



## CHAPTER V

### IDENTIFICATION, DESCRIPTION AND ASSESSMENT OF THE CUMULATIVE AND RESIDUAL ENVIRONMENTAL IMPACTS OF THE REGIONAL ENVIRONMENTAL SYSTEM

#### V.1. Identification of the effects on the structure and functions of the Regional Environmental System (RES)

In order to identify and analyze the environmental impacts that the project might cause or worsen in the Regional Environmental System, and to comply with what is indicated in the Guide for the preparation of the Environmental Impact Statement, the following was performed on a regional basis:

1. The system diagnosis was re-examined (presented in section IV.3),
2. The specialists involved analyzed the bibliographic and cartographic information and the results of on-site sampling and observations.
3. The main activities that make up the project were determined.
4. The RES environmental factors were examined on which repercussions or effects may be anticipated, derived from the main activities of the project.
5. An environmental scenario modified by the project was prepared in order to determine and assess the cumulative and residual impacts of the RES.

#### Main activities that make up the project (sources of change)

The project in question is made up by 10 main activities<sup>1</sup>, of which 9 are performed during the site preparation and construction phase (Table V.1).

Table V.1. Brief description of the project activities.

Activity	Definition
Release of the right of way	<b>Site preparation and construction</b> Transfer of the property of 62.20 Ha. In this surface, the area between zero lines is of 34.52 Ha (including 3 junctions), of which 9.6 Ha. will be used for the crown, 14.2 Ha. for junctions and the remainder for slopes and ditches.
Clearance	Removal of vegetation of trees and bushes by mechanic and manual means, in accordance with the conditions of each site. The estimates are that the activity will affect a total of 16.72 Ha of forestry vegetation, and a volume of 807.48 m <sup>3</sup> will be generated.
Excavation	Removal of the organic horizon of the ground (30 m in average); a

<sup>1</sup> There are many more specific activities required, but for our purpose only the activities that can be differentiated better and which are more relevant from the environmental impact point of view are indicated.

soil volume of 41,195 m<sup>3</sup> will be generated.

Leveling

Soil and rock extraction to the quality required and compacting of the excavation base with a depth of 0.10 m. As product of the cuts, 301,659 m<sup>3</sup> of material will be obtained. A part (97,361 m<sup>3</sup>) will be used for the construction of the embankment body and 204,298 m<sup>3</sup> will be wasted. At least 9 excavation sites are contemplated with cuts larger than 5 m, with the following locations: km 11+ 950 (20 m of cut) , 12 + 054 (6 m), 12 + 120 (9 m), 12 + 350 (9 m). 12 + 700 (16 m), 13 + 220 (7.4 m), 13 + 640 (16 m) , 14 + 360 (15 m), 14 + 760 (9 m).

Placement of works and major and minor drainage

In all the minor intermittent runoffs, a drain will be placed so that it is possible to continue with the surface runoff pattern that the RES has with no disruptions. The placement of 31 sewers is contemplated (Table II.3, Chapter II). Besides, two bridges will be built in kilometers 16 + 780.00 (length of 30 m), 18 + 446.50 (length of 64 m).

Construction of the embankment body

Formation of lower pavement layers (base, sub-base), followed by pavement application and the final sealing irrigation. The additional works of the embankment are included, such as curbs, ditches, counter-ditches, and washers for the adequate removal of the water that runs on the asphalt layer and slopes.

Activities in the asphalt plant and in excavation in material banks

Function of the asphalt plant with the ground materials of the banks. Use of 2 material banks and commercial use plant is contemplated (these are established businesses independent from the stretch construction). The environmental impact permit is the responsibility of the business itself and not of the project in question. Therefore, this activity is not included in the impact identification (Table V.3). In Km 13 + 000 100 m d/d, the opening of a new bank is contemplated for the exploitation of 12,800 m<sup>3</sup> for bases with an effect of 0.65 Ha on induced pastureland.

Movement of machinery and personnel in the zone

The activities associated with the displacement, maneuvers, and parking of equipment and machinery, temporary storage of equipment and materials, as well as the permanence of personnel in the works.

No camps will be built for the personnel to stay in them or for machinery parking. The personnel will spend the evening in the villages close-by, such as Jiménez and Panindicuaró.

**Operation and maintenance stage**

**Activity**

**Definition**

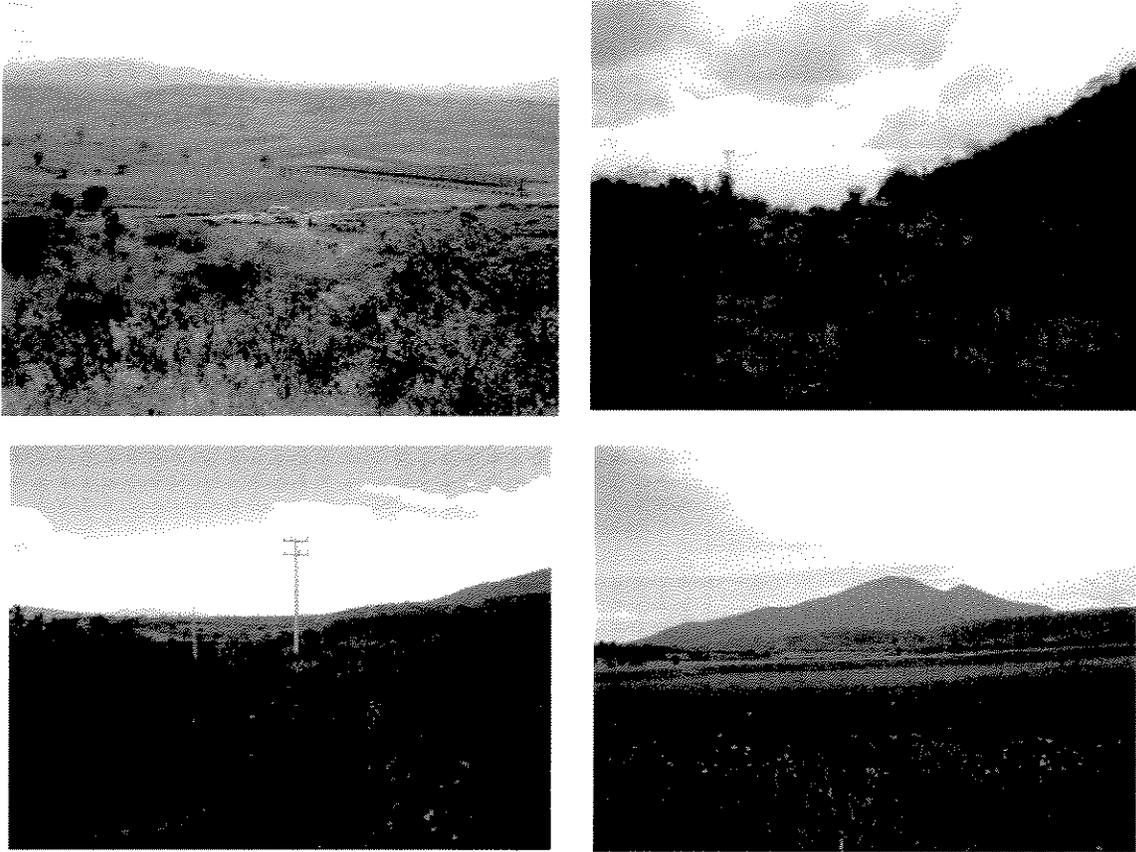
Vehicle circulation

**Site preparation and construction**

Road operation, which includes the circulation of 3,693 daily vehicles in average, with a composition of type A vehicles of 70 %, type B vehicles of 10 %, and type C vehicles of 20 %, between the Federal Highway No. 15, Zacapu and the Highway No. 15 Mexico – Morelia – Guadalajara.

Maintenance

The set of works that will make it possible to maintain the route in good conditions: re-covering, pothole repair, run-off control works, etc.



**Figure V.1. Aspects of the regional environmental system. The predominance of agricultural fields and pasturelands is evident (5,554.428 Ha of the RES that corresponds to 77.81 % of its surface)**

**Regional environmental factors associated with the project**

After reviewing the RES components, eleven environmental factors are detected on which repercussions generate by the project in question could be anticipated (Table V.2).



**Table V.2. Description of the regional environmental factors**

<b>Environmental factor</b>	<b>Description</b>
Air quality	Relative absence of suspended particles and gases produced by combustion.
Surface run-offs	Relative absence of particulates or dissolved pollutants in surface run-offs and preservation of the radial run-off pattern.
Geoform	Foothills, rolling hills and mountain.
Soil	Soil erosion, compacting, structure, fertility and / or saturation.
Forestry vegetation	The Btc and the secondary associations identified are included, as well as the gallery forest that grows in the irrigation plots of land of Villa Jiménez
Cultivated grounds	Surface in which seasonal, irrigation agricultural activities are performed as well as pastureland cultivated with cattle breeding purposes.
Urban zone and transportation infrastructure and its right of way	Human settlements, free highway, earthen roads, railroad tracks and their right of way.
Wildlife fauna	Presence of wildlife fauna populations.
Landscape harmony	Landscape condition through which continuity is seen between the environmental characteristics of the project and the forms that the project provides.
Local economy	Productive activities and commercial exchange in villages in the RES.
Transportation	Volume of goods moved between the project edges.

The identification and the revision of the potential effects were performed with the assistance of an interaction matrix between the project activities and environmental factors (Table V.3). The effects were analyzed concerning the sense (adverse or beneficial), its probability of occurrence and under the intensity, accumulation, and synergy criteria.

Worth of mention is that the residual impacts, in accordance with what is established by fraction X of Article 3 of the LGEEPA regulation in environmental impact matters, are those that persist after the application of the mitigation (and prevention) measures. Consequently and for purposes of the better presentation order, the residual environmental impact, will be described in Chapter VI after indicating the adverse impact prevention and mitigation measures in the regional environmental system.



On the other hand, as in this case most of the stretch inside the RES occurs on foothills, the intensity of usual impact for highways (such as hillside cuts, disposal of waste material) was low. Other impacts, like microclimate modification, effects on the quality of water bodies or currents, effects on the aquifer recharge, competition for water use, reduction in the soil formation capacity, relief modifications, changes in the erosion – sedimentation patterns are not perceptible at a regional level, because the relative dimensions of the product are reduced and also for the favorable relief conditions. Even though the relief presents hills and mountainous foothills, the project stretch occurs mainly on foothills and rolling hills.

For the project, no camps will be built or operated for the workers; rather, they will spend the night in Zacapú, Villa Jiménez or Panindícuaro, as is deemed convenient from the logistic point of view.

**Table V.3. Project interaction matrix. Adverse interactions are indicated with A, beneficial interactions with B.**

Actividades del proyecto \ Factores ambientales	Calidad del aire	Escorrentías superficiales	Geofoma	Suelo	Vegetación forestal	Zona urbana e infraestructura de transporte	Terrenos con uso agropecuario	Fauna silvestre	Armonía del paisaje	Economía local	Transporte
Libерación del derecho de vía							A				
Desmante					A			A			
Despalme				A				A	A		
Nivelaciones	A	A	A					A	A	B	
Colocación de obras de drenaje mayor y menor		A								B	
Actividades en planta de asfalto y bancos de material	A		A						A		
Construcción del cuerpo del terraplén	A									B	
Movimiento de maquinaria y personal en la zona	A				A			A		B	
Circulación vehicular	B					B		A		B	B
Mantenimiento		B								B	B



**(Horizontal columns)**

- Air quality**
- Surface run-offs**
- Geoform**
- Soil**
- Forestry vegetation**
- Urban zone and Transportation infrastructure**
- Grounds with cattle breeding use**
- Wildfire fauna**
- Landscape harmony**
- Local economy**
- Transportation**

**(Vertical column)**

- Project activities – Environmental factors**
- Release of way of right**
- Clearing**
- Excavation**
- Leveling**
- Placement of major and minor drainage works**
- Activities in asphalt plant and material banks**
- Embankment body construction**
- Movement of machinery and personnel in the zone**
- Vehicle circulation**
- Maintenance**

Once the project activity – environmental factor relationships which could be affected by a change are identified, it was discussed whether it would be perceptible or not at the RES level (Table V.4). What was found is that of the 31 relations identified (Table V.3), only 18 present perceptible changes in the RES; then, the relations identified as perceptible are called impact (Table V.5) and a multi-criteria quantitative method will be applied to them to know whether these impacts are relevant or not (section V.3), under the terms of fraction IX of Article 3 of the LGEEPA Regulation in matters of environmental impact assessment.

**Table V.4. Identification of project activity – environmental factor interrelationships perceptible at RES scale**

<b>Activity – environmental factor relationship</b>	<b>Discussion</b>	<b>Relevance</b>
Release of the right of way – Lands for cattle breeding use	The land owners with cattle breeding use could pose more objections to the construction of the highway. 38.62 Ha. with that use will be released. In the field, when we had the opportunity to hold interviews with some of the owners, none of them expressed any objections. On the contrary, they were pleased because their land (not included in the right of way) will give to the highway, thus increasing its price per meter.	Not perceptible

Clearance – Forestry vegetation	A surface of 16.72 Ha of forestry vegetation will be affected. Of this, 4.19 Ha are located in the UNA 7, considered as preserved with elements of the Btc and only in some boundaries with gallery forest, and 7.49 Ha in the UNA 4, considered highly preserved by the gallery forest that grows in the irrigation ditches between the irrigation agricultural fields.	Perceptible
Clearance - fauna	Of the UNAs 4 and 10, 16.72 Ha will be lost (5.2 % of their joint surface) of habitat of fauna species, which particularly in the UNA 4 are fauna species of restricted habits.	Perceptible
Excavation – soil	The impact on the soil will be caused by the removal of 41,195 m <sup>3</sup> of the horizon A of the soil profile. The impact will only occur between the zero line (area where the embankment body will be built) and there will be no border effect for the adjacent soil without excavation. This is due, on the one hand, to the fact that most of the stretch runs on foothills with mild slopes and also because once it has been excavated, at least 2 weeks will be required so that the bases are laid. This stony material will occupy the volume that was previously occupied by the soil removed. Thus, the pressure on the soil immediate to the excavation for the excavation will be reduced.	Not perceptible
Excavation – wildlife fauna	The excavation can affect amphibians that live among the fallen leaves, particularly in the UNA 4 or in the irrigation channels between the boundaries of the fields inside the UNA 10.	Perceptible
Excavation – landscape harmony	<p>The poor layout of the excavation material can affect agricultural fields, wildlife vegetation, fauna habitat, and in the rainy season, surface run-offs caused by material washed away. In this way, the landscape is affected.</p> <p>It is necessary to have a management plan of the soil removed to avoid the associated damages.</p> <p>Before, this material was usually thrown in ravines, affecting downstream the water quality and the vegetation. Currently, this is prohibited by the standards but it still occurs in the rural roads with insufficient supervision.</p>	Perceptible

