3	10	683904	68390.45	Capa Granular	Capa granular de firme 1	Empleo	
21	m3	10	545834	54583.44	Capa Granular	Capa granular de firme 2	Empleo	
22	m3	48	1576242	32838.37	Materiales Planta	MBC-S12	Medición	
23	m3	47	3134295	66687.13	Materiales Planta	MBC-S20	Medición	
24	ml	29	976704	33679.46	Cunetas	Cuneta trapezoidal mediana de autovía	Precio	
25	ml	35	1622562	46358.92	Cunetas	Cuneta trapezoidal 1	Precio	
26	Km	20000000	8000000	0.4	Túnel	Circular tipo 1	Precio	
27	Km	17500000	24500000	1.4	Túnel	Herradura tipo 1	Precio	
28	m2	600	25200000	42000	Puente-Viaducto	Pretesa 1	Precio	
29	Km	90000	3499151	38.88	Drenaje	Drenaje tipo 1	Precio	
30	Km	13000	505433	38.88	Señalización Balizamiento	Señalización tipo 2	Precio	
31	Km	55000	2138370	38.88	Reposición Servicios	Reposición 1	Precio	
32	Km	4000	155518	38.88	Correcciones Geotécnicas	Correcciones tipo 2	Precio	
33	Km	1800	69983	38.88	Desvíos Provisionales	Desvío tipo 1	Precio	
34	Km	4000	155518	38.88	Actuaciones Complementarias	Actuación tipo 2	Precio	
35	Km	200	7776	38.88	Medidas Correctoras	Medida tipo 1	Precio	
36	%	5	6757242	135144837	Seguridad y Salud	Seguridad y Salud tipo 2	Precio	
37								
38								
39								
40	**Presupuesto Ejecución Material**		**141.902.079**	€				
41	Gastos Generales	13	18.447.270	€				
42	Beneficio Industrial	6	8.514.125	€				
43	Control Calidad	1	1.419.021	€				
44								
45	Base Imponible		170.282.495	€				
46	IVA	21	35.759.324	€				
47								
48	**Presupuesto Base Licitación**		**206.041.819**	€				
49								

Image 129. Example of base bid budget list.

- **Budget Report for the Administration with public investment**

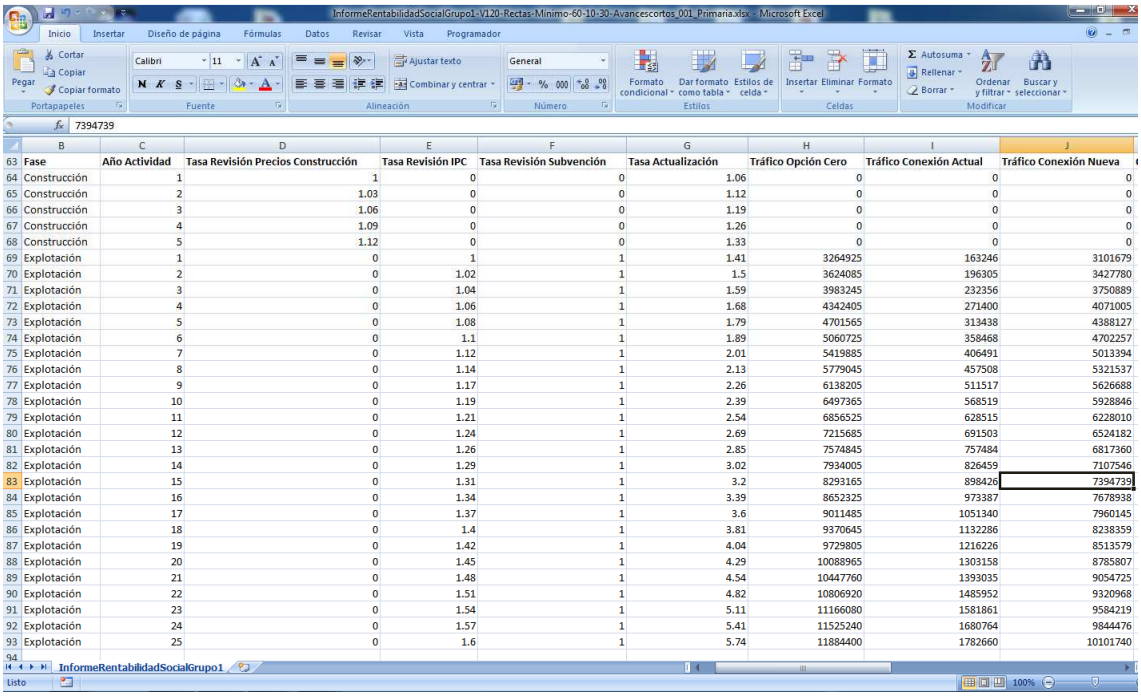


	A	B	C	D	E	F
1	**Grupo1-V120-Rectas-Mínimo-60-10-30-Avancescortos_001_Primaria**	22/07/2013 20:22				
2						
3						
4						
5	ud	Precio unitario	Precio total	Medición		
6						
7						
8						
9						
10	Presupuesto Base LicitaciÃ³n		206.041.819	€		
11	Expropiaciones		11.602.371	€		
12	Conservacion Patrimonio	1	1.419.021	€		
13	Costes Adicionales Control Calidad	1	1.419.021	€		
14	Restauracion Paisajistica	0.6	851.412	€		
15	Otros	0	0	€		
16						
17	**Presupuesto Conocimiento Administracion**		**221.333.644**	€		
18						
19						

Image 130. Example of budget report for the administration list.

