

### IV.3. Functioning of the Regional Environmental System (SAR)

As any environmental system, in the delimited SAR, there is a strong relationship between abiotic factors (physical and social) with biotic (fauna and flora); in it, we find the edaphic type which is determined by the geomorphologic unit where it is settled and, in the case of Xerosoles, it also includes superficial lithology.

Likewise, we find in the SAR a direct relationship with the weather, the edaphic type, the productive activity and the vegetation cover (Figure IV. 14).

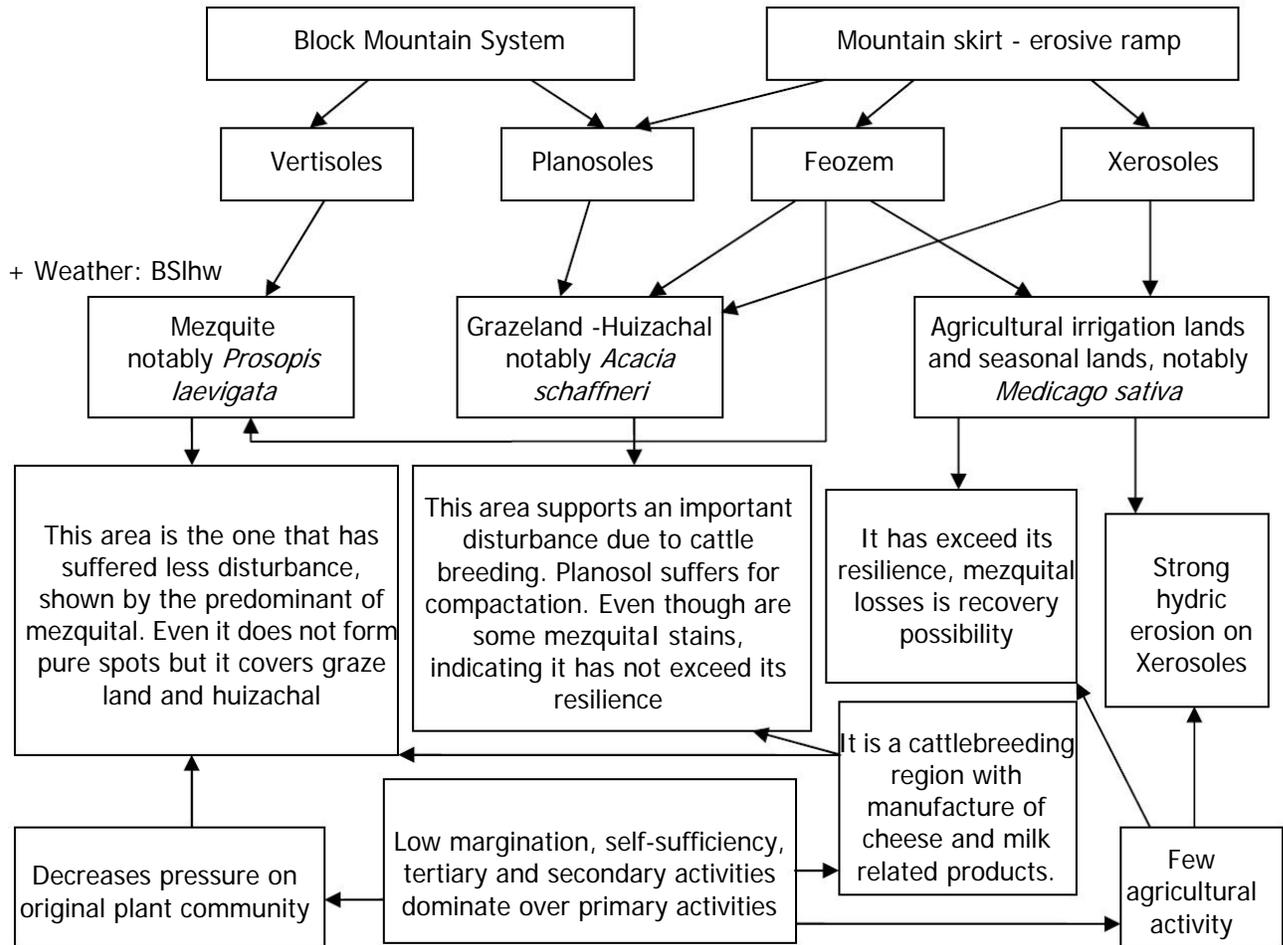


Figure IV. 14. SAR schematic functioning

From the geomorphologic unit of block mountain (as mentioned in the characterization of the geoform), at the SAR there is only settlement of the sinking block with slight slopes of a maximum of 27% (Figure IV.2); the sinking block receives material from the uprising block (tectonic pillar), which after its travel is transformed *in situ* by the action of water (since slight slopes cause a very slow or inexistent laminar flow) favoring the chemical erosion of materials and therefore, the formation of clay; due to this phenomenon, on this unit within the SAR there are basically Planosol and Vertisol type soils which texture is clayish with the dominion of the expandable type.

By the other hand, the geoform system and the skirt of the mountain - erosive ramp; also presents a differentiation on one side of the skirts of receives material, but since its run is short, the mechanical erosion is less and the material is coarse (sands and slime), which tends to form medium-texture soils, as the Feozem-type. To the North of the SAR, on this same geoform, there are Planosol-type due to the fact that they are closer to the mountain and the material that is contributed is finer, besides the chemical erosion *in situ*. On the other hand, on the same unit, on the erosive ramp, there are only Xerosol-type soils, which are formed from parental material,

grave, sands, and slimes, are overlaid, in the cases of Xerosoles of the SAR they are made from marine terraces.

We found in the SAR a direct relationship between the weather, the edaphic type, the productive activity and the plant cover (Figure IV. 14). The semi-arid weather (BSIhw) favors the growth of plants species supporting hydric stress such as huizachal and mezquital, and the fauna which normally is associated with such plant communities.

On the haplic Xerosol there is a concentration of irrigation agriculture (75,392.3 Ha) and impoverished grazeland-huizache (1,300.6 Ha) which supports herds from nearby towns; this areas present a strong hydric erosion, which is favored by the geomorphologic unit where they are located (erosive ramp) and low plant cover. Since Xerosol loses material from its superficial horizon on an constant bases, it is shown with a poor edaphic develop main, therefore, crops require continues fertilizing and management from their owners so that they may be producers, which makes them sometimes seem as Antroposoles.

The mountain skirt unit is characterized for receiving material from the erosive ramp and the mountain range; in medium areas there are Feozem-type soils such are preferred for agriculture and which are successfully supported with Grazeland land -Huizachal that are mainly used for cattle raising, which is an activity that is widely extended in the region. In this site, erosion is less than in the Xerosoles, due to slight slopes and the water infiltrates quickly due to the good structure of the soil (granular with percentages up to 4% of mineralized organic matter).