Leveling – air quality	During the cuts and material movement with the DB, dust storms are created in the dry season.	Perceptible
Leveling – surface run offs	Part of the material that is moved with the leveling could be deposited in the water bodies. However, it would not be a lot and not perceptible at the RES scale.	Not perceptible
Leveling – geoform	<p>The consideration is that such localized cuts in the landscape do not alter or modify structures, like the geoform. Its structure and dynamics will remain intact, even after the leveling activities</p> <p>All along the stretch, 9 excavation sites have been contemplated greater than 5 m, with the following locations: km 11+ 950 (20 m of cut), 12 + 054 (6 m), 12 + 120 (9 m), 12 + 350 (9 m), 12 + 700 (16 m), 13 + 220 (7.4 m), 13 + 640 (16 m), 14 + 360 (15 m), 14 + 760 (9 m)</p>	Not perceptible
Leveling – Wildlife fauna	It is precisely when the cuts and leveling filling are made that a physical barrier is formed and in the zones of higher cuts or filling, the fauna cannot pass through. From that moment on, the barrier effect starts caused by the construction and operation of the highway on the fauna.	Perceptible
Leveling – Landscape harmony	<p>Although most of the material produced by the cuts will be used, if the volume wasted is not disposed of correctly, damages can be caused on the neighboring plots of land to the road, which would modify the habitat for fauna and secondary vegetation. If this impact is added to the excavation wastes, the effects are considered as important for the landscape.</p> <p>As in the excavation case, there are standards that prohibit the incorrect disposal. However, we have documented that this is still done in some roads.</p>	Perceptible
Leveling – Local economy	Approximately 15 local people will be used for this activity, and this situation is not perceptible at RES level.	Not perceptible
Placement of major and minor drainage works – Surface run-offs	The consideration made is that the interrelationship is not perceptible if the current situation is compared as zero status, because the pattern of surface run-offs will continue unchanged and the same can be said for the water quality.	Not perceptible

	<p>For the bridge construction, pre-assembled structures are taken and placed in the site. The assembly does not cause any effects on the run-off pattern of the body waters or on their water quality (these are bridges that do not require struts inside the bed).</p> <p>The minor drainage works will be built on temporary run-offs, the sewers are placed in the dry season. In case material is lost when the slab is cast or the containment walls are inserted, it would dry in the run-off bed, becoming another river rock, without perceptible effects.</p>	
Placement of major and minor drainage works – Local economy	Approximately 15 local people will be used for this activity, situation that is not perceptible at RES level.	Not perceptible
Construction of the embankment body – Air quality	When the bases are laid, if this done in the dry season, a lot of dust is produced, besides the dust storms that occur inside the RES. Therefore, for some time, there is a large amount of suspended particles in the air in the work fronts.	Perceptible
Construction of the embankment body – Local economy	Approximately 80 local people will be used for this activity, situation that is not perceptible at RAS scale.	Not perceptible
Activities in asphalt plant and material banks – Air quality	No effects from the asphalt plant are considered because the asphalt mix will be bought from a business. Only the effects are considered of a new opening of a material bank in Km 13 + 000 in the UNA 3 considered as disrupted. Emissions will be generated during the exploitation that will be perceptible in said UNA and its neighboring area for short periods of time.	Perceptible
Activities in asphalt plant and material banks – geofom	Of the only new opening, the intention is to exploit 12,800 m <sup>3</sup> of material with an extended effect of 0.65 HA. We consider that it is not sufficient to cause disruptions at the geofom level.	Not perceptible
Activities in asphalt plant and material banks – landscape harmony	Although the geofom is not affected, there will be a change in the area relief pattern, which will create a rupture in the landscape of the place.	Perceptible
Movement of machinery and personnel in the zone – Air Quality	The machinery will cause that dust is generated in the work fronts, in addition to the combustion gases. However, they will not be perceptible at RES scale.	Not perceptible

Movement of machinery and personnel in the zone – Forestry vegetation	The machinery could affect the forestry vegetation, mainly that located inside the UNA 4, considered as highly preserved (Km 14 + 600 to 15 + 700).	Perceptible
Movement of machinery and personnel in the zone – Wildlife fauna	The machinery could affect the wildlife fauna or restricted habits, particularly that which is located inside the UNA 4, considered as highly preserved (Km 14 + 600 to 15 + 700). The UNA 10 also has native fauna, some susceptible to the disruption, which could have effects if the personnel or machinery leave the line between zero line.	Perceptible
Movement of machinery and personnel in the zone – Local economy	Approximately 240 local people will be used throughout the construction and site preparation, not perceptible in the RES economy.	Not perceptible
Vehicle circulation – Air quality	More fluid vehicle circulation as a result of the operation of the stretch in project when compared with the current stretch will result in reduction of combustion gases. However, this reduction will not be significant because the RES does not have problems.	Not perceptible
Vehicle circulation – Urban zone and transportation infrastructure and its right of way	The operation of the stretch in question will reduce traffic in the highway currently used and that covers the Zacapu, Panindícuaro route. The project tracing has high specifications (A2), does not pass through urban and suburban areas, thus reducing the traffic that these places have.	Perceptible
Vehicle circulation – Wildlife fauna	Besides the barrier effect produced in the leveling stage, there is another effect that will be caused by the stretch in operation; the fauna that can pass through the leveling and cross the asphalt cover, runs the risk of being run over by vehicles.	Perceptible
Vehicle circulation – Local economy	The local economy will get benefits because the new road will enable fast communication between the region of Zacapu (with economic growth, particularly in the secondary sector) and the cities of Morelia and Guadalajara.	Perceptible
Vehicle circulation – Transportation	Once the project is in operation, transportation will be more fluid for the vehicles that move between Zacapu, Guadalajara and Zacapu – Morelia. Besides, it will be a fast road that can be used by the drivers who move from the toll-free highway 15 and the toll highway.	Perceptible
Maintenance – Surface run-offs	The maintenance works include sewer	Perceptible

cleaning after each rainy season, enabling them to give an optimum service.

Maintenance – Local economy      We consider that the jobs generated to maintain this stretch will not have outstanding repercussions in the economy of the RES.      Perceptible

**V.2.2. Identification of cumulative and residual environmental impacts on the regional environmental system**

The residual environmental impacts of the residual environmental system will be presented in section VI.2.

In the following paragraphs, the cumulative and synergic environmental impacts on the regional environmental system will be analyzed and assessed. To identify the synergy or impact accumulation, what is discussed in Table V.4 is taken as a basis, and also in the description of the RES functioning (section IV.4, Chapter IV) and the development or deterioration trends (section IV.5, Chapter IV).

The relationships that cause effects to this same regard and nature are included in the same impact (Table V.5). Therefore, of 18 relations that were identified as causing a perceptible change in the RES, 15 impacts were obtained that can be relevant or not.

**Table V.5. Synergy of the environmental impacts identified as perceptible in the RES**

<b>Relationship</b>	<b>Impact</b>	<b>Synergy</b>	<b>Brief description</b>
Clearance – Forestry vegetation	1. Effects on forestry vegetation caused by clearance	Cumulative	The area between zero line will be cleared in an area of 16.72 Ha, which will be added to the area without forestry vegetation of the UNAs 4 and 7 (agricultural irrigation fields and clearance in limits with gallery forest), having as a cumulative impact a surface without forestry vegetation of 4339.03 Ha (without the project, the area without forestry vegetation is of 4322.31 Ha).
Clearance – Fauna	2. Habitat loss for wildlife fauna	Synergic	16.72 Ha (UNAs 4 and 7) of habitat of general fauna species will be lost in the UNA 7 and some amphibians and small mammals with domestic habits and restricted distribution (UNA 4).  The displaced fauna exercises pressure on the already established neighboring populations and the RES will have to reach a new balance. The impact is greater than the simple sum of the habitat loss caused by the project and the already lost areas in the RES.

Excavation – wildlife fauna	3.- Effect of wildlife fauna species caused by excavation.	Synergic	<p>An area of 16.72 Ha (UNAs 4 and 7) will be excavated. Considering the humid conditions of this area, it can be the habitat of species of restricted habits (among them, 4 species included in the NOM-Semarnat-2001).</p> <p>Of the UNA 3, a surface of 17.8 HA of habitat of general species and some harmful species, which also tend to live buried, will be lost.</p> <p>It is synergic because the displaced fauna exercises habitat pressure on the neighboring populations, causing a multiplying effect.</p>
Excavation – Landscape harmony	4. Effect on the landscape as a result of the incorrect disposal of excavation material and rocky material.	Synergic	The incorrect disposal of the material does not only affect the land (and its components) where it is deposited, but it also has repercussions on the biogeochemical cycles up to 1 km downhill of the waste site (if this site is not adequate).
Leveling – Air quality	5. Incorporation of suspended particles for the stretch construction activities.	Cumulative	If the leveling and laying of bases is performed during the dry season, the suspended particles generated will be additional to those produced by dust storms of the UNA 2 and the dust generated in the commercial material banks that operate in the RES and to the opening of the bank of Km 13 + 000 to provide service to the stretch.
Leveling – Wildlife fauna	6.- Barrier effect for the displacement of wildlife fauna caused by the cuts.	Cumulative	<p>The barrier effect caused by the local change of the relief is additional to the already existing fragmentation in the RES as a result of the change in soil use.</p> <p>Worth of mention is that as is explained in the cuts in Table V.4, higher fragmentation in the RES by the road is not expected.</p>
Leveling – Landscape harmony	4. Effects on the landscape caused by the improper disposal of excavation material and rocky material.	Synergic	The improper material disposal not only affects the land (and its components) where it is deposited but it also has repercussions on the biogeochemical cycles of up to 1 km downhill of the waste site (if this site is inadequate).

Construction of the embankment body – Air quality	5. Incorporation of suspended particles for the stretch construction activities.	Cumulative	If the leveling and laying of bases is performed during the dry season, the suspended particles generated will be additional to those produced by dust storms of the UNA 2 and the dust generated in the commercial material banks that operate in the RES and to the opening of the bank of Km 13 + 000 to provide service to the stretch.
Activities in asphalt plant and material banks – Air quality	5. Incorporation of suspended particles for the stretch construction activities.	Cumulative	If the leveling and laying of bases is performed during the dry season, the suspended particles generated will be additional to those produced by dust storms of the UNA 2 and the dust generated in the commercial material banks that operate in the RES and to the opening of the bank of Km 13 + 000 to provide service to the stretch.
Activities in asphalt plant and material banks – Landscape harmony.	7.- Rupture in the landscape caused by the opening of a new material bank .	Cumulative	The landscape modification in this point is additional to the effects caused by the operation of the many material banks distributed in the RES.
Movement of machinery and personnel in the zone – Forestry vegetation	8.- Effects on the forestry vegetation and on the fauna caused by the movement of machinery and personnel outside the zero line	Simple	No effects are reported on the forestry vegetation as a result of the presence of heavy machinery.  No illegal exploitation of forestry products in the RES is reported either.
Movement of machinery and personnel in the zone – Wildlife fauna	8.- Effects on the forestry vegetation and on the fauna caused by the movement of machinery and personnel outside the zero line	Simple	The UNA 4 (Km 14 + 600 to 15 + 700), which is the best preserved, has the presence at all times of farmers, and as has been said, irrigation is what has favored the gallery forest “invasion”, favored by the farmers themselves. The fauna of this UNA has not been disrupted by the agricultural zero line exercised in this UNA.
Vehicle circulation – Urban zone and transportation infrastructure	9.- Reduction of vehicle traffic in the current route and inside the villages where it goes through.	Simple	The purpose of this project is to achieve better flow and safety in the ground transportation between Zacapu and the cities of Morelia and Guadalajara, through the federal highway 15.  No other roads have been built to

			reduce the traffic in the RES.
Vehicle circulation – Wildlife fauna	10.- Risk of running over the wildlife fauna as a result of vehicle circulation.	Simple	In the RES, there are no roads with these specifications that affect the wildlife fauna in this way.
Vehicle circulation – Local economy	11.- Promotion of local economy caused by the stretch operation.	Synergic	A fast road that joins industrial and service areas as important as Bajío and Guadalajara with the region of Zamora and La Piedad will help the local economy (already in growth), both in the tertiary and in the secondary sector. It will also benefit the primary sector because the material banks will be able to take out their products through a fast road, as well as the agricultural and cattle breeding products.
Vehicle circulation – Transportation	12.- Better transportation flow as a result of the operation of the stretch.	Cumulative	The project will make transportation more fluid in the current highway as less traffic will travel on it. Besides, it will give service as a fast road that will join the urban areas of Zamora and La Piedad with industrial and service centers (Guadalajara and El Bajío).
Maintenance – Surface run-offs	13.- Sewer cleaning during maintenance.	Simple	There are no other sewers besides those in operation that give to the road and that will be cleaned.
Maintenance – Transportation	14.- Road maintenance for its optimum operation.	Simple	There are no other activities that improve the road during its operation.

## V.2 Methodology followed for the quantitative assessment of the cumulative, synergic, and residual environmental impacts

A multiple criteria assessment method was used, which consists of turning the qualitative description of the criteria determined (quality, scope, duration, etc.) into numerical values and then integrate those values in an indicator that makes it possible to discriminate the perceptible impacts (Table V.5). To assign numerical values to the qualitative descriptions of the criteria, conventions defined in Table V.6 were used.

It is worth mentioning that the relationship between values and description has the dual purpose of facilitating the differentiation in the grade and perform the mathematical operations to calculate a numerical value for the impact, which takes into account the criteria considered.



**Table V.6. Assignment of numerical values to the activity – factor relationships considered as perceptible from the qualitative point of view**

Scope Description	Value	Duration Description	Value	Extension Description	Value
Very low (not relevant to preserved UNA)	1	For weeks	1	Up to 2 % of the RES or the UNA	1
Low (only in disrupted and highly disrupted UNA)	2	For months	2	Up to 6 % of the RES or the UNA	2
Moderate (not relevant to preserved UNA)	4	For years	4	Up to 15 % of the RES or the UNA	4
High (up to 10 % in preserved UNA)	7	For decades	7	Up to 35 % of the RES or the UNA	7
Very high (more than 10 % of preserved UNA and touches a highly preserved UNA)	9	More time	9	Greater than that of the RES or the UNA 35 %	9

Interest Description	Value	Context Description	Value	Synergy Description	Value
Absent	1	Disrupted site	0.8	Not detected	1.0
Few people	2	Low disruption	1.0	Accumulation	1.1
Hundreds	4	Preserved	1.15	Synergy	1.3
Thousands	7	Few species in NOM-059-Semarnat	1.30		
Generalized	9	ANP or several species in NOM-059	1.50		

The indicator was calculated through the multiplication of importance (i), synergy (s) and context (c). The values of synergy and context are assigned in the way explained in Table V.5. The impact importance is calculated by dividing by nine the fourth root of the product of the numerical values of the criteria scope, duration, extension, and interest. By obtaining the fourth root of the product of the values of scope, duration, extension, and interest, the geometric mean has been calculated, which is a central trend measurement<sup>2</sup>

By dividing by nine, which is the maximum possible value (in case that all the criteria had a value of nine), the important values are found between zero and one. Context and synergy, on the other hand, act as factors that increase or decrease the value calculated for the importance. Based on this, in Table V.8, the assessment of impacts is expressed, which are classified into four groups, in accordance with the indicator value. In the first group, the non relevant impacts are grouped, which makes it possible to concentrate attention on the analysis of the relevant values (Table V.7), which is consistent with what is

<sup>2</sup> A central trend measurement provides a value which, under a set of considerations, describes all the values that were involved to generate it. The average or arithmetic mean is a fairly extended central trend measurement. The geometric mean is also a central trend measurement and it is considered more adequate for the purposes of environmental impact studies, due to its higher sensitivity to the low values in the set considered.



established by the LGEEPA Regulation in matters of Environmental Impact Assessment, as is indicated in Chapter III.