9.3.4.8.2. Profitability

- **Report on Social Profitability**



Fase	Año Actividad	Tasa Revisión Precios Construcción	Tasa Revisión IPC	Tasa Revisión Subvención	Tasa Actualización	Tráfico Opción Cero	Tráfico Conexión Actual	Tráfico Conexión Nueva
Construcción	1	1	0	0	1.06	0	0	0
Construcción	2	1.03	0	0	1.12	0	0	0
Construcción	3	1.06	0	0	1.19	0	0	0
Construcción	4	1.09	0	0	1.26	0	0	0
Construcción	5	1.12	0	0	1.33	0	0	0
Explotación	1	0	1	1	1.41	3264925	163246	3101679
Explotación	2	0	1.02	1	1.5	3624085	196305	3427780
Explotación	3	0	1.04	1	1.59	3983245	232356	3750889
Explotación	4	0	1.06	1	1.68	4342405	271400	4071005
Explotación	5	0	1.08	1	1.79	4701565	313438	4388127
Explotación	6	0	1.1	1	1.89	5060725	358468	4702257
Explotación	7	0	1.12	1	2.01	5419885	406491	5013394
Explotación	8	0	1.14	1	2.13	5779045	457508	5321537
Explotación	9	0	1.17	1	2.26	6138205	511517	5626688
Explotación	10	0	1.19	1	2.39	6497365	568519	5928846
Explotación	11	0	1.21	1	2.54	6856525	628515	6228010
Explotación	12	0	1.24	1	2.69	7215685	691503	6524182
Explotación	13	0	1.26	1	2.85	7574845	757484	6817360
Explotación	14	0	1.29	1	3.02	7934005	826459	7107546
Explotación	15	0	1.31	1	3.2	8293165	898426	7394739
Explotación	16	0	1.34	1	3.39	8652325	973387	7678938
Explotación	17	0	1.37	1	3.6	9011485	1051340	7960145
Explotación	18	0	1.4	1	3.81	9370645	1132286	8238359
Explotación	19	0	1.42	1	4.04	9729805	1216226	8513579
Explotación	20	0	1.45	1	4.29	10088965	1303158	8785807
Explotación	21	0	1.48	1	4.54	10447760	1393035	9054725
Explotación	22	0	1.51	1	4.82	10806920	1485952	9320968
Explotación	23	0	1.54	1	5.11	11166080	1581861	9584219
Explotación	24	0	1.57	1	5.41	11525240	1680764	9844476
Explotación	25	0	1.6	1	5.74	11884400	1782660	10101740

Image 131. Example of social profitability list per year.

9.3.4.9. Example with private investment

We assume the work will be executed with the collaboration of a private developer, who will be responsible for the route exploitation.

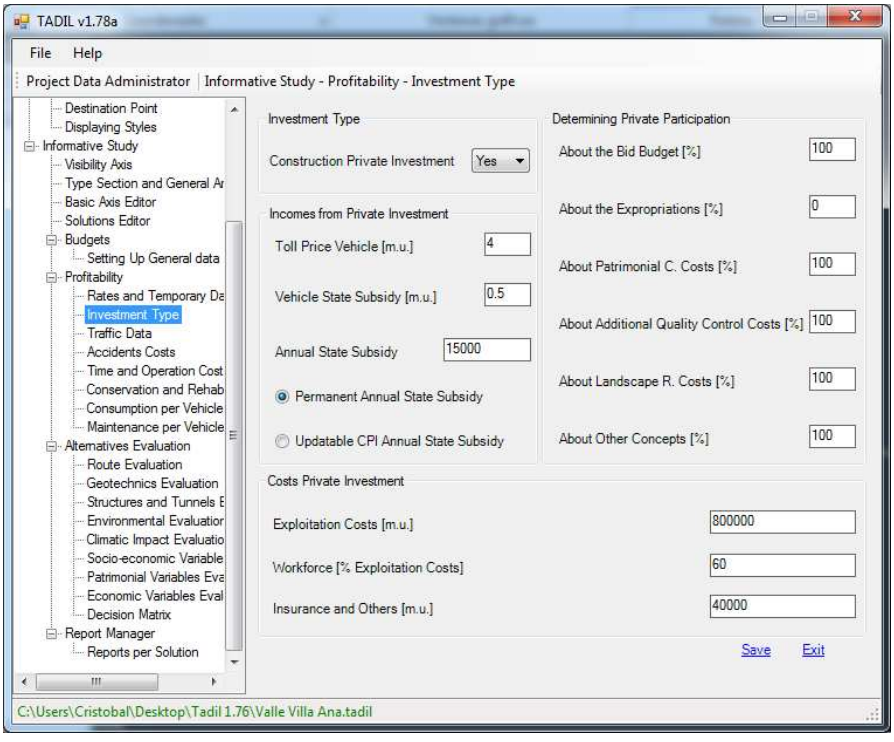
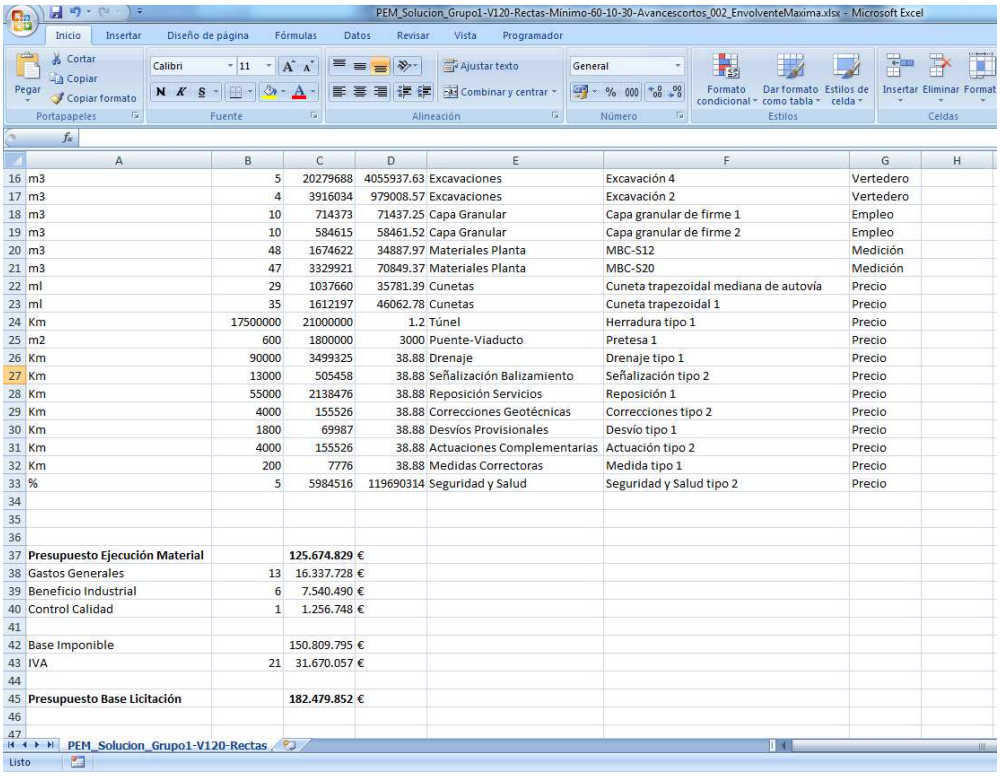