At the sinking block (the mountain range) there are Vertisoles and Planisoles (the latter are also present at the mountain skirt). The former mainly sustain mezquital in good preservation conditions and on the latter, there are some mezquites (thorny forest), and grazeland - huizache, in which case the soil hast to be washed from bases, showing the presence of a type-E diagnosis horizon. On planisoles there is cattle activity favoring the growth of grazinglands with huizache over mezquital and presenting certain compactation, therefore water tends to stagnate and there is slow infiltration originating horizon E.

It is important to highlight that the limits and differences en successions between grazeland - huizache and thorny forest (mezquital) are not well defined, since there are mezquital stains on the field within its grazeland – Huizachal matrix, or communities of Chinese huizache within mezquital. From the satellite image, it is not possible either to determine the limits, since both associations are observed with the same intensity and frequency (which provide the color component), and share the vitality of the growth of its species and coverage (mezquital has an added association with wide open areas where it shares species with grazeland - huizache). Therefore, in order to makeup the environmental units (UNA) it was decided to overlay raster maps on the use of soil and edaphology, enabling us to successfully guide such differences, even though such associations were never pure within the delimited UNA (Figure IV. 15), the are only dominant.

A gallery forest which growths on both sides of El Sauz Stream and Santa Ma. Stream, made up by *Salix bonplandiana* on its upper stratum and *Senecio sal/gnusen* on the lower forest, is the most important plant association and were the mitigation nature must be mainly focus to the fact that it is habitat for specific habit fauna (specially birds), and it differs in composition and

coverage from neighboring associations. Unfortunately, the gallery forest is well located and is not manageable in original map as one of the SAR (35,602.96 Ha), notwithstanding mitigation measures and the environmental impact ratings on the association they will be handled as if it were a very fragile UNA.

With regard the socio-economic situation of the SAR, it highlights that low margination prevails, towns have all supply, education and healthcare services. The tertiary sector is predominant on the rest mainly due to the tourist visiting the chapel of the famous image of "the virgin of San Juan de los Lagos". The region also has plat textile manufacturing sites and cattleherds, there are cheese and milk related products factories, which are sent to the rest of the Country, therefore the SAR is self-sufficient with regard labor, they receive labor from abroad (specially from City of Aguascalientes). This important contribution of capital to the area due to secondary and tertiary sector activities, decrease pressure on the primary sector which is represented by agriculture and cattle raising as shown on flat areas that still have natural vegetation (as mezquitales), a situation which is rare in the rest of the country, where usually flat plans with easy access have been cleared fully. However, as mentioned in the characterization of biotic factors, mezquitales also present different succession status due to grazing that takes places all over the SAR.

#### **IV.3.1. Construction of Environmental Units UNA**

Once the general functioning of the SAR has been explained and given the description of each environmental components: abiotic, biotic, and socio-economic, the construction of environmental units was performed within the delimited area.

Criteria that were taking into consideration for creating the environmental units of the SAR are shown in Table IV.20.

For the environmental factor to be considered as a criterion for creating environmental units, it should have the following attributes:

- 1) That it has more than one property and that they are georeferenced
- 2) That those they are indicators of the status of the SAR and have been described in the environmental characterization
- 3) That they are determinant for properties of other environmental factors constituting the SAR
- 4) That they have diagnosis properties of the SAR

**Table IV.20. Criteria chosen for defining environmental units within the delimited area for the SAR where the trace is inserted**

Criterion	Properties	Description
Use of land and vegetation	Huizachal –Grazeland, including mezquital, since it may not be differentiated in the map	Including grazeland patches with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp. and abundant <i>Mimosa monanctra</i> , grazeland with <i>Acacia schaffneri</i> , and scarce elements of <i>Juniperus erythrocarpa</i> , and grazeland with <i>Acacia schaffneri</i> , <i>Opuntia</i> spp. and scarce elements of <i>Prosopis laevigata</i> . There are also mezquitals where <i>Prosopis laevigata</i> is the dominant species and the rest are present in different frequencies.
	Seasonal and irrigation agricultural	It includes agricultural fields with or without irrigation, as well as grazing lands that growth during the rest of crops, provided it is not habitat for species such as huizachal and/o mezquital.
Edaphic type	Feozem	This soil is considered one of the most fertile. It is located on 22% within of the trace. Even though it is the best quoted edaphic type for agriculture, most part of the soil supports mezquital with huizache, and in a lesser proportion seasonal agriculture. In the SAR this edaphic type has no erosion signals, since even though cleared, due to its granular structure and medium texture, it allows fast infiltration of water and practically there is no laminar flow in its horizon A.
	Xerosol	These are soils that are neither fertile nor will be developed, that are located on the erosive ramp of the mountain skirt system. While it is a type of land which is not typically erodable, in the case of the SAR, there are signals of hydric erosion, specially due to the fact that they have lost the original plant cover (mezquitals are rarely observed in this type of edaphic), and those supporting agricultural lands are constantly fertilized, therefore they can also be classified as Antroposoles.
	Vertisol	Within the SAR, these soils, while of moderate erosion and easy cracking, they are the ones which present less degradation, since mostly they support mezquital with a good preservation status. In this type of edaphic, they are no signals of hydric erosion. When soils are degraded by cattle raising they tend to be similar to Planosoles (due to the formation of a diagnosis horizon E).
	Planosol	This soil is a moderate fertility, low erosion due especially to the fact that they are located on flat lands and the water tends to stagnate. It is located on 36.76% of the SAR. There, it is informed that 5% belongs to seasonal agricultural lands and the rest are grazing lands and mezquital.

Criterion	Properties	Description
Soils to be degraded share vertisol characteristics.		

Once the overlaying of the tropics stated as criteria (Table IV.20), 8 environmental units (Figure IV. 15), were obtained, which share the same properties for each overlay criterion; therefore we can affirm that each unit is environmentally uniform and that it can be assets as one set for the environmental diagnosis.