**Table V.7. Limit values of the impact indicator.**

<b>Interval</b>	<b>Category</b>	<b>Relevance<sup>3</sup></b>
Less than 0.400	Low	Not significant
0.401 to 0.600	Moderate	Significant
0.601 to 0.800	High	Significant
More than 0.801	Very high	Significant

### **V.3. Assessment of the impacts and detection of relevant impacts**

Based on what is presented in Table V.4 and Table V.5, fourteen probable environmental impacts of the project were detected, because in the qualitative assessment they were assigned as perceptible in the RES. The impacts are described in a qualitative way under five criteria, and they are: quality (if it is adverse or beneficial for the environmental and social processes in the SAR), intensity or magnitude (how evident is its effect for the environmental factors involved), geographic extension (the proportion of the RES area where the effects will be evident), duration (the order of magnitude of the period in which the system could recover from said impact if the causes that originate it cease, or the order of magnitude that the project will generate on the impact), and accumulation. This last criterion is associated with the occurrence in the RES of other disturbance sources whose effects could act together with the impacts originated by the project. The accumulation and the synergy are defined typically as the generation of additive effects (in the case of accumulation) or of superior order (in the case of the synergy). The results are presented in Table V.8, and once they are described, the numerical value indicated in Table V.7 is assigned to them and the method is applied to identify whether the impact is significant or not (Table V.8). In accordance with the definition established by fraction IX of Article 3° of the LGEEPA Regulation in matters of environmental impact assessment, a significant or relevant environmental impact is that which causes disorders in the ecosystems and their natural resources or in the health, obstructing the existence and development of man and of other living beings, as well as the continuity of the natural processes.

Once the description has been made each of the qualities of the relationships identified as perceptible for the RES (Table V.4), the qualities were turned into numerical value, in accordance with the values presented in Table V.7. The environmental impacts whose result is low (Table V.8), were considered not significant or not relevant, terms of the fraction IX of Article 3° of the LGEEPA Regulation in matters of environmental impact assessment.

<sup>3</sup> Under the terms of fraction IX of Article 3° of the LGEEPA Regulation in matters of environmental impact assessment.



**Table V.9. Quantitative assessment of the environmental impacts and identification or relevant or significant impacts**

Impacto	Magnitud	Duración	Extensión	Interés	Importancia	Contexto	Sinergia	Indicador	Categoría	Relev.
1.- Afectación a la vegetación forestal debido al desmonte	9	4	2	4	0.458	1.3	1.1	0.655	Alto	Relevante
2.- Pérdida de hábitat para fauna silvestre	9	2	2	2	0.324	1.3	1.3	0.547	Moderado	Relevante
3.- Afectación de especies de fauna silvestre debido al despajme	9	2	2	2	0.324	1.3	1.3	0.547	Moderado	Relevante
4.- Afectación al paisaje debido a la mala disposición de material del despajme y material pétreo	7	4	2	4	0.430	1	1.3	0.559	Moderado	Relevante
5.- Incorporación de partículas suspendidas por actividades de la construcción del trazo	7	1	2	4	0.304	1	1.1	0.334	Bajo	No Relevante
6.- Efecto barrera para el desplazamiento de fauna silvestre debido a los cortes	9	4	4	2	0.458	1.15	1.1	0.579	Moderado	Relevante
7.- Ruptura en el paisaje debido a la apertura de un banco de material nuevo	1	4	1	4	0.222	0.8	1.1	0.196	Bajo	No Relevante
8.- Afectación a la vegetación forestal y a la fauna debido al movimiento de maquinaria y personal fuera de la línea de ceros	7	1	1	2	0.215	1.15	1	0.247	Bajo	No Relevante

Impact	Magnitude	Duration	Extension	Interest	Importance	Context	Synergy	Indicator	Relevant	Category
1.- Effects on the forestry vegetation caused by clearance									High	Relevant
2.- Wildlife fauna habitat loss									Moderate	Relevant
3.- Effects on wildlife fauna species caused by clearance									Moderate	Relevant
4.- Effects on the landscape caused by the improper disposal of excavation material and rocky material									Moderate	Relevant
5.- Incorporation of suspended particles for construction activities of the stretch									Low	Not relevant
6.- Barrier effect for the wildlife fauna displacement caused by the cuts									Moderate	Relevant
7- Landscape rupture due to the opening of a new material bank									Low	Not relevant
8.- Effects on the forestry vegetation and on the fauna caused by the movement of machinery and personnel outside the zero line									Low	Not relevant



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Impacto	Magnitud	Duración	Extensión	Interés	Importancia	Contexto	Sinergia	Indicador	Categoría	Relev.
9.- Reducción de tránsito vehicular en la ruta actual y al interior de los poblados por donde cruza	9	7	4	7	0.720	1	1	0.720	Alto	Relevante
10.- Riesgo de atropellamiento a la fauna silvestre debido a la circulación vehicular	7	7	4	2	0.494	1.15	1	0.569	Moderado	Relevante
11.- Impulso a la economía local debido a la operación del trazo	9	7	9	9	0.939	1	1.3	1.221	Muy alto	Relevante
12.- Agilización del transporte debido a la operación del trazo	9	7	9	9	0.939	1	1.1	1.033	Muy alto	Relevante
13.- Limpieza de alcantarillas durante el mantenimiento	7	2	1	2	0.256	0.8	1	0.204	Bajo	No relevante
14.- Mantenimiento a la vía para su óptimo funcionamiento	4	2	1	2	0.222	0.8	1	0.178	Bajo	No relevante

- |   |           |              |
|---|-----------|--------------|
| 9.- Reduction of vehicle traffic in the current road and inside the villages it crosses | High      | Relevant     |
| 10.- Risk of running over wildlife fauna as a result of vehicle circulation             | Moderate  | Relevant     |
| 11.- Promotion of the local economy as a result of the road operation                   | Very high | Relevant     |
| 12.- Transportation flow as a result of the road operation                              | Very high | Relevant     |
| 13.- Cleaning of sewers during maintenance  | Low       | Not relevant |
| 14.- Road maintenance for its optimum operation   | Low       | Not relevant |



Out of the 14 impacts identified as perceptible in Table V.4 and V.5, 5 were rated as low, indicating that they are NOT SIGNIFICANT; of the 9 remaining impacts, they were rated as significant, 6 of them adverse, 1 in the category of high, and the remaining 5, as moderate; of the 3 beneficial, one was in the High category and the other two, in the Very high category.

The first and second significant adverse impacts correspond to 1 (high) and 2 (moderate), respectively (Table V.8) and this is the result of the clearance of 16.72 Ha of forestry type vegetation in the UNA 4 (highly preserved) and 7 (preserved). In this zone, the vegetal covering will be completely lost and, consequently, there will also be a habitat loss for species of restricted habits (particularly in the UNA 4), of them 6 included in the standard.

The third moderate adverse impact corresponds to 3 (Table V.8) and it refers to the effect on fauna species that live buried or among the dead leaves, during clearance; the most sensitive fauna would be amphibians of domestic habits. Among the amphibians, there are two species included in the standard with those habits: *Montezumae Frog* and *Pseudoerycea belli* which could be affected; in addition to the reptile *Kinosternon integrum*, classified in special protection.

The fourth moderate adverse impact (Table V.8) can occur only if the disposal is inadequate, for example, downhill or in a ravine; if this happened, the effects would be on the disruption of the biogeochemical cycles of the place and on the habitat loss in the disposal surface and to the places the material will reach.

The fifth and sixth adverse impacts (6 and 10, Table V.8) refer to the barrier effect to the fauna caused by the road construction, in addition to its operation, where the animals that cross the asphalt road can be run over. This is relevant, particularly in the UNAs 4 and 7, where the adjoining agricultural fields represent places where the fauna crosses between the separate patches of the UNA 5.

Of the beneficial impacts, the first one is High and is caused because the road operation will reduce the highway traffic currently used and that covers the Zacapu – Jiménez – Panindícuaro route. The road project has high specifications (A2) and it also spares the urban and sub-urban areas, which will reduce the traffic that these populations have inside them. Besides being an A2 highway, it will allow the drivers to avoid taking the roads that transport the rocky material from the numerous material banks of the area, reducing the driving times.

The second positive impact is in the category of very high and it refers to promoting the local economy as a result of the road operation. The RES has economic growth (municipalities with low marginalization) and the secondary and tertiary sectors are growing at the expense of the primary sector; the communication with stronger regions, particularly in the secondary sector (City of Guadalajara, Morelia, and Mexico City) will



foster the economic development of the RES because there will be faster product movement and arrival of new investments.

The last beneficial impact is also very high and it also occurs for the better traffic flow in this route, with savings of one hour between the toll-free highway and the toll highway no. 15 of the Mexico City – Morelia – Guadalajara route.

#### V.4. Impacts or effects of the RES modified by the project

In Table V.4, the impacts attributable to the project are integrated to the regional environmental diagnosis. Worth of mention is that the project impacts can be classified into different categories, depending on their interrelationship with the regional environmental situation (Table V.8); the impacts can be simple (or not additive), if in the RES there are no change processes that affect the environmental components or factors. They can be cumulative when the environmental effect results from the increase of the impacts of particular actions caused by the interaction with others performed in the past or that are occurring in the present (in terms of fraction VII of article 3° of the Regulation<sup>4</sup>); they can be synergic when the overall effect of the simultaneous presence of several actions assumes a higher environmental incidence than the sum of the individual incidences contemplated individually (fraction VIII of the same article).

To the traditional RES scenario without the project described in section IV.5 (Chapter 4), the relevant impacts of the RES were added (Table V.8) to obtain a modified scenario by the project and the cumulative and synergic impacts of the RES are described (last column of Table V.9).

Of the 6 effects identified by the RES (sections IV.3 and IV.4 of Chapter 4), 4 show additive effects with the project. Despite the additive effects, none endangers the RES functionality, as is explained in Table V.9.

**Table V.9. Description of the RES impacts integrating those caused or worsened by the project**

No.	Description	Impact or effect that presents the SAR now	Accumulation or synergy with the project.
1	Loss of flower biodiversity	<p>In the UNAs 2 and 6 (185 Ha), the original biodiversity has been completely lost, with no possibility of regeneration without human influence.</p> <p>The original composition of the UNA 1 (178.54 Ha, 17.63 % of the RES) has lost the original composition and only in the limits does it maintain original species of</p>	<p>The additive adverse impacts are number 1 and 4 (Table V.8).</p> <p>The area between zero line will be cleared in an area of 16.72 Ha (inside the UNAs 4 and 7), which will be additional to the area without forestry vegetation of the UNA ". The cumulative impact will be a surface without forestry vegetation with the conditions of the</p>

<sup>4</sup> The Regulation of the General Ecologic Balance and Environmental Protection Law in matters of environmental impact.

		the Btc and some of the gallery forest that grows on the sides of the irrigation ditches.	UNA 2, 202 Ha in the RES. The UNAs 4 and 7 will see a reduction in their surface with a joint resulting area of 1918.92 Ha.
		In the UNA 8 (2217.73 Ha), more than 80 % of its components are secondary, although the seeding bank that contains the genome of original species is still viable. However, the recruitment is difficult for the continuous presence of cattle.	Besides, the project implies an effect of 17.8 Ha inside the UNA 3. For reason of the project, this surface will become an asphalt road, thus losing forestry species in the adjacent agricultural fields. The surface of the UNA 3 will be of 535.84 Ha.
2	Change in the fauna composition and size of the populations	Wildlife fauna of restricted habits was lost in the UNAs 2 and 6 completely; and in the UNAs 1, 3, 7, 8, and 9 only native wildlife fauna with general habits remained; most of the wildlife fauna of restricted habits had to move back, particularly to UNAs 4, 5, and 10. As a result, there was a significant reduction of the population sizes.  Only a surface of 631.66 Ha (11 % of the RES) remained with conditions to lodge species of restricted habits, of which 7 are included in the NOM-059-Semarnat-2001.  Only a surface of 162.07 Ha remained with original Btc (3 % of the RES), which is the only habitat for original wildlife fauna which 90 % formerly (more than 80 years ago) lived from the RES (the rest was aquatic and sub-aquatic vegetation).  The UNAs 4 and 3 were gained from the UNA 5 for the irrigation incorporation. The distribution of the gallery forest observed in them did not exist before the irrigation ditches were constructed. These zones are also the habitat of species of restricted habits, whose populations have grown at the expense of the reduction of populations that prefer drier conditions.	The road will cross the UNAs 3, 4, 7, and 8 and 34.52 Ha will be lost (0.62 % of their joint surface) of habitat of general fauna species (in UNAs 3 and 8) and of restricted habits (in UNAs 4 and 7).  Of the UNAs 3 and 8, a surface of 11.68 Ha will be lost (0.42 % of their joint surface) of habitat of general species and some harmful species that are attracted by the food supply in agricultural and cattle fields.  Of the UNAs 4 and 7, 1.27 % of their joint area will be lost, which is the habitat of species of restricted habits.
3	Landscape fragmentation	Four patches were identified that make up the UNAs 4 and 5 (both divided in 2 patches each), all of them larger than 100 Ha. Therefore, they are considered viable to support healthy flora and fauna populations.  The patches that make up the UNAs 4 and 5 are united through the gallery forests that grow in the UNAs 1, 7, 8, and 10 and that act as very successful passing points for fauna. Thanks to the water available, the channels promote the creation of these routes and are oriented to the boundaries of the plots of land.  However, the fauna of restricted habits used to living in dry environments, as those present in the UNA 5, does not use the boundaries for mobilization reasons and only does it for the secondary vegetation found inside the UNA 9.  In conclusion, the landscape in the RES depends on the zone studies. In general terms, however, two different landscapes can be mentioned: the preserved	Impacts 6 and 10 will be additive (Table V.8).  According to Forman and Godron (1986), for a semi-arid zone, 1 km separation is required to consider it fragmented by a patch and more for one with water availability (like the UNA 4 of the RES). This situation will not occur as a result of the site preparation or the road construction and operation.  However, a barrier effect will be favored for the wildlife fauna with 8-km length, where along the 4.85 km length there are fauna displacement routes.  The barrier effect will be particularly important in the crossing with the UNA 4 (km 14 + 600 to 15 + 700) and 7 (15 + 750 to 16 + 000 and from Km 17 + 700 to the junction with the current road).

		<p>landscape in the high parts, and the degraded landscape in the low parts. In the former, the high scenic quality, the landscape connectivity, and a high grade of natural preservation prevail. In the latter, the opposite occurs. It is a typically anthropogenic landscape.</p>	
4	Air pollution	<p>In the RES, in every dry season a surface of 2,373 Ha (43 v% of the RES) is exposed to wind erosion, causing dust storms. The dust storms increase the number of suspended particles that favor respiratory diseases.</p> <p>In the dry season, weeds are also burnt, increasing the presence of suspended particles and combustion gases.</p> <p>In the RES, mining is an important activity, with the extraction of rocks. The exploitation of numerous material banks also contributes to increase the suspended particles.</p> <p>Transportation contributes with its own share to the polluting emissions, particularly on weekends for higher vehicle traffic for recreational purposes. Traffic jams are also caused by the trucks that travel from and to the material banks and that seldom move at more than 35 km / h.</p>	<p>There are no relevant additive impacts, and only one not relevant impact (number 5, Table V.8).</p> <p>The air pollution accumulation as a result of the asphalt plant operation is not considered because it operates commercially and has its own study to measure its environmental impacts.</p> <p>It will be additional to the new material bank located in Km 13, but it is not relevant.</p> <p>IF laying of the bases during the construction of the embankment occurs during the dry season, it will contribute more suspended particles to the already polluted air.</p> <p>On the other hand, we consider that this road will reduce traffic of the current one, thus reducing the emission of gases produced by combustion.</p>
5	Erosion	<p>The RES presents severe water erosion in the UNA 6 in an area of 30.24 Ha (0.54 % of the RES). In the UNA 2 there are also signs of average to severe water erosion in a surface of 155.26 Ha (2.79 % of the RES); while in the UNA 1 in 178.54 Ha (3.2 % of the RES) there are incipient signs of erosion</p>	<p>No relevant additive impacts were identified.</p> <p>The project will not make this situation worse, because after the clearance, the borders will not be exposed. The clearance is only performed between zero line, and this is where the embankment body will be built.</p>
6	Reduction of aquifers	<p>There is an overexploitation of aquifers for the increase of hydro-agricultural infrastructure and the population and economic growth of the zone will be reflected in increase of water consumption and contamination for human settlements.</p>	<p>No relevant additive impacts were identified.</p> <p>The project will not make this situation worse, because water will not be extracted from the sub-soil for any of the activities.</p>



## CHAPTER VI STRATEGIES FOR PREVENTION AND MITIGATION OF CUMULATIVE AND RESIDUAL ENVIRONMENTAL IMPACTS OF THE REGIONAL ENVIRONMENTAL SYSTEM

In the previous Chapter, fourteen impacts were identified, described and evaluated. Out of them, six adverse impacts were considered significant ones. In order to prevent, reduce, or compensate the environmental, cumulative, and synergic impacts of the project on SAR, seven mitigation measures were designed. The objective is to reduce the environmental cost of the execution of this project. The preventive measures are a priority, because its correct execution will avoid or reduce the significant adverse impacts of the project, avoiding its addition to those of SAR, as it will be described later on.