Image 132. Entering data of private exploitation.

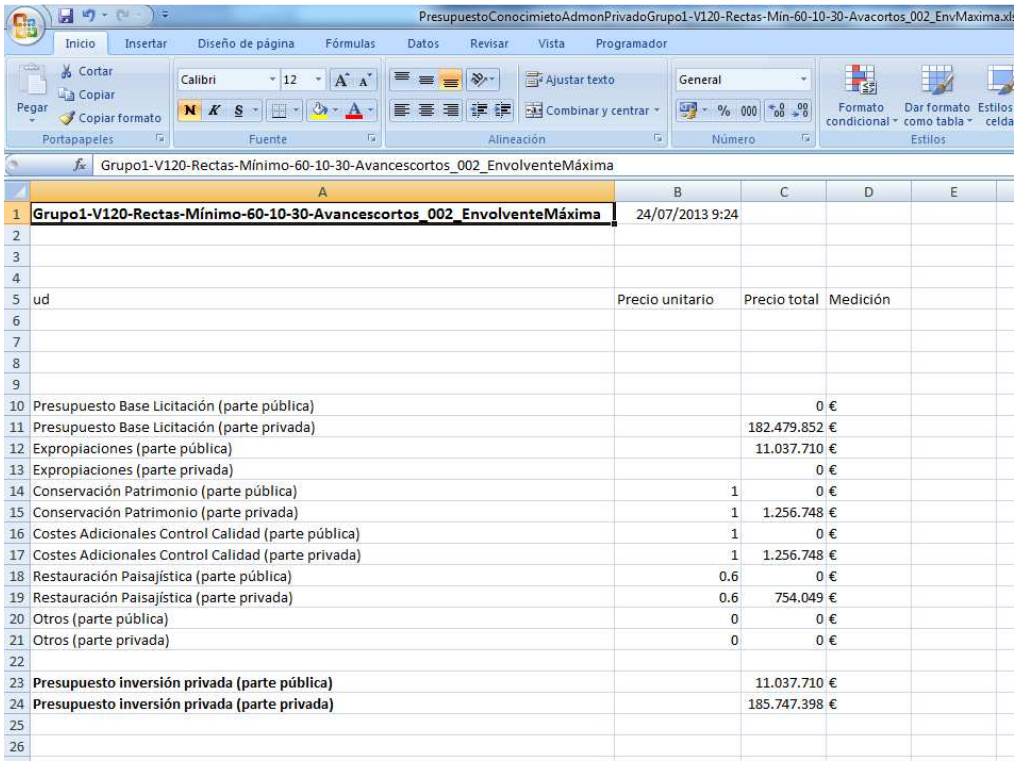
- **Budget Material Execution**



16	m3	5	20279688	4055937.63	Excavaciones	Excavación 4	Vertedero
17	m3	4	3916034	979008.57	Excavaciones	Excavación 2	Vertedero
18	m3	10	714373	71437.25	Capa Granular	Capa granular de firme 1	Empleo
19	m3	10	584615	58461.52	Capa Granular	Capa granular de firme 2	Empleo
20	m3	48	1674622	34887.97	Materiales Planta	MBC-S12	Medición
21	m3	47	3329921	70849.37	Materiales Planta	MBC-S20	Medición
22	ml	29	1037660	35781.39	Cunetas	Cuneta trapezoidal mediana de autovía	Precio
23	ml	35	1612197	46062.78	Cunetas	Cuneta trapezoidal 1	Precio
24	Km	17500000	21000000	1.2	Túnel	Herradura tipo 1	Precio
25	m2	600	1800000	3000	Puente-Viaducto	Pretesa 1	Precio
26	Km	90000	3499325	38.88	Drenaje	Drenaje tipo 1	Precio
27	Km	13000	505458	38.88	Señalización Balizamiento	Señalización tipo 2	Precio
28	Km	55000	2138476	38.88	Reposición Servicios	Reposición 1	Precio
29	Km	4000	155526	38.88	Correcciones Geotécnicas	Correcciones tipo 2	Precio
30	Km	1800	69987	38.88	Desvíos Provisionales	Desvío tipo 1	Precio
31	Km	4000	155526	38.88	Actuaciones Complementarias	Actuación tipo 2	Precio
32	Km	200	7776	38.88	Medidas Correctoras	Medida tipo 1	Precio
33	%	5	5984516	119690314	Seguridad y Salud	Seguridad y Salud tipo 2	Precio
34							
35							
36							
37	**Presupuesto Ejecución Material**		**125.674.829 €**				
38	Gastos Generales	13	16.337.728 €				