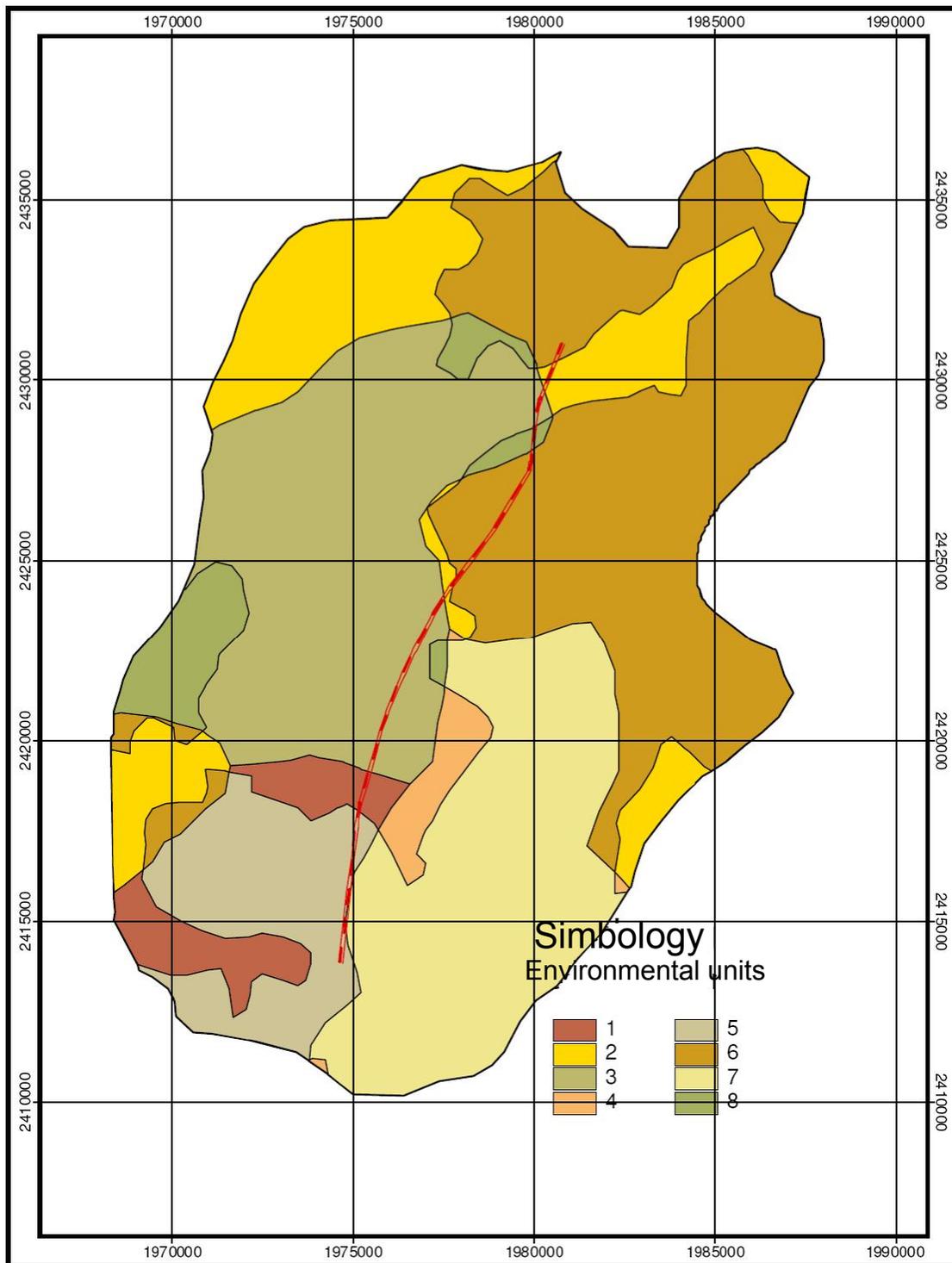


Figure IV. 15 Environmental units (UNA) generated inside the SAR

### IV.3.2. Diagnosis of UNAs that comprise the SAR

In order to perform the environmental diagnosis of the SAR, the criteria in Table IV.20 were used, each of which has certain properties (second column of Table IV.20), and such properties may be rated by means of indicators, which were described in the characterization. In the first place we give a value between 0 and 1 to each property of the criteria base on the status indicators, and the tools used were usefulness functions.

Indicators were classified from 0 to 1, where 1 is the optimum situation and 0 is the worst situation, and we choose such scale because further in the report we will provide a diagnosis weight to each criterion on the same scale. By working with a 0-1 scale, shall allow afterwards to multiply the weight of the criterion by the status of the property and by raster cells (within maps) add up a layer where the raster cells closer to 1 are located on the most fragile environmental units and with the best preservation status were the mitigation measures have to be targeted; while those closer to 0 shall correspond to most resistant and disturb units that need to head their faces to compensation or remediation measures.

#### Criterion: Use of land and vegetation

The indicators use to define the status of each plant association were:

1. Importance value of *Prosopis laevigata* (original element) with regard the importance value of *Acacia schaffneri* (favored element in the distortion).
2. Fragmentation by type of vegetation, a ratio that will be obtained by analyzing the landscape considering the size of the patch and the connectivity by type of vegetation.
3. Total absolutely density of *Acacia Schaffneri* and ecotonic elements of *Prosopis Laevigata* belonging to the thorny forest
4. Birds as indicators of state of fauna within the plant associations. Only those species sampled at the field were considered (rejecting species listed by bibliography). It refers to the number of species with restricted distribution and which not favored by the disturbance, by plant association.

The usefulness functions of each indicator were:

1. Importance value:  $fx = X/207$
2. Fragmentation:  $fx = X/35,602$
3. Absolute density:  $fx = X/354$
4. Birds as indicators of fauna distribution within plant associations:  $fx = x/20$

The results by type of vegetation by indicator are in Table IV.21, and the calculation memory may be seen in Exhibit 5.

**Table IV.21. Status of the different priorities in the use of land and vegetation criterion**

Properties	Indicators	Status of indicator (average of 4 indicators)
Huizachal – Grazingland, including mezquital	1. $VI=39.8/207=0.192$	$(0.192+0.294+0.633+0.8)/4=$ <b>0.48</b>
	2. $F=(2/35602+20961/35602)/2=0.294$	
	3. $DA=224/354=0.633$	
	4. $AF=16/20=0.8$	
Agricultural lands	1. $VI=2/207=0.01$	$(0.01+0.411+0.011+0.5)/4=$ <b>0.23</b>
	2. $F=14639/35602=0.411$	
	3. $DA=4/354=0.011$	
	4. $AF=10/20=0.5$	

Calculation memory in Exhibit 5

Criterion: Edaphic type

Indicators use to define the status of each edaphic type were:

1. Erosion. It shall be obtained by the average of soil erosion factor (Table IV.22), and the presence or not of erosion in the edaphic type in question, if it shows any signals it shall be classified as 0, otherwise with 1.
2. Edaphic type as substratum as each plant association. They are mainly mezquital=3, if it basically supports grazeland-Huizachal with little mezquital 2, and if it mainly supports farmlands 1.
3. Status. This indicator states if the soil has suffers any Transformation due to an atrophic activities in the region. If visibly alter =1, otherwise = 0.