The residual impacts will be presented at the end of the chapter.

The summary of measures, its stage of application, and the impacts being prevented or mitigated are depicted on Table VI.1. The definition of mitigation measures was oriented to the adverse impacts that were evaluated as significant ones, either high (1) or moderate ones (3) (Table V.8, of Chapter V). The mitigation measures may have also mitigated low impacts, but that shall not deviate the focus from the main intention, which is to mitigate the significant SAR impacts, in accordance to the mode of this Declaration.

Other measures –although not mitigating any significant impact– were also included. They are mandatory due to the fact that they are set forth in some law, regulation or Mexican Official Standard. If this is the case, next to the impact being mitigated, the regulation in question is mentioned.

<b>Table VI.1 Mitigation Measures System for Cumulative, synergic, and/or Residual Impacts of SAR</b>		
<b>Mitigation Measures</b>	<b>Application Stage in Accordance to the Project's Activities</b>	<b>SAR Impact being Mitigated (Table V.8), and/or Regulation it Complies with</b>
1. Guidelines for the personnel during their stay in the works	During preparation and construction of the site	Preventive It avoids abuse of the wild fauna It establishes procedures for compliance with NOM-081-SEMARNAT-1994

2. Monitoring of machinery and equipment emissions	During the preparation and construction of the site	Compliance with 3 Mexican Official Standards: NOM-045-SEMARNAT-1996, NOM-085-ECOL-1993 and NOM-050-ECOL-1993
3. Keeping fauna away, recovery of nests and species living underground	Before and during the site preparation	It prevents: 3. Harm of the species of wild fauna due to grass pull up
4. Recovery of tropical deciduous forest genome and gallery forest for reforestation works (MM7)	During the preparation (before clear cutting, recovery of the juveniles) and during construction (recovery of genome)	It compensates: 1. Impact on the forest vegetation due to clear cutting 2. Loss of habitat for wild fauna
5. Management of the material produced during clear cutting, grass pull up and leveling	During preparation (grass pull up and leveling)	It prevents: 4. Impact on landscape due to bad disposal of grass pull up material and stone material
6. Construction of troughs for the fauna in the minor drainage works to favor the movement routes	During placement of the minor drainage works	It reduces: 6. Barrier effect for the displacement of the fauna due to the cuts 10. Risk to run over wild life due to vehicle traffic
7. Reforestation program	During construction (during the placement of sheet asphalt, during the placement of signs and for one year more)	It compensates: 1. Impact to the forest vegetation due to clear cutting 2. Loss of wild fauna habitat 6. Barrier effect for displacement of the wild fauna due to cuts

### **Mitigation Measure 1: Guidelines during the Stay of the Works Personnel**

Measure Type: Prevention and reduction

Space Location: Along the road span

Application Stage: Once the bidding process is completed and awarded, as of the preparation of the site and during construction

Impact Mitigating the Standard being Complied with: Compliance with NOM-081-SEMARNAT-1994



**Objective:** The personnel shall know: the restrictions that are to be complied with during construction and handling of machinery; and the reason for such constraints as well as the corresponding sanctions in case of non-compliance. Avoid the inappropriate disposal of waste material from leveling and grass pull up.

**Procedure:** Three days before starting the site preparation activities, all the construction and supervision personnel will be asked to go to an appropriate site. In this meeting the workers will get the following information:

- It shall be forbidden to go out of the works front and only the area between the line of zeros may be used.
- Saniseco-type portable toilets shall be used as located in the different fronts of the works to defecate. These toilets will be emptied once a month by the company leasing them, the product will be mixed with the grass pull up material.
- In each front of the works, there will be a trashcan with a lid where all the garbage (household-type residues) will be placed. The inner bag containing the garbage will be delivered to the cleaning system of the Villa Jimenez town or Panindícuaro town, according to the location of the works.
- The burlap with some solvent, oil, fuel or any other substance, shall be placed in the drum for hazardous wastes inside a bag with the label indicating "HAZARDOUS WASTES (OILS AND SOLVENTS)". Even though based on the volume these residues are not considered as hazardous by the NOM-052-SEMARNAT-1993, they shall be delivered to the closest gas station upon joint agreement in order to be disposed of with their own wastes.
- It is forbidden to make any type of repair work outside of the authorized workshops. If machinery requires any type thereof, this shall be taken to a workshop with commercial operations in Zacapu, Panindícuaro, Morelia or Guadalajara. Even oil changes, washing engines or any other type of minor work of the vehicles or machinery will not be done outside of the workshops, gas stations and/or a car wash.
- It is forbidden to work during nighttime and/or remain on the works front during night time (from 6:30 PM to 7:00 AM).
- No plants from the surroundings shall be picked. Unnecessary deliberate damage to the natural vegetation will be avoided.
- No wild fauna will be hunted or disturbance thereof caused.
- If a hazardous or poisonous animal is found, immediate notice will be given to one of the biologists or non-graduated assistants who will remain in the works during the site preparation activities, for them to trap it with a herpetological pole and to relocate it.



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- All food eaten in the work front will be cold. It is forbidden to light fires to cook or for any other purpose. All the garbage coming from this activity will be placed in the garbage cans located in the works fronts.
- It is expected that the construction work and the operation of transportation vehicles for materials to the works front will not exceed a maximum of 68 dB(A) (for construction work), and a maximum of 90 dB(A) (for the vehicle operation) during exposure times no greater than 15 minutes. If the noise level was higher, there will be a 5-minute break from work every 15 minutes of work. Excavation in type-C material cuts (Annex 8) may exceed 90 dB(A). This activity will take place during daytime only, from 9:00 to 18:00 hours. Machinery operators will use hearing protection equipment, which is to be provided by the employer. In the zones located less than 1 km away from town, activities will be limited to this schedule: from 9:00 to 18:00 hours. In the Km 14+500-to - 17+500 (UNA 4 and surroundings) section, no heavy machinery will be used which generates noise above 68dB(A).
- Once the construction work is finished, all the wastes generated during the different phases of the works will be picked up: particularly, the waste such as diesel drums and those of other oils for machinery, iron pieces, and metal sheets. Paying special care to avoid oil and other fuel spills is recommended, as well as picking up toxic or potentially toxic wastes.

The contractor will supervise the compliance with these provisions, and it will be responsible of the cases of non-compliance on the part of the workers.

### **Mitigation Measure 2: Monitoring of Emissions from Machinery and Equipment**

Type of Measure: Reduction

Special Location: Within the right of way, outside of the surface between the line of zeros and next to the right of way

Application Stage: During the site preparation, construction and maintenance

Mitigated Impact or Standard being Complied with: The measure complies with 3 Mexican Official Standards: NOM-045-SEMARNAT-1996, NOM-085-ECOL-1993 and NOM-050-ECOL-1993



**Objective:** 1) Avoiding having suspended particles during the laying out of the bases; and 2) Making sure the machinery is operated at optimum conditions and to avoid leaks, spills or repairs within the right of way. The polluting gas emission will comply with the official regulations.

**Procedure:**

1) In order to avoid excessive generation of dust, it is recommended to conduct the layout of the bases between May and November. Or a tank truck will be placed on the works front with treated water for irrigation (from the one being supplied for agriculture irrigation of SAR). The material will be irrigated before and after placing it.

2) The contractor shall check emissions for the mobile machinery such as dump trucks, machinery and vehicles. The measurement of emissions will be done in an authorized verification workshop. The plate and type of machinery will be specified. The emission limit is established on Table VI.2. The general supervisor of the works will verify to make sure that the machinery being used in the works has been verified, and it complies with this mitigation measure.

Trucks transporting material shall cover it with a canvas. To this end, it is suggested to tie one side as the truck is being filled in the cut area, or in the material bank; once it is full, the other end of the canvas will be placed over and tied on the missing side. This measure is simple, fast, and it avoids losses due to the motion during the trip, and dispersion of the material in case of strong winds.

<b>Table VI.2. Emission Limit for the Machinery</b>				
<b>Type of Vehicle</b>	<b>HC (ppm)</b>	<b>CO % Vol.</b>	<b>NOx (ppm)</b>	<b>Opacity</b>
With gasoline engine	100	1.0	1200	***
With diesel engine	***	***	***	1.27 m <sup>-1</sup>
With gasoline motor for material transportation	200	2.0	1500	***
With natural gas or L.P. gas engine	200	1.0	1000	***

**Note: Limits set forth are in accordance to the following Standards: NOM-045-SEMARNAT-1996 and NOM-050-ECOL-1993.**



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The asphalt plant, crusher and any other fixed equipment being considered, will be in compliance with NOM-085-SEMARNAT-1994, in accordance to the limits included on its Tables 4 and 5 (of that NOM). The owner of the bank will submit its results to the supervisor every 6 months. The brand name, model, year, serial number and verification result will be included.

The machinery and equipment will be checked every 2 months to make sure there are no oil or fuel leaks, and it will be included in the results log. If there are any leaks, it will be sent to the authorized workshop until they are eliminated and the one responsible for the leasing of the machinery will have to remove the oil or fuel from the soil or sheet asphalt and take it to a gas station for it to be treated with its residues.

### **Mitigation Measure 3: Keep Fauna away, Recovery of Nests and Species Living under Ground or in Holes in the Area of Clear Cutting and Grass Pull up**

Type of Measure: Prevention and reduction.

Special Location: Along the whole road span part of this study

Application Stage: During the site preparation, starting one month before the beginning of clear cutting

Impact being Mitigated or Standard being Complied with: 2. Loss of habitat for wild fauna; 3. Impact of the wild fauna species due to the grass pull up

Objective: Avoiding impacting the wild fauna which is living in the area or damage thereof during the preparation and construction works of the road span.

Procedure:

Annex 7 contains a listing of the fauna that could be affected by the works mentioned herein. In SAR, two amphibian and four reptile species are distributed as listed in: NOM-059-SEMARNAT-2001. The following amphibians can be found: (*Rana montezumae* and *Pseudoerycea belli*), and the *Kinosternon integrum* reptile can be found mainly all along UNA 4 (Km 14+550 to 15+750), and in the surroundings of the gallery forest of UNA 7 (Km 15+750 to 16+050, and from 17+650 to 19+600). The *Sceloporus grammicus*, *Pituophis deppei* and *Masticophis flagellum* reptiles prefer open areas such as the induced grasses, Btc or rain-fed farming agricultural fields. Therefore, they can be present in any part of the SAR.



Due to the difficulty to conduct an accurate identification during the removal of fauna, no specific measures will be applied for these species.

Most of the species living in the SAR have same-place- living habits, and only a few reptiles and mammal such as the coyote and the vixen travel large distances.

On the other hand, in the case of seeing wild fauna, the accurate identification means to cause some level of damage<sup>1</sup> –which may go from moderate damage to death– which would be against the purpose of this measure. Thus, there will not be measures tending to protect species in particular, but the objective will be to keep away and relocate all the wild fauna. In particular, species of high mobility, when they find some motion, they go away from the site of disturbance.

In order to keep away and relocate the wild fauna, it is recommended to implement the following points:

1) A crew of biologists or non-graduated assistants will be hired. They will be in charge of keeping fauna found in the road span away towards the neighboring zones. They will conduct rides perpendicularly to the road span, towards both sides and inwards of the whole road span, including UNA 4 and 7; as well as tree boundaries of the agricultural fields of UNA 3 and 8. The crew will work three days in advance of the work front conducting the clear cutting.

During the rides, the surrounding vegetation will be hit with sticks and noise will be made to keep animals away which could be found in the zone; these rides will be conducted during the first hours of the morning (5:00 a.m. to 8:00 a.m.) and when it gets dark (6:00 p.m. to 7:00 p.m.), in order to keep away amphibians, birds and small, medium and large mammals since these hours are those with more this type of fauna, because they are searching food. For reptiles, mainly lizards, it is recommended to do the rides less time in advance, from 9:00 to 16:00 hours (Uribe-Peña et al., 1999; Aranda, 2000). The reason is to prevent animals from coming back to the road span before the clear cutting starts.

This measure is more effective with birds and medium and small (flying) mammals, since amphibians, reptiles and small (non-flying) mammals tend to go back to the place of origin (in item 2, it is explained the removal of fauna with same-place-living habits).

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<sup>1</sup> It is common for the zoologist to have to kill an animal to take it to his or her laboratory to identify it using codes since most specialist in every fauna order do not know in general all its specific composition through single sample analysis in the field.



For medium-size mammals, it is recommended to use traps only in the stretches of road of the section located in UNA 4 (Km 14+550 to 15+750) and 7 (Km 15+750 al 16+050 and from 17+650 to 19+600) between the line of zeros. It is recommended to use traps in such a way that one can be reasonably sure to have kept away the fauna that can be affected by the project. The use of traps will be done in the early morning three hours before starting clear cutting works. The traps being recommended are Havahart-type traps:

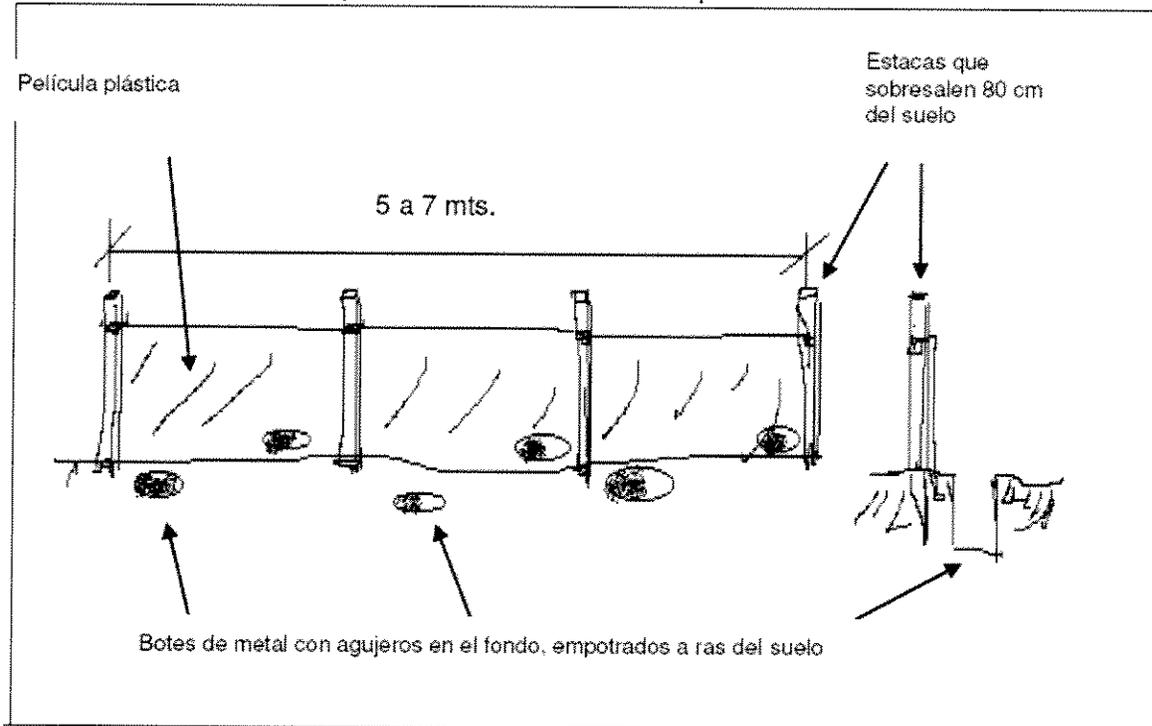
- An easy-set Havahart cage trap with double doors: the design of this trap prevents animals from moving once inside of it to avoid harming them. Model 2074001 is made of stainless steel, and it is 10" in length x 3" in width x 3" in height, weighing 2 lbs., and it is ideal for mice, shrews and common opossum.
- An easy-set Havahart cage trap with double doors: the design of this trap prevents animals from moving once inside of it to avoid harming them. Model 274000 is made of stainless steel, and it is 16" in length x 6" in width x 6 ½" in height, weighing 4 lbs., and it is ideal for rats, weasel and squirrels.
- An easy-set Havahart cage trap with double doors: the design of this trap prevents animals from moving once inside of it to avoid harming them. Model 274002 is made of stainless steel, and it is 24" in length x 7" in width x 7" in height, weighing 6.5 lbs., and it is ideal for skunk and ferret.
- An easy-set Havahart cage trap with double doors: the design of this trap prevents animals from moving once inside of it to avoid harming them. Model 274006 is made of stainless steel, and it is 36" in length x 11" in width x 11" in height, weighing 19.5 lbs., and it is ideal for porcupine, vixen and coyote.