39	Beneficio Industrial	6	7.540.490 €				
40	Control Calidad	1	1.256.748 €				
41							
42	Base Imponible		150.809.795 €				
43	IVA	21	31.670.057 €				
44							
45	**Presupuesto Base Licitación**		**182.479.852 €**				
46							
47							

Image 133. Example of budget material execution and base bid.

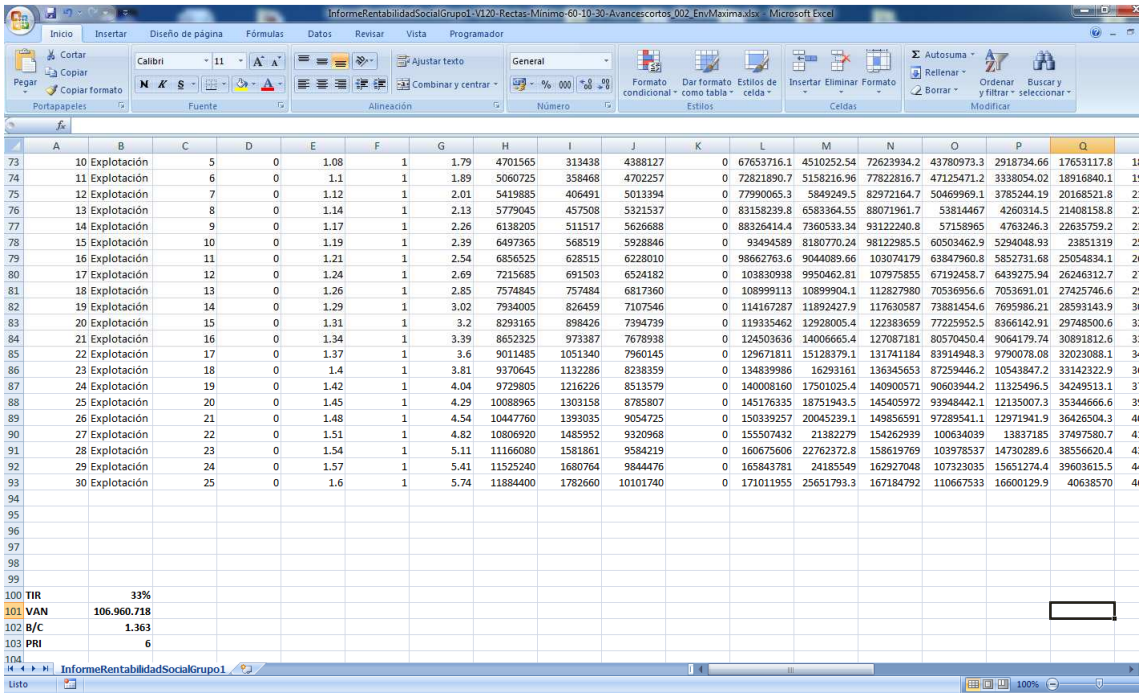
- **Budget Report for the Administration and the private investor**



	A	B	C	D	E
1	**Grupo1-V120-Rectas-Mínimo-60-10-30-Avancescortos_002_EnvolventeMáxima**	24/07/2013 9:24			
2					
3					
4					
5	ud	Precio unitario	Precio total	Medición	
6					
7					
8					
9					
10	Presupuesto Base Licitación (parte pública)		0 €		
11	Presupuesto Base Licitación (parte privada)		182.479.852 €		
12	Expropiaciones (parte pública)		11.037.710 €		
13	Expropiaciones (parte privada)		0 €		
14	Conservación Patrimonio (parte pública)	1	0 €		
15	Conservación Patrimonio (parte privada)	1	1.256.748 €		
16	Costes Adicionales Control Calidad (parte pública)	1	0 €		
17	Costes Adicionales Control Calidad (parte privada)	1	1.256.748 €		
18	Restauración Paisajística (parte pública)	0.6	0 €		
19	Restauración Paisajística (parte privada)	0.6	754.049 €		
20	Otros (parte pública)	0	0 €		
21	Otros (parte privada)	0	0 €		
22					
23	**Presupuesto inversión privada (parte pública)**		11.037.710 €		
24	**Presupuesto inversión privada (parte privada)**		185.747.398 €		
25					
26					

Image 134. Example of breakdown of public and private investment.