Useful functions for each indicator were:

1. Erosion  $fx=((I-X_1/5)+(X_2/I))/2$
2. Edaphic type as substrate of each plant association  $fx=X/3$
3. Status  $fx=X/I$

**Table IV.22. Status of indicators of properties for the edaphic type criterion**

Properties	Indicators	Status of indicator (average of 3 indicators)
Feozem	1.Er= $((1-3/5)+1/1)/2=0.7$	$(0.7+0.66+1)/3=$
	2.TV= $1.98/3=0.66$	<b>0.787</b>
	3- Es= $1/1=1$	
Xerosol	1.Er= $((1-2/5)+0/1)/2=0.3$	$(0.3+0.33+0)/3=$
	2.TV= $1/3=0.33$	<b>0.211</b>
	3- Es= $0/1=0$	
Vertisol	1.Er= $((1-3/5)+1/1)/2=0.7$	$(0.7+0.957+1)/3=$
	2.TV= $2.87/3=0.957$	<b>0.886</b>
	3- Es= $1/1=1$	
Planosol	1.Er= $((1-2/5)+1/1)/2=0.8$	$((0.8+0.667+0)/3=$
	2.TV= $2/3=0.667$	<b>0.489</b>
	3- Es= $0/1=0$	

Calculation memory in Exhibit 5

After qualifying the status of each of the properties in the type of soil and edaphic type criteria, they were given a weight (W). As we know not all criteria have the same diagnosis weight in an environmental system, and this applies to ours. Table IV.23 shows the weight given to each criterion and justify according to the discussion among expert on the reason of such weight.

**Table IV.23. Weight of the criteria chosen**

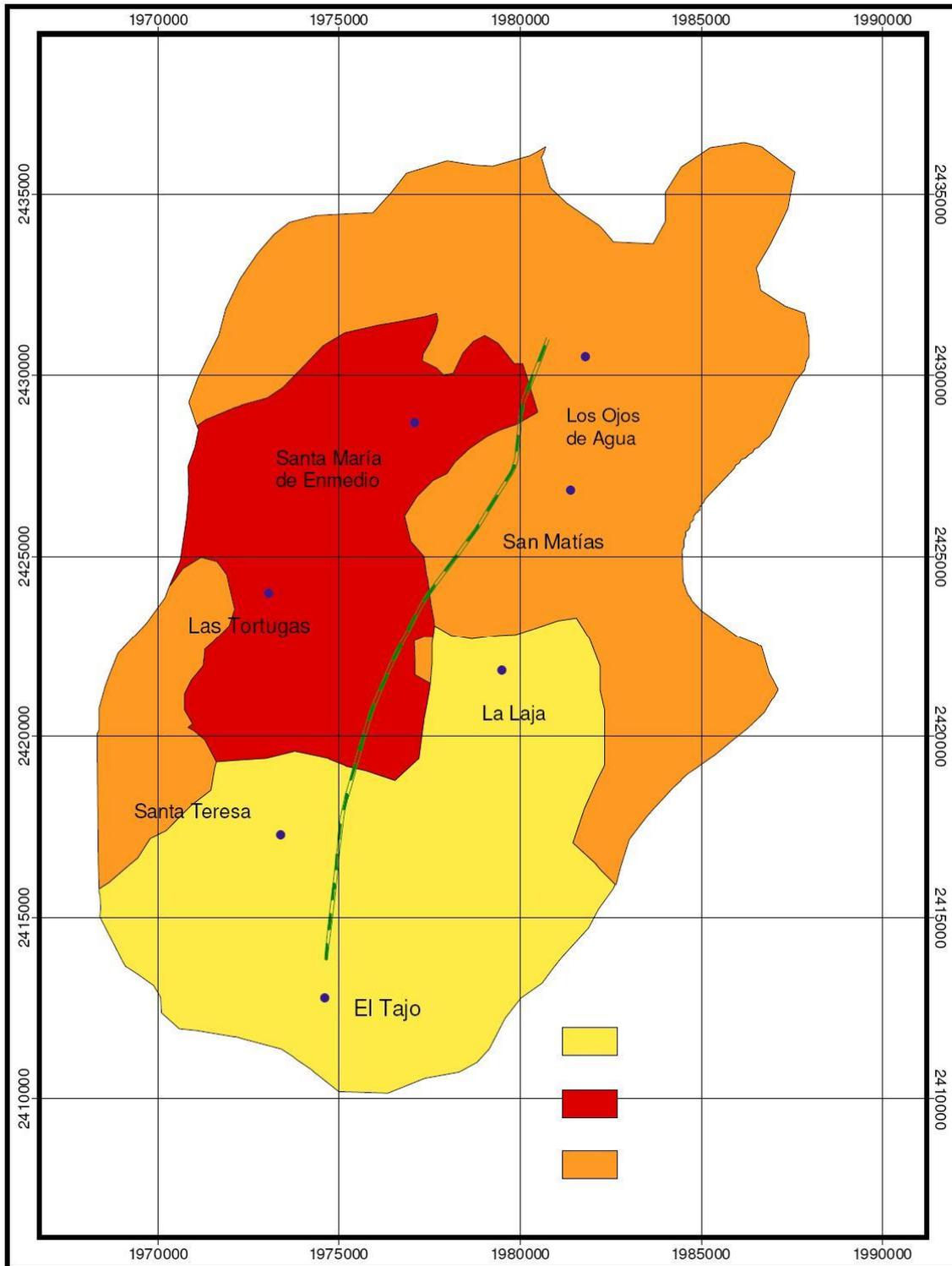
Criterion	W	Explanation
Use of land and vegetation	0.40	Even though the plant cover is the best criterion to rate the status of an environmental system. In case of our SAR, vegetation is fragmented and a regional scale it is not possible to differentiate the original vegetation (mezquital) from a secondary succession (huizachal-grazeland), therefore it was necessary to group them into regular polygons, as if they were all the same type.
Edaphic type	0.60	In the case of the diagnosis of the SAR in question, the edaphic type receive a higher weight than the plant association, because

Criterion	W	Explanation
		<p>we noted an association between the edaphic type and the use of land, situation which was very evident en vertisoles and not so clear in Feozem.</p> <p>The edaphic type, besides guiding us with grater accuracy in the distribution of plant associations, it allows us to guide the sites that have suffer a grater disturbance, therefore it is a better indicator of status than the rest of the criteria.</p>

Calculation memory in Exhibit 5

Lastly, in order to have a diagnosis map of the status (with four categories: very disturbed, disturbed, disturbed and very preserved) the sum of the use of land with edaphology was made. The value by property of each criterion was kept when multiplying the state of the property. The value by property of each criterion was obtained by multiplying the status of the property (indicators average) by the weight (Calculation memory in Exhibit 5). The result is provided in Figure IV. 16.