Together with the traps in the same stretch of road, nests will also be located where branches will be cut, and tied at more than 100 m away from the works zone in the same UNA where the nest was found, in a tree with the same cover of the hosts, and at the same height. In the logbook, it will be written the site of location and re-location, pictures will be taken which will be attached or printed in the logbook.

The holes will be reviewed on the ground looking for reptiles searching with a herpetological pole. If a reptile is found, this pole will be introduced in a canvas bag marked with a sign reading "possible poisonous animal". The reptile will be

released one kilometer away from the works in a vegetal formation and similar coverage in the same UNA. In the logbook, it will be written the species, the UTM coordinates where it was found, and coordinates where it was released taking pictures of both processes.

2) It is recommended to conduct a rescue of fauna whose dwelling environment is reduced and/or with reduced displacement capabilities, as it is the case of most amphibians, many reptiles and small mammals mainly those belonging to the *Rodentia* and *Didelphimorphia* orders. Even though, it is well-known that the latter move rapidly, most of the times their living surroundings do not exceed a 60-meter distance (Sánchez-Cordero et al., 1997; Sánchez-Cordero and Canela Rojo, 1991; Baker, 1968). In the stretches of road found from 14+500 to 16+700 (surroundings of the UNA 4), and from 18+400 – 18+460 (River in UNA 7); it is recommended to install traps since it is a potential habitat of such species.



Plastic film

Stakes coming 80 cm out of the ground

5 to 7 m.

Metal cans with holes at the bottom embedded on the ground level

**Figure VI.1. Trap with Barrier for Amphibians, Reptiles and Small Mammals.**



For removal of amphibians, reptiles and small mammals with same-place-living habits, folding Sherman traps may be used which are made of aluminum and available in three different models:

- LFA model, folding trap, made of 0.020" aluminum weighing 0.8 lbs. with 3" in height x 3 ½" in height and 9" in length.
- LFATD6 model, folding trap, made of 0.020" aluminum weighing 1 lb.; the hook to actuate the door is made of galvanized steel; it is 3" x 3 ½" x 9".
- XLK model, foldable trap, made of 0.025" aluminum weighing 1.8 lbs; the hook and door actuating the door is made of galvanized steel; it is 3" x 3 ¾" x 12".

There are other traps for small mammals such as:

- LNA model, non-folding Sherman trap made of 0.020" aluminum weighing 1 lb. which is 3" in height x 3 ½" in height and 9" in length.
- Model 3310A, non-folding Sherman trap made of 0.025" aluminum, weighing 1 lb.; which is 3" in height x 3" in height and 9" in length.

Although these traps are not exclusive for amphibians and reptiles, many times such animals end up trapped in them. Other useful traps for reptiles and shrews are those with floor barrier as shown in Figure VI.1. The animals so-trapped, will be withdrawn approximately from 500 m to 1 km away from the road span (inside the same UNA), with the objective of having enough space for the balance of the wild populations to be re-established.

3) Heavy machinery is not to be used inside the UNA 4 and surroundings (Km 14+550 to 15+750), nor next to the water bodies with gallery forests. Before the beginning of the clear cutting of the road span and/or sinking work for the bridges, the fallen leaves and soil cover will be removed with a shovel and a wheelbarrow (Table II.1, Chapter II). The fallen leaves will be deposited in the same UNA, at least 1 km away and it will be spread, if a turtle or frog is found, it will immediately be transported among the fallen leaves and placed next to the body of water.

The felling of trees will be done using a manual saw. In no case, the 68-dB noise level will be exceeded. The working hours will be limited from 10 a.m. to 5 p.m. All activities required inside the gallery forest will be manual ones and only between the line of zeros. The grass pull up will be done manually.



No works will be conducted between July and September which is the most important reproductive time for the birds that could live in the gallery forest.

4) A general recommendation suggested for the construction company is the implementation of an environmental education program aimed at its workers before starting work in the field, since it is known the attitude of people when they encounter local native fauna. Mainly in the case of reptiles, they are always killed on the site where they are found, because there is the generalized idea that all species are poisonous. The same applies to lizards which are considered to be poisonous species by them.

All the time during the construction, a biologist or non-graduated assistants will be present to prevent workers from killing animals for food, or because they are deemed a threat. Forestry Suppliers or another similar company, if done, will conduct the rescue of the snakes, using herpetological poles such as the Azel snake catchers. Once the snake is immobilized, the poles are placed inside closed canvas bags so that the animal calms down, and can be transported to other site. The bag will be made of canvas to prevent the animal from dying of suffocation. These animals will be transported at least one km away from the works in a cross-section direction from the road span. At any rate, the crew members are to be keep fauna away. Each one of them will have a herpetological pole to conduct the rescuing. The supervisor will also have a pole.

#### **Mitigation Measure 4: Genome Recovery from the Tropical Deciduous Forest and the Gallery Forest for the Reforestation Works (MM7)**

Type of Measure: Compensation

Special Location: In UNA 4, 5 and 7

Application Stage: 4 days before clear cutting, in accordance to the progress of each front of the works and the recovery of the genome outside of the right of way during the construction of the embankment body

Mitigated Impact or Standard being Complied with: 1. Impact to the forest vegetation due to clear cutting; 2. Loss of habitat for the wild fauna

Objective: 1) Having juveniles and seeds for the reforestation program coming from the conservation zones of SAR (UNA 4 and 5; as well as boundary gallery forest in UNA 7) with which the introduction of exotic genome will be avoided



Procedure:

Two botanists experienced on field work and genome recovery will be hired.

a) During clear cutting inside UNA 4 and 7, all the found juveniles of these genera will be collected: *Salix*, *Taxodium* and *Fraxinus*. Since little regeneration of this species was observed, it is anticipated to collect a maximum of 200 juveniles. Additionally, the *Baccharis heterophyla* (*Jara, escobilla*), *B. salicifolia* (*Jara*) and *Lasianthaea macrocephala* bushes will be collected.

The common criteria for the collection of juveniles is as follows: healthy specimens with a maximum height of 1.2 m and a diameter under 10 cm. They will be withdrawn from the ground including the root ball, and making sure to excavate in such a way that the roots are not damaged, avoiding physically damaging them or exposing them to air and sun. The juveniles will not be released in any type of weeds or other plant which means competition at the time of been re-planted.

All the collected juveniles will be taken to the disposal site (MM5), and efforts will be made to leave them near the land boundary under the trees that normally grow producing a shade.

An inappropriate transportation or storage may considerably affect the plant batch with which the recovery will be made. Thus it is important to pay special attention to how this activity is conducted. In all instances, transportation will ensure that juveniles suffer the minimum possible damage: either mechanical, drying and/or warm-up. Thus, this will be done in covered, well-ventilated vehicles. The maximum capacity to store the plants will not be exceeded; they will be properly placed in the vehicle in order to reduce the number of trips, since this translates into damage to the plants, which can be irreversible. It is possible to stack two layers of plants as long as the containers of the plants are resistant enough, and of similar size in order to have a homogenous arrangement allowing stacking two layers. It is not recommended to stack more than two layers since this may damage the plants at the bottom.

The plants will be provisionally stored in the disposal site (MM5), in order to be used for reforestation on the edges of the way. With this, connectivity among patches will be favored for those which presently no longer have communication at such point. This will reduce to some extent the lack of continuity of patches forming UNA 3 and 8.



Preferably, the rescue of the flora will take place between June and October. These are the months with more cloudy days, and weather conditions favoring survival of the plantlets and juveniles.

A survival rate of 70% is expected. A lower value would indicate a bad management of juveniles, and it would be necessary to re-collect genome, and to conduct germinations until the dead individuals are recovered. In such a situation, the responsible company to conduct the mitigation measures will be the one organizing such activity. In this case the program would be submitted to SEMARNAT for assessment.

b) In a parallel fashion, during the construction of the body of the embankment, seeds from the UNA 5 will be collected. The botanist in charge of collecting the seeds will carry a paper or canvas bag. He will have gloves, and will collect the seeds exclusively from the following species: *Acacia pennatula*, *Agonandra racemosa*, *Bursera cuneata*, *Casimiroa edulis*, *Cedrela dugesii*, *Celtis caudata*, *Eysenhardtia platycarpa*, *Eysenhardtia polystachya*, *Lysiloma acapulcensis*, *Pistachia mexicana* and *Quercus deserticola*, since these species are the original ones and will help to give shade so as to cover the area of the undergrowth. 3 kg. of seeds will be collected. The seeds will be exclusively collected in the UNA 5 (Chart 9, Annex 2).

It is recommended to conduct the collection of seeds in November in order to be able to sundry them, and the time, at which the cold weather takes place, coincides with winter in order to avoid affecting their cycles.

Once collected, the seeds will be submerged for 3 days in an HCl 0.5 M solution at 36°C<sup>2</sup>. Later a sheet will be spread over the ground, placing the seeds on it. Then, every separate sheet is covered with a mosquito net to avoid losses due to air or wild animals. They will be left there until they are fully dried.

Once the seed is dry, it will be mixed with the grass pull up material (only that coming from UNA 4 and 7), and the wastes from the dry toilets. In the same disposal site, such volume will be separated in a different mound. Once mixed, it will remain for a maximum of 2 weeks in the disposal site (MM5) before using it to cover the edges of the highway (MM7).

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<sup>2</sup> These seeds normally have to go through the digestive system of an animal acting as a vector. The hydrochloric acid stimulates this step and scarifies the seed. This favors its breaking and germinating.



**The recovered germoplasm** in this mitigation measure, mixed with the grass pull up material, and product of the dry toilets **will be used in the reforestation works as described in MM7.**

### **Mitigation Measure 5: Handling of the Product Coming from Clear Cutting, Grass Pull up and Leveling**

Type of Measure: Reduction and prevention

Special Location: Along the whole road span

Application Stage: During the site preparation, and leveling

Mitigated Impact or Standard being Complied with: 4. Impact to the landscape due to the bad disposal of grass pull up and stone material.

Objective: Avoiding leaving the waste material abandoned next to the road or in mounds on not very appropriate sites which over time end up in the water bodies, and/or as part of the air suspended particles. Also, having material useful for reforestation of the road side and remediation of the material bank (new opening) located on Km 13+000 100m d/d.

#### Procedure:

For the location of the disposal sites, 2 sites will be chosen. Preferably, there will be an open and abandoned front at some of the material banks with commercial exploitation scattered on the site with an access road. Two-2,500 m<sup>2</sup> land lots with the following characteristics will be leased:

- Being located at the UNA 1 and/or 2 (Chart 8, Annex 2),
- Slope under 15%,
- Being private or *ejido* property (in this case, the rent will be authorized in writing on an assembly minutes),
- Located next to an access road, and
- More than 1 km away from a gulch, low land, fault or the UNA 4.

The material produced from the clear cutting which cannot be turned into timber (Annex 6) will be taken to the leased land lot, to cut into pieces and pile it.



In order to dispose of it, the grass pull up material will be piled in the land lots without mixing the material per UNA, thus in total there will be 4 mounds. Each one of them will be covered with a canvas and will be left in plies until the reforestation works are completed (MM7).

It is foreseen to generate waste equivalent to 204,298 m<sup>3</sup> of type B and C materials from the cutting. This material will be taken to a leased land lot or depleted front, and it will be piled there. If a depleted attack front has not been used as a disposal site, once the construction work is finished, the material coming from the leveling and 70% of the grass pull up material from UNA 3 and 8, will be donated to the municipalities to cover the open dumps together with the pieces from the clear cutting coming from such UNAs.

The material coming from the grass pull up of UNA 4 and 7 will be used for reforestation works of the edges of the highway. This material will be mixed with the small pieces from the clear cutting (from said UNAs). In MM7, it is described how to use it in the reforestation works.

Once the construction work is finished, the stone material (from the leveling works) will be taken to the material bank located on Km 13+000 100m d/d. There it will be arranged on the attack front simulating the original relief, and it will be covered with 30% of the volume of the grass pull up material coming from UNA 3 and 8. Then, the grass pull up material will be compacted to 90% of its original volume, and will be watered (only if it is the dry season) every third day until it is covered by grass. On the one hand, the benefit of this will be to recover the original form of the geoform, and on the other hand, to favor a rocky area to be the habitat of the reptiles preferring such surfaces, since three species of those present in SAR are include in the NOM-059-SEMARANAT-2001 Standard.

The Commercial use of the Proposed Bank is not Included in this Declaration.

### **Mitigation Measure 6: Constructing Fauna Passages and Favoring to Continue their Movement Routes**

Type of Measure: Reduction

Special Location: In UNA 4 and 7, where the main fauna movement routes are located, which will be interrupted by the road span

Application Stage: Between the laying out of the bases and paving, construction can be done simultaneously with both activities



Impact being Mitigated or Standard being Complied with: 6. Barrier effect for the displacement of the wild fauna due to the cuts; 10. Risk of running over the wild fauna due to vehicle traffic

Objective: To favor movement of animals through the drainage works (in order to establish new routes), and to prevent them from crossing over the sheet asphalt with the risk of being run over

Procedure:

In all the drainage works located in the UNA 4 (Km 14+550 to 15+750) and UNA 7 (Km15+750 to 16+050 and from 17+650 to 19+600), there will be a rustic trough placed on both extremes of its clearance. One third of the drainage works on such spans will have technical specifications for a 50% expenditure higher than what is specified by the hydraulics of the project.

Also, in the rest of the stretches of road (inside of UNA 3 and 8), 1 out of 3 drainage works, there will be a trough built to prevent fauna more resistant to disturbance from crossing the sheet asphalt, but to establish its routes through the drainage works and the cattle passages.