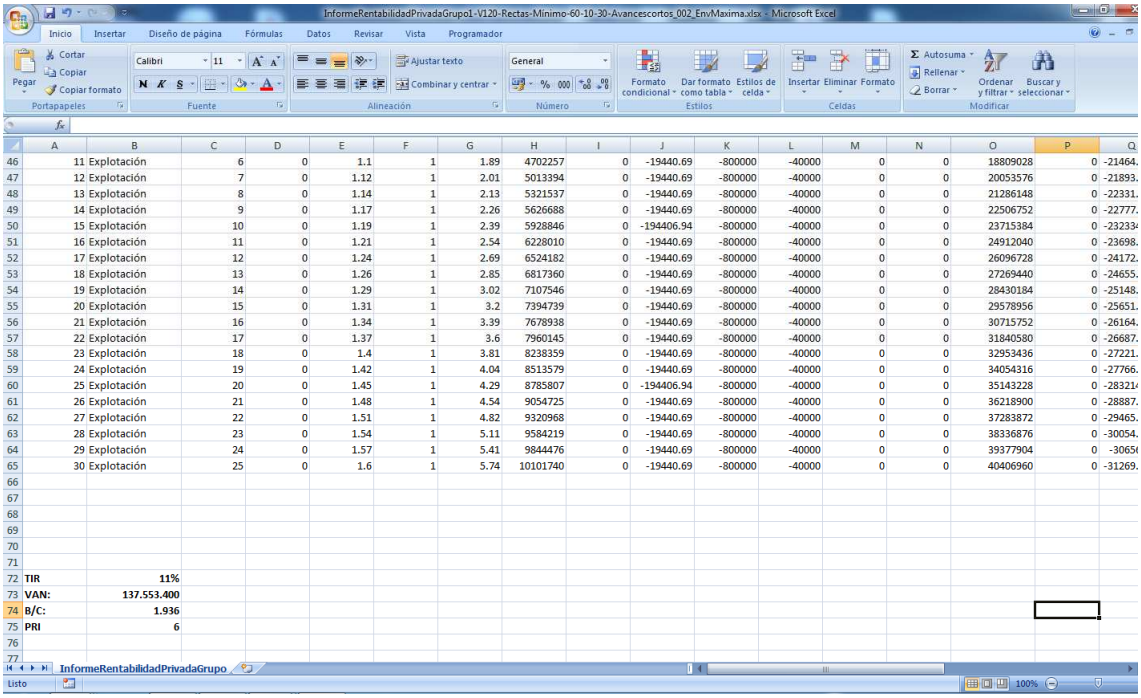
- **Report on Social Profitability**



73	10	Explotación	5	0	1.08	1	1.79	4701565	313438	4388127	0	67653716.1	4510252.54	72623934.2	43780973.3	2918734.66	17653117.8
74	11	Explotación	6	0	1.1	1	1.89	5060725	358468	4702257	0	72821890.7	5158216.96	77822816.7	47125471.2	3338054.02	18916840.1
75	12	Explotación	7	0	1.12	1	2.01	5419885	406491	5013394	0	77990065.3	5849249.5	82972164.7	50469969.1	3785244.19	20168521.8
76	13	Explotación	8	0	1.14	1	2.13	5779045	457508	5321537	0	83158239.8	6583364.55	88071961.7	53814467	4260314.5	21408158.8
77	14	Explotación	9	0	1.17	1	2.26	6138205	511517	5626688	0	88326414.4	7360533.34	93122240.8	57158965	4763246.3	22635759.2
78	15	Explotación	10	0	1.19	1	2.39	6497365	568519	5928846	0	93494589	8180770.24	98122985.5	60503462.9	5294048.93	23851319
79	16	Explotación	11	0	1.21	1	2.54	6856525	628515	6228010	0	98662763.6	9044089.66	103074179	63847960.8	5852731.68	25054834.1
80	17	Explotación	12	0	1.24	1	2.69	7215685	691503	6524182	0	103830938	9950462.81	107975855	67192458.7	6439275.94	26246312.7
81	18	Explotación	13	0	1.26	1	2.85	7574845	757484	6817360	0	108999113	10899904.1	112827980	70536956.6	7053691.01	27425746.6
82	19	Explotación	14	0	1.29	1	3.02	7934005	826459	7107546	0	114167287	11892427.9	117630587	73881454.6	7695986.21	28593143.9
83	20	Explotación	15	0	1.31	1	3.2	8293165	898426	7394739	0	119335462	12928005.4	122383659	77225952.5	8366142.91	29748500.6
84	21	Explotación	16	0	1.34	1	3.39	8652325	973387	7678938	0	124503636	14006665.4	127087181	80570450.4	9064179.74	30891812.6
85	22	Explotación	17	0	1.37	1	3.6	9011485	1051340	7960145	0	129671811	15128379.1	131741184	83914948.3	9790078.08	32023088.1
86	23	Explotación	18	0	1.4	1	3.81	9370645	1132286	8238359	0	134839986	16293161	136345653	87259446.2	10543847.2	33142322.9
87	24	Explotación	19	0	1.42	1	4.04	9729805	1216226	8513579	0	140008160	17501025.4	140900571	90603944.2	11325496.5	34249513.1
88	25	Explotación	20	0	1.45	1	4.29	10088965	1303158	8785807	0	145176335	18751943.5	145405972	93948442.1	12135007.3	35344666.6
89	26	Explotación	21	0	1.48	1	4.54	10447760	1393035	9054725	0	150339257	20045239.1	149856591	97289541.1	12971941.9	36426504.3
90	27	Explotación	22	0	1.51	1	4.82	10806920	1485952	9320968	0	155507432	21382279	154262939	100634039	13837185	37497580.7
91	28	Explotación	23	0	1.54	1	5.11	11166080	1581861	9584219	0	160675606	22762372.8	158619769	103978537	14730289.6	38556620.4
92	29	Explotación	24	0	1.57	1	5.41	11525240	1680764	9844476	0	165843781	24185549	162927048	107323035	15651274.4	39603615.5
93	30	Explotación	25	0	1.6	1	5.74	11884400	1782660	10101740	0	171011955	25651793.3	167184792	110667533	16600129.9	40638570
100	TIR	33%															
101	VAN	106.960.718															
102	B/C	1.363															
103	PRI	6															

Image 135. Example of social profitability list in a public-private investment.