- One very disturbed UNA was considered when its raster cells obtained a value lower than 0.25.
- A disturbed UNA was that which raster cells obtained a value between 0.251 and 0.5.
- A preserved UNA was that which raster cells obtained a value between 0.51 and 0.75
- A very preserved UNA was that which raster cells obtained a value above 0.751



**Figure IV.16. Environmental diagnosis of SAR**

**Table IV.24. Diagnosis of project by stretch**

Stretch	UNA	Diagnosis
Km 0+000 al 4+000	5	Preserved
Km 4+000 al 5+000	1	Preserved
Km 5+000 al 10+577	3	Very disturbed
Km 10+577 al 11+000	2	Disturbed
Km 11+000 al 15+242	6	Disturbed
Km 15+242 al 15+998	8	Disturbed
Km 15+998 al 17+876	3	Very disturbed
Km 17+876 al 18+635	6	Disturbed

### IV.3.3. Discussion on the results of the diagnosis and implications for the SAR

The results obtained in the diagnosis are provided in Table IV.25 which explains the status of such UNA, its fragility and it establishes certain policies. Such results are the basis for determining the magnitude of the impacts stated in Chapter V and guide the mitigation measures described in Chapter VI.

**Table IV.25. Results of the diagnosis of each UNA and considerations**

UNA	Valor	Status	Justification	Considerations
1	0.564	Preserved and not very fragile. It has a very high value of resistance to disturbance	This UNA has a Feozem-type soil and this cover with agriculture, even though the original plant cover was has been completely loss, it has no erosion signals, due to its location and flat lands. It is consider d not very fragile, because building on this UNA, shall not cause any erosion processes, it does not interrupt the laminar flow since it is inexistent (flat land and well structure soil which infiltrates water vertically), there is no original vegetation that may be damage and fauna does not support the disturbance, since it has migrated to mezquital patches that are in better standing.	This UNA shall bear the most impacting activities. It is preferable that the route of such roads follows these lands. There are not important routes for fauna passages. Machinery could operate and stay the night in this UNA without causing any related impacts.

UNA	Valor	Status	Justification	Considerations
			Having the road crossing this UNA shall not affect the fragmentation or interruption of fauna routes.	
2	0.293	Disturbed Not very fragile It has a high value for resistance to disturbance	<p>This UNA has a Planosol-type soil and seasonal and irrigation agricultural lands. It is not considered as fragile due to its structure and differentiated texture by horizon (it has one clay A and one sandy E), which causes the lamina flow to inexistent and infiltration is slow and vertical.</p> <p>The UNA has fully lost its original plant cover and has exceeded its resilience; it has no apparent erosion signals even though there are losses in the basis and the movement of its texture components (which makes up its horizon E). We consider that the disturbance factors that could occur have already happened and this is a soil resistant to handling due to the construction and operation of the route.</p> <p>As it was mentioned, the plant cover has already been lost, therefore only a general fauna or favored by the disturbance lives in the area.</p>	<p>This UNA may be used as the temporary receiver of the material from the digging, since given that it is located on the lowest areas of the SAR and it has a low infiltration soil, one may assume that the material will not be lost.</p> <p>We recommend operating machinery outside the right of way of this soil given that it is very compactable and infiltration would be slow.</p> <p>Choose this UNA for the construction and operation of the route is a good option.</p>
3	0.219	Very disturbed Fragile Very low resistance to disturbance	<p>This UNA combines Xerosol-type soil with agriculture. Even though Xerosol is not a typically erosion soil, in the case of this SAR it is located on an erosion ramp or the skirts of the mountain, situation which along with the lost of plant cover, has concentrated hydric erosion of the SAR, even though no erosive bad lands has been observed, there are incipient signals.</p> <p>This is a soil which, if compacted, and if the plant cover is lost, tends to rapidly erode. There is no laminar flow through it (due to its structure), and water tends to drip while it infiltrates.</p> <p>This UNA is the habitat for general fauna or those species favored by the disturbance</p>	<p>Compaction must be avoided on this soil.</p> <p>Only the construction area must be excavated and leveled, neighboring areas should not be touch.</p> <p>Machinery must limit its activities to maneuvering on the zero line area.</p>
4	0.624	Preserved not very fragile	This UNA corresponds to a flat area with a lower altitude within the SAR, where fine materials are accrued which are dragged from upper parts. This is the smallest UNA	Only the construction area must be excavated and leveled, the neighboring areas must

UNA	Valor	Status	Justification	Considerations
		It has a medium resistance to disturbance	<p>in the SAR, since these areas are cleared for agricultural, but since these are very clayish soils, they crack open and saturate during the rainy season (because its clays are expandable), and they are abandon by their owners and are left without clearing, since they will not be useful anymore.</p> <p>Due to its location and type of soil, there is a low vertical infiltration of water, and there is not laminar flow.</p> <p>Unfortunately, original vegetation has not established again, given to the previous condition and the area has become habitat for general and noxious fauna.</p>	<p>be left untouched.</p> <p>Machinery must limit its activities to maneuvering in between zero line area.</p> <p>It is advisable that any work performed on this UNA protects border of the soil, since in case one excavation is left open (more than 2 days during the rainy seasons), because the rains saturate the area and it tends to become very plastic.</p> <p>This is a good site for the dumping bank.</p>
5	0.664	Preserved Not very fragile High resistance to disturbance	<p>This is the UNA where the mountain skirts and sinking block of the mountain range are located, therefore, it has very slide slopes, the soil is well structure and has a medium texture. There is no laminar flow since, there is excellent vertical infiltration.</p> <p>It has grazing lands-Huizache with a strong cattle raising activity. It is habitat for generalist fauna, noxious and some with restricted habitat share with the mezquital, specially those birds link with huizache chino and mezquite, or that eat the fruits of the cactus in the area. There are also small mammals with home habitats.</p> <p>Within the graze lands-huizache they are isolated groups of mezquite and <i>tascate</i>, which are residues of the original vegetation, even though scares and aggregated distribution.</p>	<p>Prior to any work, it is necessary to implement a program for frightening and relocating fauna with home habits.</p> <p>This UNA can be used for maneuvering machinery outside the in between zero line, but it is recommended to make it within the right of way area in order to avoid damage to the neighboring vegetation.</p> <p>It is not necessary to protect the soil between the clearing area and the rest of the activities.</p>
6	0.485	Disturbed Fragile medium resistance to disturbance	<p>This area has not been affected by the cattle raising activity it supports, the UNA has more fragile land than the previous one, therefore compaction causes slow infiltration of water and the formation of horizon E.</p>	<p>This UNA be chosen for compensation activities such as reforestry.</p>