The trough will have a rustic construction, 20 cm deep, 30 cm long and 20 cm wide. It will be built on the ground level next to the clearance of the drainage works, and only 50 cm away and right next to the neighboring vegetation. The trough will be filled with rain and irrigation water, so that it will last long enough before the water is depleted (due to the shadow of the neighboring vegetation). This water reserve will motivate animals to move through these routes rather than choosing to cross the sheet asphalt

Along the whole length of the road span, the whole road will be fenced with barbed wire, or other material preventing middle-size animals from crossing the sheet asphalt (at 0.4 m from the ground). This is only for areas where the drainage works are above the natural ground (Figure VI.2). This will favor the establishment of movement routes between the patches crossed by the road span. The barrier will not be maintained, because once the routes are modified, they will keep on using them even without a physical barrier.



**Figure VI.2. These Sites are to be Fenced Creating a Funnel-Like Effect Directing Animals Towards the Drainage Works.**

### **Mitigation Measure 7: Reforestation Program**

Type of Measure: Compensation

Special Location: Right of way in the UNA 8 (Km 11+600 to 12+200) and UNA 3 (Km 12+200 to 14+550 and from 16+050 to 17+650)

Application Stage: Immediately after placement of signals on the road span, and once in operation

Mitigated Impact or Standard being Complied with: 1. Impact to the forest vegetation due to the clear cutting; 2. Loss of habitat for the wild fauna; and 6. Barrier effect for the displacement of wild fauna due to the cuts

Objective: Favoring the creation of an edge effect on the side of the highway uniting patches separated by farming fields, and for the wild fauna to be able to use



this strip to move in-between. Recovering a small area with the gallery forest - tropical deciduous forest ecotone will also serve as habitat for restricted-habit fauna, and increase the connectivity between patches separated inside the SAR.

#### Procedure:

a) Before the incorporation of the juveniles, a channel with irrigation water will be excavated, and which comes from UNA 4 and 7. The channel will stay on the external end of the right of way on both sides of the road span, only where the embankment ends in a slope less than 2 m, or in areas where the slope is at the subgrade level. The channel water will be for the juveniles in the gallery forest to have water availability all-year long.

Homogenized grass pull up material in the UNA 4 and 7 will be used with the seeds, and the dry wastes from the dry toilets as a substrate for the reforestation works. A bed will be laid on both sides of the traffic bodies 9 m wide; both external ends inside the right of way with such material. The transplanted juveniles will serve as a nursery for the new plantlets being born from the seeds.

The recovered juveniles from MM4 will only be planted next to the channel on the sites where the embankment ends on a slope under 2 m, or in areas where the slope is at the subgrade level. No juveniles will be planted on slopes with more than 2 m in height.

The juveniles will be planted next to the channel inside the stretches of road indicated in UNA 8 and 3.

For the placement of the juveniles, a narrow and deep hole will be excavated (40 cm in depth by 500 cm<sup>2</sup> in surface). To this end a drill bit can be used. The root will be dropped lengthwise in the hole without touching it. The bag will only be pulled out with the root ball. The body of the juvenile will have to stop on the surface on a natural way (with gloves). Once the root is extended in the hole, it will be filled with the same material that was excavated. It does not matter if material B is mixed with material A. Irrigate.

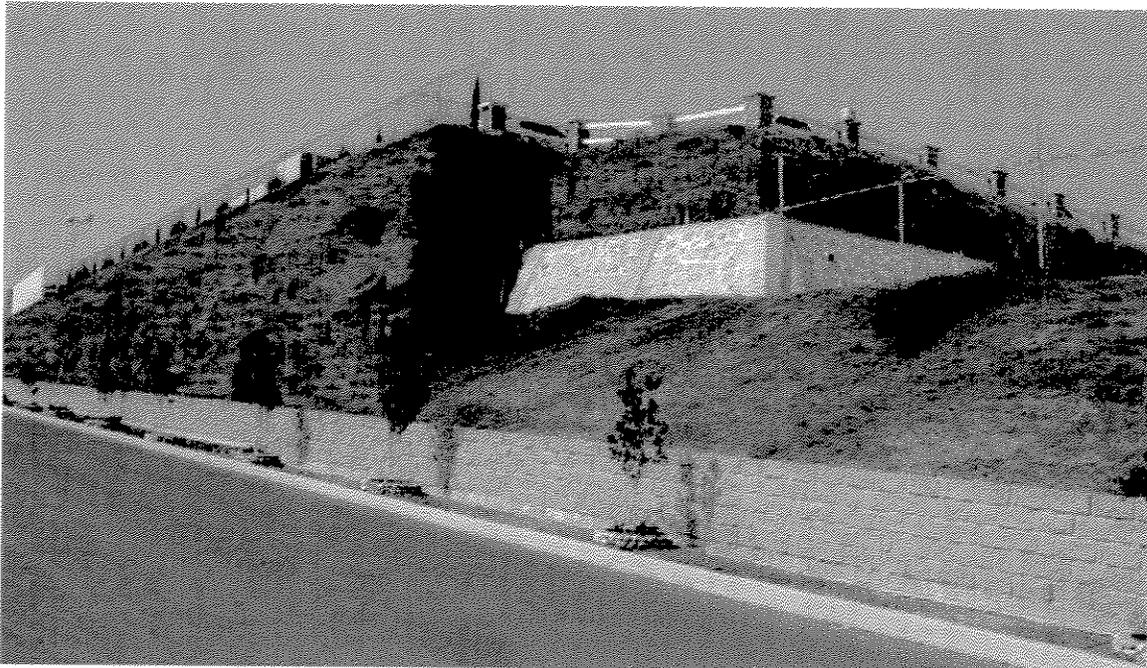
The same procedure will be followed for every new individual being planted. In general terms, those zones with shadow at least half the day will be preferred, or low lands will be chosen for their placement in order to reduce stress and losses.

It is not recommended to use a second reforestation on the edges, since the grass pull up seedbed bank with the collected seeds, with species favoring moisture

conditions of the SAR, may create spots whose appearance is that of the gallery forest – Btc ecotone, similar to the cover of UNA 4.

The implementation of juveniles or adults is not suggested in the UNA 4 and 7, because the present association has an acceptable cover, and the fauna uses these sites to move inside and outside of the SAR.

Slopes higher than 2 m inside the stretches of road mentioned (UNA 8 and 3) will not be reforested with the juveniles, but they will be covered with the grass pull up material. It is recommended to place a geo-synthetic material such as those offered by ML Ingenieria Company ([www.mlingenieria.com](http://www.mlingenieria.com)) in order to avoid the erosion and favor reforestation (Figure VI.3).



**Figure IV.3. Reforested Slope Fixed with Geo-Mesh**

Source: [www.mlingenieria.com](http://www.mlingenieria.com)

b) As compensation for the clear cutting, the promoter will comply with the restoration actions contained in the Change of Use of Forest Lands or make the corresponding payment for the reforestation activities directed by CONAFOR.



### IV.3. Program and Quantities of Work of the Mitigation Measures or Compensation

Below, there are the quantities of work for their bidding (Table VI.3). Only those which are to be part of the bid are included, since there are no prohibition measures.

<b>Table VI.3 Quantities of Work for the Bidding of the Mitigation Measures</b>			
<b>MM No.</b>	<b>Description</b>	<b>Quantity</b>	<b>Unit</b>
1	Guidelines during the stay of the staff on the works site.	1	Session
2	Emission monitoring of machinery and equipment.	1	Lot
3	Keeping fauna away, collection of nests and species which live underground and in holes in clear cutting and grass pull up areas.	1	Lot of traps
4	Recovery of genome from the tropical deciduous forest, and gallery forest for the reforestation works (MM7).	3	Botanists
5	Handling of materials from the clear cutting, grass pull up, and leveling	2	Leased land lots
6	Construction of troughs for the fauna on the minor drainage works to favor the continuation of their movement routes.	1	Rustic troughs lot
7	Reforestation program.	1	Lot of juveniles and seeds



The activities program will be matched with the construction program provided by the winner of the bid. However, in the following sample program, the time it will take each one of the mitigation activities to be included in the bid is mentioned.

Activities	Quarters											
	1	2	3	4	5	6	7	8	9	10	11	12
MM1												
MM2												
MM3												
MM4												
Grass Pull up												
Clear Cutting												
Leveling												
MM5												
Drainage Works												
MM6												
Embankment Body												
MM7												

#### VI.4. Residual Impacts of SAR

Mitigation measures presented in the previous section are focused on reduction, compensation and rehabilitation of the affected sites or environmental factors due to six adverse impacts considered as significant or relevant. (Table V.8, Chapter 8).

The degree in which the mitigation measures are able to reduce each adverse environmental impact was evaluated. The evaluation was done in a subjective manner. The percentage value was obtained by means of the average of the values allocated by the participating specialists in the study after having discussed the extent, magnitude, duration and context of the impacts as well as the scope of each mitigation measure separately. In every instance, a low value was taken for the efficacy of every measure in order to avoid over-estimating the joint efficacy. Each measure was examined and it is deemed feasible from the technical view point.



Based on the consideration of the mitigation measures, four of the adverse impacts are mitigated (impacts 2, 3, 4 and 6). Based on their reduction degree, they are not considered relevant (in the context of Section IX of Article 3<sup>rd</sup> of REIA). Similarly, impact 1 reduced its degree to a moderate level (it is still relevant). Impact 10 maintains the degree originally allocated. Therefore, in summary, the relevant residual adverse impacts are two (1 and 10).

<b>Table VI.4. Residual Impacts of the Project</b>				
<b>Impact</b>	<b>Impact (Original Value)</b>	<b>Impact Category</b>	<b>Residual Impact</b>	<b>Residual Impact Category</b>
1. Impact to forest vegetation due to clear cutting	0.655	Moderate	0.458	Moderate
2. Loss of habitat for wild fauna	0.547	Moderate	0.328	Low
3. Impact on wild fauna species due to grass pull up	0.547	Moderate	0.328	Low
4. Impact on the landscape due to the bad arrangement of the grass pull up and stone material	0.559	Moderate	0.112	Low
6. Barrier effect for the displacement of the wild fauna due to the cuts	0.579	Moderate	0.347	Low
10. Risk to run over the wild fauna due to vehicle traffic	0.569	Moderate	0.415	Moderate

The paragraphs below will include a discussion on the importance of the residual impacts (relevant due to their degree), and the way in which the mitigation measures do not fully achieve prevention or reduction thereof.

Residual impact: Impact to the forest vegetation due to clear cutting. Thanks to the mitigation measures 4, 5 and 7, the impact is reduced to a *moderate* level. However, neither the recovery of genome, nor the reforestation are able to fully



attenuate the loss in 4.6 Ha inside of UNA 4 (considered highly preserved), with gallery forest vegetal cover, which is the habitat of restricted distribution species.

Residual impact: Risk of running over the wild fauna due to vehicle traffic. Thanks to mitigation measure 6, it is reduced, but maintaining its level, since despite operating the passages of fauna, many animals, mainly reptiles, will continue crossing the sheet asphalt since they normally establish wet zones for their routes.

The beneficial environmental impacts were not covered due to mitigation measures, for obvious reasons. The three significant beneficial impacts are maintained after the application of the mitigation measures. Also, the mitigation measures foster the skilled labor concentration, as well as that of materials and equipment. But this positive effect will not be detectable at the SAR level.

#### **VI.5. Follow-up and Control**

Monitoring or follow-up of variables of interest for the project are a critical activity to verify that the mitigation measures have worked properly, and, if necessary, to determine if they need to be modified and which ones.

The monitoring program and the environmental supervision structure seek the feature of being as simple as possible, and, at the same time, efficient enough to comply with the objectives. It is important for the program to be simple because that way it has more possibilities to be 100% implemented, and it will be easier for SEMARNAT to check that its components are in operation and effective.

The following paragraphs will develop the components of the monitoring program: objectives, indicators, procedures and scheduling of activities.

#### **Monitoring Program Objectives**

- 1) To verify and document the appropriate implementation of the mitigation measures (and, given the case, the project conditions),
- 2) To examine the effectiveness and sufficiency of such measures (and conditions) in order to be able to minimize the programmed levels for prevention, reduction and mitigation of adverse environmental impacts.
- 3) To determine, given the case, the necessary modifications or additional mitigation measures to achieve the levels mentioned above.



### Indicators of the Monitoring Program and Compliance with the MMs

For a correct follow-up, it will be necessary to conduct a field supervision of the different stages of construction whereby the right implementation of the proposed mitigation measures is verified. It is recommended to hire an environmental impact supervisor, who in turn, may have two assistants. The profile of the supervisors is suggested as follows:

Coordination Supervisor (Supervisor 1): Professionally trained in biology, ecology, with environmental system Bachelor's Degree or management of natural resources with experience in the activities regarding highway construction and/or the development of Environmental Impact Measures of highway projects.

Supervisor 2: Graduate or non-graduated assistants trained in botany.

Supervisor 3: Graduate or non-graduated assistants trained in zoology.

The supervisor will be responsible to make sure that the supervision actions, and the compliance with the mitigation measures are documented, kept in logbook, and that pictures and videos are taken.

The supervisor will prepare the monthly reports of the compliance with the mitigation measures of SCT, which will submit the annual compliance reports to SEMARNAT.

Table VI.5 shows the supervisor responsible for each MM, its indicators, and what is expected in terms of the indicators.

<b>Table VI. 5. Compliance Indicators with the Mitigation Measures</b>		
<b>Mitigation Measure</b>	<b>Indicators</b>	<b>Excepted or Threshold Value</b>
MM1. Guidelines during the stay of personnel on the works	a) Number of signatures of attendance to the works initiation meeting b) Number of sanctions	a) Same as the number of workers b) None
MM2 Equipment and machinery monitoring of emissions	a) Proof of verification on the authorized facility for each one of the pieces of machinery, and equipment operating at	a) Results within the applicable standards, which are indicated in each MM

	the works	
MM3. Keep away the fauna, recovery of nests, and species which live underground and in the holes of the clear cutting and grass pull up areas.	<ul style="list-style-type: none"> <li>a) Area where the activity was conducted</li> <li>b) Number of months where the activity was conducted</li> <li>c) Number of rescued and relocated individuals</li> <li>d) After all the activities, number of trapped individuals in the verification traps</li> </ul>	<ul style="list-style-type: none"> <li>a) 72.12 Ha</li> <li>b) Between 4 and 8 months depending on the progress of the fronts of the works</li> <li>c) All those found</li> <li>d) None. No clear cutting will be done until this indicator is complied with as expected</li> </ul>
MM4. Recovery of genome from the tropical deciduous forest and gallery forest for the reforestation works (MM7)	<ul style="list-style-type: none"> <li>a) Number of recovered juveniles</li> <li>b) Percentage of survival of juveniles before their transplantation</li> <li>c) Volume of collected seeds</li> </ul>	<ul style="list-style-type: none"> <li>a) More than 150 juveniles</li> <li>b) More than 70% of the survivors</li> <li>c) 3 kg</li> </ul>
MM5: Handling of the material produced during clear cutting, grass pull up and leveling	<ul style="list-style-type: none"> <li>a) m<sup>3</sup> of excess material piled up on the sides of the works</li> <li>b) m<sup>3</sup> of excess material piled u on the leases land lot</li> </ul>	<ul style="list-style-type: none"> <li>a) Nothing piled up on the side of the works</li> <li>b) 262,453 m<sup>3</sup> of pull up material, and 41,195 m<sup>3</sup> of leveling materials</li> </ul>
MM5. Construction of troughs for the fauna on the minor drainage works to favor the continuation of their movement routes	<ul style="list-style-type: none"> <li>a) Number of minor drainage works in UNA 4 and 7 which will have troughs</li> <li>b) Number of works with a size greater than 50% of the maximum flow of the runoff</li> <li>c) Number of troughs in the rest of the road span</li> </ul>	<ul style="list-style-type: none"> <li>a) All troughs on both sides of the clearance</li> <li>b) A 50% of the works of UNA 4 and 7</li> <li>c) The third part of the total of the works of the rest of the road span</li> </ul>
MM7. Reforestation program	<ul style="list-style-type: none"> <li>a) Reforestation compensating area</li> <li>b) Appearance of the right of way 2 years after the completion of the works</li> </ul>	<ul style="list-style-type: none"> <li>a) 17.62 Ha</li> <li>b) With 2 strips of gallery forest - tropical deciduous forest ecotone with an approximate area of 13 Ha</li> </ul>



## CHAPTER VII

### REGIONAL ENVIRONMENTAL FORECASTS AND, IF APPLICABLE, EVALUATION OF ALTERNATIVES

#### VII.1 Trend in the environmental scenario

The trend in the environmental scenario contained in the Regional Environmental System (SAR) without project was described in Chapter IV (section IV.4). It is transcribed herein:

As it happens in most of the environmental systems, the triggering mechanism of change resides in the social and environmental conditions. The demographic growth rate in the municipalities constituting the SAR system is zero or relatively low (IV.2.4. Social Environment, Demography). However, this trend is not related to the economic growth. This is due to demographic factors such as a reduction in the fertility ratio, as well as to economic factors, such as the migration of people in search of work opportunities that results in a larger amount of adults in comparison with children count (CONAPO, 2004). This is in turn reflected in SAR, where adults (persons between ages of 15 and 64 years) exceed in the average, by 20% the infant population. This is a consequence of the employment supply in the manufacturing industry of food products, textiles, medicines, machinery and equipment as already exists in Zacapu and in the farming and animal husbandry industry at semi-intensive and extensive levels as it is found in Jiménez and Panindícuaro.