- **Report on Private Profitability**



46	11	Explotación	6	0	1.1	1	1.89	4702257	0	-19440.69	-800000	-40000	0	0	18809028	0	-21464.
47	12	Explotación	7	0	1.12	1	2.01	5013394	0	-19440.69	-800000	-40000	0	0	20053576	0	-21893.
48	13	Explotación	8	0	1.14	1	2.13	5321537	0	-19440.69	-800000	-40000	0	0	21286148	0	-22331.
49	14	Explotación	9	0	1.17	1	2.26	5626688	0	-19440.69	-800000	-40000	0	0	22506752	0	-22777.
50	15	Explotación	10	0	1.19	1	2.39	5928846	0	-194406.94	-800000	-40000	0	0	23715384	0	-23233
51	16	Explotación	11	0	1.21	1	2.54	6228010	0	-19440.69	-800000	-40000	0	0	24912040	0	-23698.
52	17	Explotación	12	0	1.24	1	2.69	6524182	0	-19440.69	-800000	-40000	0	0	26096728	0	-24172.
53	18	Explotación	13	0	1.26	1	2.85	6817360	0	-19440.69	-800000	-40000	0	0	27269440	0	-24655.
54	19	Explotación	14	0	1.29	1	3.02	7107546	0	-19440.69	-800000	-40000	0	0	28430184	0	-25148.
55	20	Explotación	15	0	1.31	1	3.2	7394739	0	-19440.69	-800000	-40000	0	0	29578956	0	-25651.
56	21	Explotación	16	0	1.34	1	3.39	7678938	0	-19440.69	-800000	-40000	0	0	30715752	0	-26164.
57	22	Explotación	17	0	1.37	1	3.6	7960145	0	-19440.69	-800000	-40000	0	0	31840580	0	-26687.
58	23	Explotación	18	0	1.4	1	3.81	8238359	0	-19440.69	-800000	-40000	0	0	32953436	0	-27221.
59	24	Explotación	19	0	1.42	1	4.04	8513579	0	-19440.69	-800000	-40000	0	0	34054316	0	-27766.
60	25	Explotación	20	0	1.45	1	4.29	8785807	0	-194406.94	-800000	-40000	0	0	35143228	0	-28321
61	26	Explotación	21	0	1.48	1	4.54	9054725	0	-19440.69	-800000	-40000	0	0	36218900	0	-28887.
62	27	Explotación	22	0	1.51	1	4.82	9320968	0	-19440.69	-800000	-40000	0	0	37283872	0	-29465.
63	28	Explotación	23	0	1.54	1	5.11	9584219	0	-19440.69	-800000	-40000	0	0	38336876	0	-30054.
64	29	Explotación	24	0	1.57	1	5.41	9844476	0	-19440.69	-800000	-40000	0	0	39377904	0	-3065
65	30	Explotación	25	0	1.6	1	5.74	10101740	0	-19440.69	-800000	-40000	0	0	40406960	0	-31269.
72	TIR	11%															
73	VAN:	137.553.400															
74	B/C:	1.936															
75	PRI	6															

Image 136. Example of private profitability list in a public-private investment.

10. MEASURE UNITS.

TADIL uses the metric decimal system to measure the axis, to establish their labelling per kilometre points, the design of grade line and the section measures that we have set up in the budget.

We can use the monetary unit (m.u.) that we wish.

In the construction units and prices, the monetary unit are:

- Cut materials: m^3.
- Excavations: m^3.
- Fill sections: m^3.
- Materials from treatment plants: m^3.
- Ditches: linear metre.
- Walls: m^3.
- Structures: m^3.
- Tunnels: km.
- Macro-prices: km.
- Expropriations: m^2.

11. ERROR MESSAGES.

Next we list the most frequent error messages from TADIL:

- *Error while Assigning Maximum{0} and Minimum {1} Marks*

We have entered a mark out of the range between 0 and 10.

- *Error while Saving File*

We have clicked on "Save as" and, after that, we have aborted the process. The file is not saved.

- *Error while Validating Form Data*

We have entered data out of range or we have not entered any mandatory data.

- *Value out of Range ; Maximum Value {0}*

We have entered a value which is higher than the maximum one.

- *Value out of Range ; Minimum Value {0}*

We have entered a value which is smaller than the minimum one.

- *The Text Length is out of range ; Maximum Value {0}*

The text has more characters than allowed.

- *You must select one record*

We have clicked on a calculation button but we have not selected the project to be calculated.

- *The route plan axis already exists*

We have clicked on "Route plan axis" in a solution where the route plan axis was previously calculated.

- *Entity with IDs {0} \not found in the current file*

We have calculated the linear work and the name of the solution have remained in the TADIL memory. We have modified some data in the TDB or we have opened a cartography which does not correspond to the place where the work was first calculated. After that, we have open the file again and, when we have tried to use it, TADIL does not identify it. We recommend using and saving the cartography and the TDB for each single project.

- *To remove the record linked to the entity is recommended*

When a solution is not found in the file, we recommend removing the solution.

- *The lineal work already exists*

We have clicked on "Linear Work" in a solution where the linear work was previously calculated.

- *The longitudinal profile already exists*

We have clicked on "Longitudinal Profile" in a solution where the longitudinal profile was previously calculated.