UNA	Valor	Status	Justification	Considerations
			<p>On the soil of this UNA there are pounds where migrating birds prepare the temporary habit during their reproduction season.</p> <p>It is fragile, because it supports grazeland - huizachal and aggregates of mezquital, which makes it the habitat for generalist fauna and the restricted distribution associated with mezquital, huizachal and that usually eats fruits from the cactus in the area.</p> <p>El land of this UNA is compacted, due to the fact it is located on a flat and low area in the SAR (under skirts and sinking block in the mountain system.)</p> <p>It has slow infiltration and no laminar flow (very slight slow) and has no saturation either, since the horizon E is sandy.</p>	<p>Prior to any work it must be necessary to implement a frightening program and relocation of home habit fauna</p> <p>It is recommended that all machinery maneuvers within the zero line only, since this soil has clayish horizon A.</p> <p>The works performed at this UNA must protect the borders of the soil, since if they are left open (for more than 4 days in rainy season), since their horizon A is clayish and may become a plastic when saturated.</p>
7	0.724	Preserved Very fragile Low resistance to disturbance	<p>This UNA is the one that has the best preservation status in all the SAR.</p> <p>It has residual vegetation, since mezquital are located in it (thorny forest) with the best preservation status.</p> <p>On the soil of this UNA there are ponds where migrating birds use to establish their temporary habitat during their reproduction season.</p> <p>This is habitat for specific distribution and homy species associated with the flora that only growth on such patches.</p> <p>Soil is quite erodable if vegetation is removed, it has clayish texture of the expandable type, therefore becomes plastic when saturated with water and it cracks during the summer, depending on the plant cover for its preservation.</p> <p>From July through September this becomes an area for the nesting of birds, which only takes place in this UNA.</p> <p>For the size of the UNA (6,453 Ha), it is</p>	<p>We recommend not to touch this UNA for the location of the trace.</p> <p>In case the civil work is necessary, it needs to be strictly on the border and may not go inside more than 100 m.</p> <p>At less than 500 m of this UNA no noise may be caused exceeding 68dB between July and September since it could affect the reproduction of birds.</p> <p>Clearing of mezquital aggregates will not be allowed, if it is necessary to enter the UNA clearing shall only be on graze land - Huizachal that may have isolated aggregates of mezquital and will be compensated with the</p>

UNA	Valor	Status	Justification	Considerations
			<p>considered that it supports healthy populations of fauna, with good genetic reserve and connectivity with oks located outside the SAR.</p> <p>No fragmentation is observed inside the UNA, due to the fact that the fauna may still move between the dominant association of Chinese huizachal.</p> <p>It supports cattle raising mainly oriented to grazinglands huizachal, there is little incursion within the mezquital due specially to thorny components and with cover above 60%.</p>	<p>double of reforest area.</p> <p>Borders of the soil, in case of excavation shall not be left exposed for more than one day during rainy season.</p>
8	0.319	Disturbed Fragile Low resistance to disturbance	<p>This UNA is very small and does not form one patch, but it comprises 4 patches with huizachal – graze land, inserted in the agricultural fields matrix.</p> <p>What makes it fragile is the type of Xerosol and its location within the erosive ramp of the mountain skirt, since water that is infiltrated tends to drip on the top, when the plant cover is continuous (there is no laminar flow on the top of the soil as with other edaphic types), no erosion signals are present, but when the soil is left exposed it compact by the action of cattle, and starts presenting erosion signals (known as cow footsteps).</p> <p>This is a habitat for generalist species, even though some of them are noxious, and associated with huizache, added to mezquite, where some birds with strictly habits may be observed (even though scares species) and mammals and reptiles with home habits.</p>	<p>No more than 10% of the UNA may be used for construction. Do not locate dumping banks.</p> <p>Only the line between zeros may be cleared. Huizache growing within right of way shall be left intact.</p> <p>Machinery may not maneuver within this UNA, outside the line between zeros. The machine must get until UNA that allows it.</p> <p>Even though there are erosion signs in this soil, there is no problem if border are left open in an excavation, however they should not be left open for more than 2 weeks.</p>

#### IV.4. Development and deterioration trends of the SAR

The determinant factor for the change within the SAR is the economic growth of the municipality of Encarnación de Díaz. Therefore, the environmental situation of the area shall depend thereon, as well as the growth of the population and the relation of it with the system. On the one hand, population growth in the municipalities involved in this project is null or relatively low (IV.2.4. Social Environment, Demography). However, this does not imply that economy declines. In fact, there are places such as Mexico City, which have very low population growth, but a very important economic growth (2005 Report of the Environment in Mexico.) This is due mostly to migration of the population to the employment sources, which is observed largely amongst adults rather than in children. This reflects that the SAR, where adults (persons between 15 and 64 years old) outnumber children in 20%. This is due to a job offer of the industry (pottery and fabric manufacturing, basically clothing) and extensive cattle breeding at Encarnación de Díaz, therefore there are more adults (active PEA) than children.

Thanks to this industry and to cattle breeding, there is economic flourishing in the area. Therefore, there is migration to the area from other municipality such as San Juan de los Lagos, and states such as Aguascalientes. In fact, the status of migration of San Juan de los Lagos is reported as expulsion, meaning that is migrating to other sides, as the municipality of Encarnación de Díaz. On the other hand, this municipality has a balanced migration status even though it has a slight trend to immigration. This means that the municipality receives people from other places, mainly adults, which makes its natural population growth rate stable without any significant variation and, consequently, migration (which has one of its nature components the growth rate) has not any steep change. However, industrial trade and cattle activities in the area are an excellent indicator that economic growth and employment are booming and it is possible to stay that migration in the municipality is slightly towards receiving people.

The increase of population, as a consequence of economic flourishing involves, increase in the areas for establishing industry, trade, housing developments, and pastures or grazing lands (the latter in the lower scale, but with an important effect on the system). If such construction receives a greater economic earning, it is feasible to abandon or change the uses of land from agriculture to urban areas. By analyzing the trends for 1995 to 2000 with regard activities and EAP by activity, there is a clear connection to activities from the secondary sector (from 27% to 34%) and tertiary sector (24% to 31%), specifically the manufacturing and construction industry. While primary activities are going down, during 1990 there was a 43%, and for 2000 only 32% (Municipal information system - 2006). If we follow this trends, it is easy to estimate that in following years they will follow this same trend, reducing the agricultural borders and increasing the urban area.

This increase has important repercussions on the environment of the SAR. Currently it is considered as a semi-altered system, with some large patches of vegetation, and some small that serve as connecting nodes with those of larger extension in order to keep continuity in the system. On this type of systems, the threshold or critical distance is not relevant (Caughley and Gunn 1996, Díaz 1996, Forman and Godron 1986, Keitt *et al*/1997, With and Crist 1995). This due to the fact that the separation between patches is the same for 1 Km or for 5 or 10 Km, if the size of the patch is not sufficiently effective to keep species or populations living thereat (Gardner *et al*/1987, Keitt *et al*/1997, Noss 1987). Consequently, isolation among patches should not be considered as an independent factor, since the functioning of the landscape depends on the relationship between, the form and the connectivity amongst them.