The main economic support of the region is base in industrial, farming and animal husbandry and services activities that usually take place in Zacapu. However, in the last decade important expulsion migratory flows have occurred at the municipalities of Jiménez and Panindícuaro. By itself, the degree of migratory intensity is very high at Jiménez, high at alto Panindícuaro and intermediate at Zacapu. Therefore, the first one reached 20% at dwellings with emigrants to the United States in the last five years, against 10% in the two other municipalities (CONAPO, 2000).

The population growth ratio in Zacapu during 2000-2005 evidenced an increase of 0.13%, and the municipality ranked above the state average, with a value of 0.1% for the same period. This trend is associated to the development of industrial, commercial, agricultural and livestock activities in the area, that is translated into economic growth and employment generation that converts it in a population center with an attracting migratory impact at regional level. In spite of the low values of the growth rates at Jiménez and



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Panindícuaro, with figures of -1.2 and -1.4 respectively, a slight recovery can be observed in both cases for the same five-year period, after having suffered drastic decreases in the decade of 1990-2000 as a result of emigration.

In its condition as water supply area in the region, strategies for economic growth have been implemented in the region of Zacapu, thus propitiating an expansion of the zones for the establishment of industries, commercial enterprises, urban developments and areas for tending flocks (the latter at a smaller scale, but with great effect on the system). When obtaining larger economic profits from such activities, it becomes more feasible to abandon or the change the land uses from agricultural to urban developments. When analyzing the trend of the PEA by sector of activity during the period from 1995 to 2000, a clear trend is noticed toward activities of the secondary sector (from 18.4 to 24.85%) and tertiary (46.6 to 48.81%) sectors, and specifically in the manufacturing, construction and commercial industries, whereas for the primary activities a decrease can be observed; year 1995 reports a value of 34.9% and by year 2000 this value decreases to 23.7% (CONAPO, 2000; INEGI, 2000). If these trends continue, it is possible to explain that in years to come the same path will be followed, i.e by decreasing the agricultural borderline and increasing the urban area. This increase has important repercussions on the SAR system environment.

The SAR corresponding to this project is a semi-disturbed system with large tracts of rain-fed and irrigated agricultural areas, but it also evidences patches with indigenous vegetation that acts as a genomic reserve and forests of galleries on top of irrigated parcels, therefore increasing the connectivity among conservation patches.

Intensive and semi-intensive agricultural areas and grazing areas for livestock benefit from the hydro-agricultural infrastructure installed at Zacapu irrigation district. Connectivity between both basins of Angulo and Zacapu Rivers that integrate the area of the SAR operates as the conducting wire of the biologic processes that provide continuity to this system. It should be taken into account that according to the evaluation made by the *Secretaría de Urbanismo y Medio Ambiente* officers, the condition of the aquifers and flood plains of the Angulo River Basin indicates equilibrium, whereas the Zacapu River basin has been over-exploited (SEPLADE, 2004).

Processes for change of land use will become the triggering mechanism to increase fragmenting of the system. That is to say, the increase in the area covered by cattle ranges, pastureland, livestock husbandry, agricultural areas, modification of river beds and basis (such as for example in the vicinity of Jiménez) and the change in the land use of farming land converted into cattle ranges at the northern part of the SAR as well as the substitution of agricultural soils by urban infrastructure at the southern part.

Specifically, in the SAR the construction of the project is not a cause for fragmentation of the zone. The economic growth is in fact the reason for change of the system as a whole. This involves an improvement of the economy that is translated into an eventual expansion



of the urban zone (industry, services, human settlements) with the consequent fragmentation and degradation of the environmental system. In addition, the strategies for development that include an acceleration of agricultural and livestock related activities (SEPLADE, 2004) would contribute to such fragmentation processes in the short and medium terms. However, mention should be made that actions of reforestation, optimization of the hydraulic systems and promotion of the economic activities such as fishing, forestry and eco-tourism are also carried out (SEPLADE, 2004) and in the short and medium terms they could also help to mitigate the processes of deterioration and fragmentation.

Table VII.2 shows a summary of the trends.

**Table VII.2. Trends identified in the SAR without the project**

Change factor	Conditions affected	Trend	Situation in 20 years
Urban infrastructure	Permanence of adult population due to generation of employment opportunities at the zone. Expansion of industrial and urban infrastructure. Urban areas currently cover 2.5% (140 ha) of SAR	The population growth will still be a trend. However, effects on the systems will not be proportional. An increase is expected in commerce, construction or expansion of industry. Better equipping of population centers in the area will be required.	The trend of the urban infrastructure of SAR is toward growth being Zacapu the pole of strategic development (Plan Estatal de Desarrollo 20022008). Population growth processes continue at a relatively low pace because migratory flows with high expulsion rates also continue. The urban area is likely to cover 4% of SAR, with growth centered around Zacapu. The region has strategies for development defined to foster the industry of food products, industrial materials (plastics) and technology applied to agriculture and animal husbandry. It is part of industrial and commercial flows of the Bajío region (SEPLADE, 2004)
Semi-intensive and extensive agriculture and	Agriculture is distributed at environmental units	Intensification of agriculture at Jiménez	UNA 3 will evidence the same phenology as UNA

cattle farming	<p>(UNA) 1, 2 and 7 Livestock farming is oriented toward UNAs 2, 3 and 8. Loss of natural topsoil due to increased agricultural activities. Additional areas are reclaimed for gallery forests at irrigated farm parcels. Compaction and loss of fertility of soil only at UNA 3. Contamination from traditional fertilizers</p>	<p>and Panindícuaro for crops of wheat, barley, chickpea, tomato and strawberry. Production of bovine and caprine milk-producing flocks will be favored. Investment for infrastructure to support agriculture and livestock will be promoted. UNA 3 has a strong livestock farming activity although at present no severe damages have occurred. They are likely to develop if the same degree of livestock production continues at the same rate. This UNA would tend to lose its natural features. There is a trend to reclaim area for gallery forestry on UNAs 4, 8 and 10 due to the incorporation of additional agricultural fields to irrigation canals. This increases the connectivity of SAR and compensates fragmentation caused by land clearing of rain-fed agricultural fields. Resilience of the systems has not been exceeded and if the tertiary sector, even at municipalities such as Villa Jiménez and Pandícuaro, it has been considered that a recovery of Btc and of a gallery with aptitude as habitat for species of restricted habits could be achieved. This trend was observed particularly at UNAs 8 and 10.</p>	<p>2 with severe eroding processes due to overgrazing. UNA 8 will become divided: 220 ha will be incorporated into UNA 2 and the rest to UNA 4 showing the same phenology than the BtcForest gallery ecotone. UNA 10 will tend to increasingly resemble UNA 4 with predominance for gallery forest thus extending the surface with habitat for species of restricted habitat living in the gallery forest.</p>
Mining (borrow pit materials for construction)	<p>Existences of rocky borrow pit materials at Zacapu and Jiménez. PEA will displace from sectors such as the primary, toward this extraction sector because of better prices. Promotion of construction industries.</p>	<p>Laws and regulations for its exploitation are currently being issued to be included in the State Law of Ecologic Equilibrium and in the Program to Manage the ANP 'Laguna de Zacapu'. Evident progress of the</p>	<p>Moderate impacts if guidelines of the respective rules and regulations are complied with. Increase of activities at other sites of the region due to the multiplying effect. Expansion of the</p>

	<p>Contribution to the immigration of PEA from other localities, thus generating migratory flows toward the zone. High demand of water for extraction processes. The use of explosives negatively affects species distributed in the area.</p>	<p>secondary sector with respect to the primary one. Sustained population growth at the region above the state value. Water supply services become more expensive. Displacement of species of flora and fauna of the zone. Topsoil removal will contribute to erosion-prone processes.</p>	<p>services (tertiary) industry to support mining activities. Eroded and desert degraded soils. Depletion of hydraulic resources.</p>
<p>Transformation of hydraulic processes</p>	<p>Damming and modification of river beds. Erosion due to ill irrigation practices. Floods and overflowing. Contamination and low water quality for human consumption. The state proposes the integral management of the Zacapu river basin as a planning unit.</p>	<p>It has been estimated that over-exploitation of underground water will continue due to the increasing hydro-agricultural infrastructure. Continuous alteration of natural river beds interrupts biological cycles and migratory flows of endemic flora and fauna and favors species living at gallery forests. Population and economic growth of the area will be reflected in an increased consumption and pollution of water for human settlements. Processes of integral management of river basins may lessen deterioration processes.</p>	<p>Depletion of groundwater resources to irreversible levels. Displacement and decrease of populations of species of the zone typical of dry environments. Exploitation of water sources at farther distances from the region. Future investments should be focused on improving the efficiency of the hydro-agricultural infrastructure and of the urban and rural sewage systems. If strategies for river basin management are timely implemented, the effects of the activities developed in the zone could be reduced.</p>

## VII.2 Environmental scenario with the Project

Taking as a basis the trend scenario described in section VII.1, the environmental impacts identified in Chapter V as significant (Table V.8) were also incorporated. Table VII.2 depicts the scenario of SAR with the project, according to the information presented in section V.4 of Chapter V.

Although the project contributes with certain changes with respect to the present scenario of SAR (Table VII.2), they are not sufficiently strong to modify perceptibly the situation in a term of 20 years and as a result the two trend scenarios for the SAR with and without project are quite similar (third column of Table VII.2).



**Table VII.2. Trend scenario of SAR with environmental impacts due to the project and with no mitigation actions**

Description	Impact or effects currently evidenced by SAR	Accumulation or synergy with the project
<p>Loss of flora-related biodiversity</p>	<p>The original biodiversity has been completely lost at UNA 2 and 6 (185 ha) with no possibility of regeneration without human influence. The original composition of UNA 1 (178.54 ha, 17.63% of SAR) has been lost and only at the boundaries indigenous species of the Btc can be found as well as some living in the gallery forest growing at the sides of the irrigation canals.</p> <p>At UNA 8 (2217.73 ha) more than 80% of its components are secondary, although the seed bank containing the genome of the native species continues to be viable; nevertheless, its collection is hindered by the continuous presence of livestock.</p>	<p>Cumulative adverse effects correspond to numbers 1 and 4 (Table V.8). The area between zero lines will be cleared along an area of 16.72 ha (within UNAs 4 and 7), to be added to the area with no wooded area of UNA 2, having as cumulative impact a surface with no wooded areas with conditions similar to UNA 2 (202 ha) inside the SAR. UNAs 4 and 7 will experience a decrease in their area with a resulting common area of 1918.92 ha. Furthermore, the project implies encroachment of 17.8 ha inside UNA 3. As a result of the project, such surface will become an asphalt paved overlay. Forest dwelling species will be therefore lost along boundaries with the agricultural tracts; the area of UNA 3 will be left as 535.84 ha.</p>
<p>Change in the fauna-related composition and size of populations</p>	<p>Wild fauna of restricted habits was completely lost at UNAs 2 and 6; at UNAs 1, 3, 7, 8 and 9 only the native wild fauna with general habits was left. Most of the wild fauna with restricted habits had to retreat particularly at UNAs 4, 5 and 10 and as a result the size of the populations decreased considerably. Only an area of 631.66 ha (11% of SAR) remained with sufficient conditions to accommodate species with restricted habits, seven of</p>	<p>The alignment will go through UNAs 3, 4, 7 and 8 and 34.52 ha (0.62% of their joint surface) of the habitat of general fauna (at UNAs 3 and 8) and of restricted habits (at UNAs 4 and 7) will be lost. An area of 11.68 ha (0.42% of their combined surface) will be lost as habitat for general species and some harmful species that are attracted by the availability of food in agricultural and animal husbandry field. Of UNAs 4 and 7, 1.27% of</p>