- *There is no solution maximum envelope curve*

From the primary solution, there is no solution of maximum envelope curve

- *There is no solution minimum envelope curve*

From the primary solution, there is no solution of minimum envelope curve

- *There is no solution with the parameters of initial design*

There is no solution with the data entered by the user. We recommend changing the origin and destination point and, if this is not possible, trying with the distance, the orography and the global cost. The route plan slopes and the structures can be also modified. If we make different combination of these factors, we might not find any solution.

- *There are no entities to export*

If we have not calculated the linear work, neither have we created the plan or the cross sections, we cannot export them.

- *The lineal work has been already exported*

We have clicked on "Export Plan and Sections" in a solution where we had previously exported the plan and the sections.

- *The selected entity is not a polyline*

We have selected an entity in AutoCAD Civil 3D which is not a polyline. We must stress that, when we link polylines to GIS, these must be polylines and not just lines.

12. FREQUENT ASKED QUESTIONS

In this section we gathering together some of the FAQ by the users:

a. What type of land digital model can I load?

The land digital model must have been generated with AutoCAD Civil 3D. In the future, TADIL will incorporate some algorithms from MDT in cad. Therefore, the aforementioned software will not be needed.

b. Can I modify the regulation and save it?

You can generate your own regulation with the specified format in the Regulation Editor, where you must indicate the radius and the banking for each speed of the axis and, for elevation, the minimum and optimum Kv for convex or concave transition curve on undulating track.

c. Can I work in the project administrator without completing the database file?

At least, you must complete the geotechnical area of earthwork, structures and tunnels as well as the geotechnical area of foundation, indicating the general areas. At the same time, by completing those areas you will be requested to complete the corresponding construction units.

The remaining GIS areas have just a qualitative nature, so you do not need to complete them. If you want to calculate expropriations, you will have to specify the socioeconomic areas with their evaluation and the patrimonial areas with the land value.

d. Is it necessary to enter the banned areas again if we have specified them in the GIS?

No, it is not. You can enter areas you have not implemented in the Database Administrator.

e. By clicking on "Select Banned Area due to Slope" is a banned polygon automatically created?

No, it is not. The MDT triangles whose maximum slope is higher than the specified one will be ticked. Afterwards, you will be able to draw a polygon including them and then, tick the area as banned area.

f. Can I specify the destination and origin alignment just with its length?

No, you cannot. You must specify its azimuth too.

g. What happens when the origin or destination permanent alignment does not comply with the project criteria?

The software warns that the project parameters related to the origin alignment are not respected, but it keep on calculating.

h. Can I load in TADIL the displaying styles that I have created myself in CIVIL 3D?

Yes, you can. In fact, the displaying styles are only from CIVIL 3D.

i. How can I enter Target points?

The target points are entered just like the manual visibility axis.

j. Can I calculate alternatives without indicating general areas?

For the informative study, you must indicate the general areas. For the previous study, you do not have to.

k. How does the option "Allow Isolated Speed Reductions" affect?

It may affect to the isolated failure of some vertical transition curve on undulating track.

l. How does the modification of dynamic evaluation condition the obtaining of drafts?

The higher the evaluation percentages per distance are, the shorter and more direct will be the drafts, but more expensive instead. The higher the evaluation percentages per cost are, the cheaper will be the infrastructure per length unit, but longer instead.

m. What is Aij constant for?

This option aims to be used in very complicated orography, with high slopes and very marked stream beds. Entering values of Aij constant allows you to have more success in searching for itineraries, although this algorithm will impose isolated radios reductions (and, therefore, speed reductions) when it is not possible to find solutions with your criteria.

n. What are coefficients of reduction for?

They allow to carry out sensitivity studies and to obtain new solutions for reducing some or all the parameters regarding maximum cut sections/embankments or slopes.

o. For obtaining budgets, which data are the percentages of the Setting Menu Project Data given about?

About the Budget Material Execution.

p. How can I enter other mandatory taxes in my country?

With the variable VAT. In addition to the VAT itself, you can add other direct taxes.

q. What is the difference between prices update rate and annual CPI update?

The prices update rate is just applicable to the construction costs of the infrastructure for the years of construction, whereas the annual CPI update is applicable to every income and cost from the first exploitation year.

r. What is the difference between the annual state subsidy and the vehicle state subsidy?

The annual state subsidy is a static or updatable quantity per IPC, independent from the number of vehicles, whereas the vehicle subsidy is applicable to the total number of vehicles in a year, with a static or updatable value per IPC.

s. Where can I get some information about the death and hazardousness rate?

Generally, the National Department of Traffic of the Ministry of Internal Affairs or the Ministry of Public Works or Transport include this kind of information annually or every two or three years, depending on the country. Sometimes they not include all the roads, so you will be able to consider the connection features or to look for in specialized literature.

t. What is the time cost's weighting coefficient?

It is a coefficient which allows to consider the vehicle percentage to be used by the new connection. Here the "time reduction" plays an important role. In general, the local traffic which uses only partially the connection and, in some cases, travels for reasons other than work, can be considered travels where the time variable has not such relevance.

u. How does TADIL apply the conservation and rehabilitation costs?

The conservation costs are applicable annually to the new and former connection, if it is maintained. The rehabilitation ones, every ten years.

v. Can I modify the tables of vehicle consumption and maintenance?

Yes, you can. You can modify tables and save them.

w. Are there any standard criteria to stablish weighting coefficients of the variables of each chapter?

No, there are not. You must give greater emphasis to the variables which have greater impact on the road.

x. Are there any standard criteria to stablish weighting hypothesis of chapter?