Even though distance is not a critical factor in this system, the conjunction of factors such as the reduction in the size of patches, the change of limits (form), and the total elimination of connection nodes is (Forman and Godron 1986, Game 1980, Gustafson and Parker 1992, Keitt *et al*/1997, Noss 1987). In this way, fragmentation is in fact an important element in the SAR system. Basically, the change in the use of land and the expansion shall be the trigger for increasing the fragmentation. This means that the increase of: pastures, graze lands for racing cattle, agricultural lands and the change of the use of land of agricultural lands for cattle lands or urban infrastructure. It is unavoidable that this shall be at the expense of the remainders of natural vegetation, which in the best of cases could reduce the area without affecting the species, but in the worst case scenario, (and which is the most probable due to the status of the SAR), shall be the total elimination of small patches that serve as connection between the larges ones. This would cause a cut in the flow of species, increasing the probability of local extinction (Forman and Godron 1986, With and Crist 1995).

Specifically, in this SAR the construction of the project shall not be the direct cause of increasing fragmentation in the area. As it was stated above, economic growth is the factor of change all over the system. This implies that an increase in the economy will translate into an extension of urban areas (trade, industry, human settlement) with the consequent fragmentation and degradation of the environmental system. This fragmentation would take the system to a collapse, given that there would be a reduction in the size of the patches, the disappearance and the subsequent breaking of continuity. This translated into species would mean the unavoidable loss of biological diversity, as well as vegetation cover, which by being dessert in type is much more sensitive than any type of cover due to the fact that its recovery period is very high.

In edaphologic terms, soil degradation will take place basically due to agricultural, cattle activities and the change in the use of land. In fact, cattle breeding in the area is extensive, generating excess grazing. This is one of the main reasons for desertification (2005 Report on Environmental Situation in Mexico), referring to the loss soil and the destruction of dessertic systems. This damage is not at local level, since it also changes the micro climate, the flora, the biochemical cycles, the hydrologic cycles and it has repercussions at world level. Such activity, when it is not productive anymore, causes a change in the use of land from cattle rising to urban. However, the soils of this SAR, specifically those located within the geomorphological system of the erosion ramp (mainly xerosoles) shall be the most damaged due to their physical characteristics and the hydric erosion. However, soils such as feozem (located also within geomorphological unit) shall not suffer the same damage as the previous one. In general, the other edaphic types shall not have a material deterioration even if there is a change in the use of land.

**Table IV.26. Change trends at the SAR**

Change factors	Affectation	Trend	Situation in 20 years
Urban infrastructure	-Migration of adult population to employment sources of the municipality of Encarnación	<ul style="list-style-type: none"> <li>-Trend is and shall be as low increase of population. However, the effects on the systems shall not be proportional.</li> <li>-There shall be a trend to increase trade, construction or broadening of industry and housing development.</li> <li>-Better and more basic services for the population would be required.</li> </ul>	<ul style="list-style-type: none"> <li>- The trend of the urban infrastructure at the SAR shall depend of the economic and political situation of the country. This is due to the fact that, while depending basically on industry, fluctuations in imports and exports of products may affect or help the economy of the area. However if the current situation is considered and it is foreseen that it will keep the same development pace, then it is possible to increase the functioning of industry, trade and cattle breeding generating more jobs, therefore requesting more services.</li> </ul>
Extensive cattle raising	<ul style="list-style-type: none"> <li>- Cattle is concentrated in UNAs 5, 6, and 7</li> <li>- Loss of natural plant cover, in exchange for forage plant cover</li> <li>- Intrusion of flora and fauna into the system, such as ticks, rodents, etc.</li> <li>- Lack of recovery of the natural vegetation due to the occupation by cattle</li> <li>- Compactation and loss of fertility</li> </ul>	<ul style="list-style-type: none"> <li>- Exceeds grazing activities</li> <li>- Even though cattle raising is limited to UNAs aforementioned, number 5 has a strong cattle raising activity, which even though at this time has not cost to severe damage, it could. In case of UNA 6 and 7, they are fragile, little tolerant to disturbance (especialy UNA 7, which has preserved areas). Therefore, the same degree of cattle activity continues, they shall lost their naturality</li> <li>-There is a trend to loose natural</li> </ul>	<ul style="list-style-type: none"> <li>- Due to the excess grazing, part of the primary herbaceous cover is and will be substituted by secondary vegetation. With regard compacting of the soil, it causes that part of the seeds bank does not germinate and lastly, the excretions that are deposited on the soil with seeds that disseminate to the places where they were not originally located, modifying the distribution of plant species, therefore this is not the scenario which in twenty years would be expected to have dominion almost absolute by huizache over the rest of the associations</li> </ul>

of the soil

cover of scrublands, for grazing lands in use and forage species, as a consequence of the incorporation of cattle raising activities – compression of vegetation- which leads to the fact that if it is intensive there is no recovery period, which in the arid areas is slower than in other

-In the long term, cattle would not be sustainable but by this system. Therefore, affection in twenty years of the SAR would not be directly cause of this activity, but of the change of the use of land.

- The trend of the local fauna is to disappear as a consequence of the competition, predation, illnesses, etc., caused due to the increase of fauna associated with cattle

However, current consequences and the future in ten years will lead to the fact that pressure on such activity shall be responsible for the alteration of the biological and physical system, leading to the intervention of other human activities.

- Affection [sic] that will due to the increase of cattle, specially at UNAs 6 and 7, which shall be more affected by the type of soil it they have underneath (easy de-compactable)

- Local increase of desertification process

Changing the use of land

A decrease of natural cover (huizache, scrubland, natural grazing land) decreasing the size of the patch, transformation in the form and major alteration it the connectivity between patches

Clear alteration in the size of wild fauna populations, as well as

- There is a clear trend to increasing agricultural border, mainly at UNAs 1 and 2, leading to the occupation of natural areas<sup>1</sup>.

- The trend to fragmentation is extremely strong, since it is the combined actions of different anthropogenic factors

- Agriculture introduces into the system exotic vegetation species according to the crops involved, which serve as the food for animal species which modify their populations in an artificial form due to the abundance of food, also causing growth of native and exotic undergrowth. Exotic species displace native species.

<sup>1</sup> 4. According to the report of the environmental situation in Mexico (2005) the increase of the agricultural frontier does not imply that it is a growing or better paid activity as other sectors –secondary and tertiary-, and that such extension means the using of the fields. Very frequently there is a report of an increase of agricultural areas even though the economy of the region does no depend on such activity.