	<p>them included in standard NOM-059-SEMARNAT-2001. Only an area of 162.07 ha with original Btc (3% of SAR) remained as the only habitat for indigenous wild fauna that in former times (more than 80 years ago) lived in up to 90% of SAR (the remaining area was covered by aquatic and sub-aquatic vegetation). UNAs 4 and 10 were reclaimed from UNA 5 through the incorporation of irrigation; the distribution of gallery forests that is observed in them did not exist prior to construction of the irrigation canals. These zones are also the habitat of species with restricted habits whose populations have grown at the expense of the decreased populations that prefer drier conditions.</p>	<p>their common area will be lost as habitat for species of restricted habits.</p>
<p>Landscape fragmentation</p>	<p>Four patches were identified at UNAs 4 and 5 (both split into two patches each), all of them larger than 100 ha and they are therefore considered viable to sustain healthy populations of flora and fauna. Patches constituting UNAs 4 and 5 are connected through gallery forests growing at UNAs 1, 7, 8 and 10 that serve as very successful paths for fauna due to the availability of water; canals favor the development of these routes that are oriented toward the boundaries of the parcels. Nevertheless, fauna with restricted habits that is used to live in dry environments such as those present at UNA 5 fail to use boundary lines to move across and only walks through the secondary vegetation found at the interior of UNA 9.</p> <p>As a conclusion, the landscape at SAR is a function of the zone to be studied. Although in general terms mention can be made of two different</p>	<p>Impacts 6 and 10 will be cumulative (Table V.8). According to Forman and Godron (1986) a semi-arid zone requires 1-km spacing for a patch to be considered fragmented and a similar zone with water available (such as UNA 4 of SAR) demands a larger separation. This situation is not expected because of site clearing or construction and operation of the alignment. Nevertheless, a barrier effect will be indeed favored for wild fauna along a distance of 8 km where along 4.85 km paths for fauna displacement are available. The barrier effect will be particularly important at the intersection of UNA 4 (Km 14+600 to 15+750) and UNA 7 (Km 15+750 to 16+000 and from Km 17+700 to the intersection of the existing road).</p>

	landscapes: the one preserved uphill and the degraded one found at the lower parts. The former is characterized by the high quality landscape pattern, the landscape connectivity and a high degree of natural preservation. In the second, opposite conditions exist; it is a typical anthropogenic landscape.	
Atmospheric contamination	<p>At the SAR system each dry season an area of 2373 ha (43% of SAR) becomes exposed to wind erosion, causing dust storms. Dust storms increase the amount of suspended particles favoring respiratory tract diseases. The dry season is also the time to burn stubble fields therefore increasing the presence of suspended particles and combustion gases.</p> <p>At SAR one important activity relates to quarrying, with extraction of rocky material; the exploitation of numerous borrow pits also contributes to the increase of suspended particles.</p> <p>Transportation also contributes, proportionally, to contaminant emissions, particularly during weekends, due to the largest flow of vehicles for recreational purposes. Traffic bottlenecks are also caused by freight trucks traveling from and to material borrow pits and that rarely exceed speeds of 35 km/h.</p>	<p>There are no relevant cumulative impacts; only one non relevant impact (number 5, Table V.8).</p> <p>Accumulation of air pollution due to the operation of the asphalt processing plant is not considered because it functions on a commercial basis and it has its own study to measure its environmental impacts.</p> <p>The recently opened borrow pit located at Km 13 should be added; however, it is not relevant.</p> <p>Placement of base courses during construction of the earth embankment, if it occurs during the dry season, will add suspended particles to the already contaminated atmosphere.</p> <p>On the other hand, it has been considered that the existing road will reduce the traffic flow of the present thoroughfare therefore reducing the emission of gases produced by combustion.</p>
Erosion	The SAR system experiences severe water erosion at UNA 6 in an area of 30.24 ha (0.54% of the SAR); UNA 2 also evidences traces of medium to severe water erosion across a surface of 155.26 ha (2.79% of SAR) whereas at UNA 1 an area of 178.54 ha (3.2% of SAR) shows incipient traces of erosion.	No cumulative relevant impacts were identified. The project is not likely to worsen this situation because after clearing the edges will not be left exposed; clearing is only carried out between zero lines where the body of the embankment is to be built upon.
Drawdown of underground	An over-exploitation exists of	No cumulative relevant

aquifers	underground aquifers due to the expansion of the hydro-agricultural infrastructure and the population and economic growth of the region will be reflected in an increase of water consumption and contamination for human settlements.	impacts were identified. The project is not expected to worsen this situation because no water will be extracted from the subsoil for any of the activities.
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### VII.3 Environmental scenario with the project and impact mitigation actions

As it is indicated in Table VII.2, the trend scenario with or without impacts is similar, because the change processes that modify the SAR system are social and economic processes leading to a synergy of its past and are an addition to the phenomena likely to be expected in the future; these macro-trends are not going to be modified noticeably by the project (Table VII.3); although the beneficial impacts will indeed noticeably improve the communication of the SAR with areas of potential economic projection such as the capital cities of Morelia and Guadalajara.

**Table VII.3. Trend scenario of SAR environmental impacts due to the project and with **no** mitigation actions (MM)**

Description	Scenario of SAR with project	Scenario of SAR with project and MM
Loss of flora-related biodiversity	Additive adverse impacts correspond to numbers 1 and 4 (Table V.8). The area between the zero lines shall be cleared in a surface of 16.72 ha (inside UNAs 4 and 7) that will be added to the area with no forestry vegetation of UNA 2, resulting as cumulative impact an area with no forest vegetation having the conditions of UNA 2 covering 202 ha inside SAR. UNAs 4 and 7 will have a resulting combined area reduction of 1918.92 ha. In addition, the project involves encroachment of 17.8 ha within UNA 3. As a result of the project, such area will be covered by an asphalt-wearing surface. Therefore, forestry species will be lost at the boundaries with the agricultural fields; the area of UNA 3 will be reduced to 535.84 ha.	After implementing MMs at UNAs 4 and 7 the external borderlines of the right of way along both sides of the alignment will be reforested with the purpose of achieving an appearance of the eco-tone Btc-Gallery forest existing at UNA 4; therefore, an area of approximately 13 ha will be added to UNA 4 to arrive at a combined area of UNAs 4 and 7 equivalent to 1932 ha. The impact to UNAs 3 and 8 will not be prevented by the asphalt ribbon and a combined area of 535.34 ha will be left. Additionally, paragraph (b) of MM7 (Chapter VI) recommends reforestation of 33.5 ha to leave an appearance of UNA 5 inside the SAR so that UNA 5 will have a resulting area of 195.57 ha.
Change in the fauna composition and size of	The alignment will go through UNAs 3, 4, 7 and 8 and 34.52	MM3 proposes extraction and driving away of the fauna living

populations	<p>ha (0.62% of their combined surface) of the habitat of general fauna (at UNAs 3 and 8) and of restricted habits (at UNAs 4 and 7) will be lost. UNAs 3 and 8 will be reduced by an area of 11.68 ha (0.42% of their combined surface) in the habitat of general species and of some harmful species that are attracted because of the availability of food in agricultural and animal husbandry fields.</p> <p>From UNAs 4 and 7, 1.27% of their common area will be lost as habitat of restricted habits species.</p>	<p>at UNAs 3, 4, 7 and 8, and that exists within the right of way, therefore reducing damages to the populations.</p> <p>MM4 suggests collecting the genome and MM7 the reforestation of the external boundaries of the right of way through UNAs 3 and 8 so that in the course of time (7 years approximately) an area of 13 ha will be developed with an appearance corresponding to eco-tone Btc-Gallery forest available as a quality habitat (such as that existing at UNAs 4 and 7) for restricted habits fauna.</p>
Landscape fragmentation	<p>It will be additive to impacts 6 and 10 (Table V.8).</p> <p>According to Forman and Godron (1986) a semi-arid zone requires 1-km spacing for a patch to be considered fragmented and a similar zone with water available (such as UNA 4 of SAR) demands a larger separation. This situation is not expected because of site clearing or construction and operation of the alignment.</p> <p>Nevertheless, a barrier effect will be indeed favored for wild fauna along a distance of 8 km where along 4.85 km paths for fauna displacement are available.</p> <p>The barrier effect will be particularly important at the intersection of UNA 4 (Km 14+600 to 15+750) and UNA 7 (Km 15+750 to 16+000 and from Km 17+700 to the intersection of the existing road).</p>	<p>Although the project is not likely to cause fragmentation of the landscape (as described in Chapter V), the MM7 will reduce the existing fragmentation, on the one hand by the reforestation of 13 ha; along the boundaries of UNAs 3 and 8 the connectivity between UNAs 4 and 7 will be favored.</p> <p>On the other hand, paragraph (b) of MM7 will allow UNA 5 to reduce its isolation through its connection with UNAs 4 and 9.</p> <p>The barrier effect to be induced by grading will be reduced by MM6; fauna will take approximately 2 years to reestablish routes through culverts. In spite of the risk of animals to be run over, particular those of general habits with wide displacement, after the alignment becomes operative, the risk of being run over will persist.</p>
Atmospheric contamination	<p>At the SAR system each dry season an area of 2373 ha (43% of SAR) becomes exposed to wind erosion, causing dust storms. Dust storms increase the amount of suspended particles favoring respiratory tract diseases.</p> <p>The dry season is also the time to burn stubble fields therefore increasing the presence of suspended particles and combustion gases.</p> <p>At SAR one important activity relates to quarrying, with extraction</p>	

	<p>of rocky material; the exploitation of numerous borrow pits also contributes to the increase of suspended particles.</p> <p>Transportation also contributes, proportionally, to contaminant emissions, particularly during weekends, due to the largest flow of vehicles for recreational purposes. Traffic bottlenecks are also caused by freight trucks traveling from and to material borrow pits and that rarely exceed speeds of 35 km/h.</p> <p>No significant impacts are added to the project.</p>
Erosion	<p>The SAR system experiences severe water erosion at UNA 6 in an area of 30.24 ha (0.54% of the SAR); UNA 2 also evidences traces of medium to severe water erosion across a surface of 155.26 ha (2.79% of SAR) whereas at UNA 1 an area of 178.54 ha (3.2% of SAR) shows incipient traces of erosion. No relevant additive impacts were identified.</p>
Drawdown of underground aquifers	<p>An over-exploitation exists of underground aquifers due to the expansion of the hydro-agricultural infrastructure and the population and economic growth of the region will be reflected in an increase of water consumption and contamination for human settlements. No relevant additive impacts were identified.</p>

#### VII.4 Evaluation of alternatives

The evaluation of alternatives for this project was performed during the engineering phase because the engineering project should comply with the specifications established by the *Secretaría de Comunicaciones y Transportes*, in what refers to prevailing grade, average traveling speed, maximum degrees of curvature, distance, etc. An analysis was made of the final location alternatives taking into account aerial photographs and restitution. A detailed topographic work was performed on the preliminary alignment with the purpose of determining the points along the location and the layout and drawing of curves. It can be confirmed that the evaluation of alternatives was based on the engineering specifications and on the topographic conditions of the zone.

During the development of this declaration of environmental impact (MIA) an analysis was also made of the disturbance and fragility inside the SAR (Table IV.25) by dividing it into 10 polygons to be identified as environmental units (UNA). It could be observed that the final location crosses UNA 4 that is considered as well preserved and fragile, affecting an area of 4.6 ha within it; it will also go across UNA 7 (affecting 10.2 ha) regarded as preserved (but resistant). On the other hand the alignment falls outside UNA 5 considered as very well preserved and very fragile.

It has been considered that less environmentally affecting alternatives could be developed in comparison with the final location of this project, if the alignment were shifted to cross units UNA 8, 3, 1 and 7 (there is no possibility to avoid UNA 7) so as not to affect UNA 4. Unfortunately, when this MIA declaration was prepared the final project had been already defined and the evaluation was only performed on the potential areas affected by this alignment.

However, although the final location goes through UNA 4, it has been considered that the mitigation actions are sufficient to attenuate and partially compensate impact 1, derived from land clearing inside this UNA, although it is not totally mitigated (a moderate residual impact exists).



## VII.5 Conclusions

This document contains the works and activities related to the project of the Zacapu - E.C. Autopista México – Guadalajara Road, Sub-section Km 11+600 to Km 19+600, in the State of Michoacán. It includes the construction of a paved highway (Type A2 as per the road classification issued by the *Secretaría de Comunicaciones y Transportes, S.C.T.*). The highway will have the following characteristics: roadway width of 7 m, crest width of 12 m, shoulder width of 2.5 m. The project has an actual length of 8 km and it is located in the municipalities of Zacapu, Jiménez and Panindícuaro, in the state of Michoacán. The maximum speed will be of 110 km/h; the road will have a grade from 2 to 6% and has a maximum curvature of 2°30' (Chapter II).

Applicable plans and regulations were identified and examined (Chapter III), detecting that the project is compatible with the regional development plans for the northwestern part of the state of Michoacán and that it complies with municipal regulations, ordinances of the zone and official standards. It was also found that the initial part of the road section goes through the ANP La Hoya or La Alberca de los Espinos; however, encroachment on this ANP will correspond to an area with secondary vegetation of the Btc not sharing the conservation conditions at the higher parts.

The regional environmental system (SAR) was delimited and characterized and its environmental diagnosis was performed. Ten environmental units of the SAR were determined through the use of status indicators (vegetation and geomorphology). It was found that there is not a single UNA very much disturbed within the SAR; 88.63% (4922.77 ha) of SAR corresponded to a disturbed status; 4.49% of SAR (249.42 ha) to the category of preserved, and 6.88% (382.24 ha) to well preserved (Figure IV.9 and Chart 10, Appendix 2). These results are compatible with the characterization of SAR; disturbed area is classified as such on the basis of the loss of the original topsoil and/or erosion processes (although its resistance has not been exceeded). On the other hand, there are preserved zones that even though they have experienced impact in their interior even in the change of land use, their resilience is far from being exceeded and they may even become a UNA to serve as habitat for restricted habits species; areas with their native characteristics still exist (UNA 5) or with an uncommon biodiversity (UNA 4) such as in the case of the gallery forest that has been expanded thanks to the incorporation of irrigation in fields that were formerly cleared.

As a result of field and office work effects of the activities of the project likely to impact the environmental factors (and the natural and social environment as a whole) were identified. Of special mention are the impacts due to land clearing inside UNA 4 (4.6 ha).

Impacts of SAR were evaluated with a multi-criteria indicator (Chapter V) through the application of an algorithm that takes into account the criteria of magnitude, duration, extension, context and synergy. With the indicator it is possible to rank the impact in four degrees of impact: low, moderate, high, and very high, from which the last three



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correspond to relevant impacts. For this project, nine impacts were identified and evaluated as significant or relevant, 6 of them being adverse, 1 ranked as high and the remaining 5 as moderate, whereas 3 of them are beneficial from which one of them is ranked high and the two others as very high.

Seven mitigation actions of adverse impacts to SAR were determined (Chapter VI) that are regarded as feasible from a technical, social, environmental and economic point of view. Four significant adverse impacts of the project move to the low category (not relevant), whereas two adverse residual impacts remain in the category of moderate. The 3 impacts identified as significantly beneficial are not mitigated and therefore the residual impacts experience no changes (1 high and 2 very high).

After applying the mitigation actions (MM) of Chapter VI a comparison of scenarios was performed: SAR with no project, SAR with project and SAR with project and mitigation actions; the three scenarios were found to be similar because the functionality and trend of SAR are governed by change factors that have been implemented during several decades. Nevertheless, the scenario with fewer impacts to the SAR is the one contemplated by the project plus mitigation actions particularly due to the reduction in the fragmentation of SAR (as a result of the implementation of MM7) and to the speed up of transportation inside and outside the SAR.

After an analysis of the performance of SAR, of the impacts on the project and of the implementation of mitigation actions, it can be reaffirmed that the project is not likely to induce impacts that compromise the performance of the SAR. On the other hand, it will produce beneficial impacts that will have repercussions inside the SAR and outside it due to the more expeditious traffic between Zacapu and the Atlacomulco-Guadalajara turnpike.

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## CHAPTER VIII

# IDENTIFICATION OF THE METHODOLOGICAL INSTRUMENTS AND TECHNICAL ELEMENTS SUPPORTING THE RESULTS

### VIII.1 Presentation of the information

#### *VIII.1.1 Cartography*

Appendix 2 contains the thematic charts; a list of the themes is presented as follows.

- Chart 1. Macro-location (complete municipalities with access roads)
- Chart 2. Climates
- Chart 3. Geology
- Chart 4. Geomorphology
- Chart 5. Edaphology
- Chart 6. Surface hydrology
- Chart 7. Sub-basins
- Chart 8. Land use and vegetation
- Chart 9. Environmental Units (UNA)
- Chart 10. Diagnosis of UNAs

#### *VIII.1.2 Photographs*

Appendix 3 presents the list of land photographs arranged in illustrations whereas Appendix 4 depicts the alignment superimposed on orthophotographs (1986) and on a satellite image (Google Earth 2006).

### VIII.2 Other appendices

- Appendix 1. Legal documents
- Appendix 2. Thematic cartography
- Appendix 3. Land photographs
- Appendix 4. Official gazette of the state of Michoacán de Ocampo, dated March 14, 2003, decree of the protected natural zone of "*La alberca de los Espino*".
- Appendix 5. Calculations logbook
- Appendix 6. Method for sampling plant species and volume of unsawn lumber of forestry species
- Appendix 7. Fauna listing



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Appendix 8. Plan and cross-section drawings of the project and of intersections with volume of work calculations and topographic coordinates **ONLY IN DIGITAL FORMAT**