No, there are not. Just as in the previous question, it will depend on the kind of construction. So, in constructions which have been projected in high-valued environmental or landscape spaces, the chapter environmental variables will be very important. In a construction with private investment, the economic variables will be highly important.

y. How can I enter the my national currency?

In the section monetary units of the Database Administrator.

z. Can I just enter prices from a created database?

No, you cannot. We recommend creating new prices in concordance with the infrastructure and the land.

aa. Should I consider general prices or prices which had been based in a particular study of my work?

The study quality is given by the knowledge on land and on its difficulties. So, for example, it will not be the same excavating in rock with blastings or with pneumatic hammer.

bb. Do the cut section prices consider the canon of landfill?

For cut section, we consider an only price which must be appropriate to be used in revegetation of slopes in the workplace or to be sent to the landfill.

cc. How does TADIL the earthwork balance?

TADIL looks for the maximum use of workplace materials. A granular material can be used as such and, in addition, as a substitute for any other basecourse and filling material A basecourse material will count also as filling material. Let us imagine we have 100.000 m3 of excavation in a workplace. 30.000 are graded aggregate ZA-25, 40.000 are selected soil S-2, 20.000 are tolerable soil T0 for filling and 10.000 are no usable marginal soils. You must create filling sections, esplanades and pavements by using materials coming from the excavation itself. If you specified to create granular layers with ZA-25, esplanades with S-2 and embankments and filling with T0, then you would have the following data:

- For granular roadbase layers: 30,000
- For basecourse layers: 70,000
- For fill sections: 90,000

First of all, TADIL assigns use materials to the granular layers, then to the basecourse ones and finally to fill sections.

Each time that TADIL assigns materials, it updates the available earth bank. Therefore, for example, if it used only 20.000 m3 of granular layers, in the the bank it would remain 50.000 for basecourse and 70.000 for fill sections. In each action, use materials are affected by the swelling coefficient whereas the landfill materials are affected by the embankment coefficient.

Following the example, if TADIL needs 40.000 m3 for roadbase material, it will remain 50.000 for fill sections. If we had a total of 120.000 m3 of fill sections while measuring, we would need 70.000 m3 to be borrowed.

dd. Which units are considered in pavement materials from treatment plants?

Every unit to be used in pavement and which comes from treatment plants such as concrete, asphalt conglomerate, pavers, etc.

ee. How can I differentiate two structures or tunnels with equal geometry but lands which have very different geotechnical properties?

In a qualitative way, by differentiating both foundations. In a quantitative way, by considering different prices.

ff. Does the macro price include the measuring of ditches?

No, it does not. The measuring of ditches is made by linear metre. The macro-price refers to the transversal drainage works, canalizations and longitudinal works.

gg. How is health and safety quantified?

Per percentage, with regard to Material Execution.

hh. Where are the land production and patrimonial evaluation used?

In the expropriations consisting of land production compensation and land patrimonial value.

ii. How can I reflect geological groups which include several lithological groups in my map?

A easy way is to use the same colour for different lithological groups.

jj. How is the coefficient for embankment applied, and the coefficient of swelling?

The coefficient of swelling entails changing the volume of measured material in profiles to fill sections, whereas the coefficient for embankment affects to the volume of the landfill material; both coefficients have a clear influence in the budget from chapter "Earthwork".

kk. How is the parameter "Recommended maximum land slope" considered?

It is a qualitative parameter. The higher the slope, the more stable the land is.

ll. How does the cut materials' thickness affect?

The cut materials' thickness affects to the Earthwork measures. Fill sections or cut sections will be made on cut lands, hence a higher cut section increases embankments and decreases cut sections.

mm. How does the assignment of materials for exploitation affect?

In the excavation use. I would be senseless that excavations would produce a great range of materials and, however, we would scale embankments, basecourse and roadbase layers with other materials since it would entail an general increase in construction.

nn. What is the parameter "Maximum Slope without Step" for?

From this slope TADIL includes steps in the scaling.

oo. How should I enter the roadbase and basecourse layers?

You should enter them from top to bottom.

pp. May several areas which represent different parameters of a environmental variable classification cross? How are these areas evaluated?

Yes, they may. It is normal, for example, that several protected species cohabit in an area. In that case, the evaluation can be added up to 10.

qq. Is it necessary to fill out all the GIS chapters?

No, it is not. Only those regarding the geotechnics of earthwork, structures, tunnels and foundations. You can specify if you do not want to project with structures and/or tunnels in some areas or in the whole land.

rr. What should I do to obtain the expropriations?

You should enter compensation values for production in the socioeconomic variables and the land value evaluation in the patrimonial variables as well as specify in the budget data the margin of the rights of way areas.

ss. What happens if I modify the database file after having calculated several alternatives and I continue calculating new solutions in the same project administrator?

It would keep on calculating but you should take into account that the alternatives are not homogeneous when you compare them.

13. ALGORITHMS CALCULATION

The algorithms used by TADIL are structured as follows:

- Algorithms for searching local and land itineraries.
- Algorithms for generating the basic axis.
- Algorithms for generating the route plan axis.
- Algorithms for generating the grade line.
- Algorithms for calculating the linear work.
- Algorithms for obtaining the earthwork balance.
- Algorithms for evaluating the works and the profitability study.
- Algorithms for evaluating the alternatives.

The intellectual rights of the aforementioned and the exploitation rights have been set in public deed in favour of the Group Techniques for the Automatic Design of Linear Infrastructures Project, hence their reproduction in other software is strictly forbidden.