<p>reproductive and feeding cycles</p> <p>Displacement of agricultural areas to natural areas as pressure of the increase in urban infrastructure</p>	<p>- Nodes or connecting patches will tend to disappear as the response to the increase in human activities</p> <p>- There is a trend to decrease wild fauna due to the alteration of the vital cycles as the consequence of the isolation between patches favored by the agricultural frontier as in the case UNA 8, or the intrusion of cattle raising activities</p>	<p>- Consequently, plant cover in the area is shall be limited to induced grazing land, pasture, agricultural areas and other type of infrastructure</p> <p>- As a consequence from the isolation of the populations due to defragmentation and lack of connecting nodes, fauna populations living in the area will decrease.</p>
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## CHAPTER V

# IDENTIFICATION, DESCRIPTION AND EVALUATION OF ENVIRONMENTAL IMPACTS, ACCUMULATIVE AND RESIDUAL OF THE REGIONAL ENVIRONMENT OR SYSTEM

### V.1. Description of criteria to identify, describe (characterize) and assess environmental impacts, accumulative and residual, of the regional environment or system

In order to identify environmental impacts, the regional environmental system was reviewed (Chapter IV), under the following terms:

- Identify and describe the impacts: effect, environmental component, direct action, project face and work or activity from which it is originated
- Generate two scenarios from the regional environmental system: trend-based and that created for foreseeable consequences if the project under study is undertaken
- Identify accumulative and kinetic impacts
- Quantitative assessment of possible impacts

Table V.1 shows a summary description of the procedures used for identify environmental impacts, as well as the support, strengths and limitations or weaknesses, if any.

**Table V.1. Summarized description of the processes followed to identify and assess impacts on the regional environmental system**

Method	Description, support and limitations
Description of the interrelations between activities and environmental factors. (Potential impacts)	<p>The judgment of our specialists is based on bibliographic, cartographic information, visits to the site and interviews with the populations and the members of the topographic clue. Each source identified was verified with evidence</p> <p>Reviews of the SAR and the interaction which may be reasonably foreseen between these components of factors and the activities of the project. The disturbance sources that the project generates or increases are examined in detail.</p> <p>In this point any interrelations which changes were considered not significant or perceptible at the SAR by the Board of Experts were not considered.</p>
Operation of two foreseeable scenarios.	<p>The situation and diagnosis expressed in Chapter IV and the review of disturbance sources were reviewed</p> <p>The limitation comes from the relative lack of information regard change parameters such as erosion, habitat deterioration, changes in the dominance of the forest, water quality deterioration sources, change in the use of land,</p>

Method	Description, support and limitations
	etc.
Cumulative and synergic impacts	Review of the diagnosis and examination of the trends in the original environmental systems. Following what is suggested by the Guide for preparing environmental impact and manifest, a systemic approach is applied to identify the component and environmental factor, the effect detected, the action that causes it and the related element
Quantitative assessment	By means of a multi-criteria assessment, the quantitative assessment of the impacts is performed which allows defining for significant decrease considering magnitude, direction, extension, interest, context, and synergy of accumulation.

## V.2. Description of interrelations between project activities and environmental factor

This project is comprised by 11 activities (Table V.2), and 9 environmental factors were identified which could be changed in certain degree by the aforementioned activities (Table V.3).

**Table V.2. Brief description of the activities of the project**

Activity	Definition
<b>Preparation stage</b>	
Release of the right of way	Transfer of a 111.82 Ha for the construction of two circulation bodies and related works.
Clearing	Removal of the tree and shrub vegetation by mechanical and manual means according to the conditions of each site. It is estimated that this activity shall affect a total of 34.64 Ha.
Stripping	Removal of organic horizon of the soil (30 in average), generating a soil volume of 208,242 m <sup>3</sup>
<b>Construction stage</b>	
Leveling	Extraction of soil and rock up to the equality required and compacting basis of the excavation with a depth of 0.10 m. Some 137,912 m <sup>3</sup> will be obtained from the leveling of type B material, which most of it will be used in building the embankment and only 1,650 m <sup>3</sup> will be wasted. Leveling include 10 cuts, most of them close to 3 m in the highest point, even though the cut at Km 14+578 is of 88.11 in its highest point.
Placement of major and minor drainage works.	At all intermittent minor drippings, a slab will be placed that will allow continuing the dendritic pattern of surface dripping that SAR has without any alteration. In perennial drippings a bridge will be built, considering 5 in total.
Construction of the embankment body	Formation of the lower layers of paving (base and sub-base), followed by the application of pavement and irrigation of the final seal. It includes additional works to the embankment such as curves, ditches and washers for the

Activity	Definition
	adequate removal of water by dripping over the asphalt layer and banks.
Activities for the asphalt plant and the excavation at material banks.	It includes mixing asphalt with ground material from the bank filling of the transportation in the Banks; exploitation of 4 material banks, with open front (except for el Sauz bank). Both the plant and the banks are private with trade activity.
Movement of machinery and personnel in the area.	Activities linked to the displacement, maneuvers, parking of equipment and machinery, temporary storage of equipment and material, as well as the stay of personnel at work fronts.  It is important to state that no accessory works will be built for the stay of machinery or equipment. Facilities of close towns will be used such as the city of Aguascalientes, which is located 20 minutes away from the works site.
<b>Horizontal and vertical signaling</b>	Signaling works for information, prevention and restrictions.
<b>Stage of operation and maintenance</b>	
Vehicle traffic	Operation of the road including the traffic of vehicles type A, B and C, moving between highways No 80 and 45.
Maintenance	The set of works that will allow keeping the road in good conditions: Replacement of asphalt layer, repair of holes and works for controlling drippings, etc.

Regarding physical, biotic, and social factors to be considered, due to some change by the works, are presented in Table V.3.

**Table V.3. Description of environmental factors**

Environmental factor	Description
Air	Quality for air regarding the amount of suspended particles and gases product of combustion.
Surface drippings	Quality of water from surface drippings, mass expense and/or superficial or sub-superficial dripping pattern.
Geoform	Mountain skirt with erosive ramp and/or block mountain (sinking blocks). Includes movement of the mass over conglomerate, sand and grave.
Soil	Erodability, compactation, structure, fertility and/or saturation of the soil.
Vegetation	Loss or gain of huizachal-grazing lands and/or mesquite. Changes in the structure, recruitment of species.
Fauna	Changes in the habitat, pressure on wild fauna, distribution within the landscape of wild fauna.
Landscape	Refers to defragmentation of the landscape, including connectivity between patches (preservation or disturbance of connection nodes).

Environmental factor	Description
Populations	Includes populations inside the municipalities of San Juan de los Lagos and Encarnación de Díaz. Changes in the distribution of economic activities and/or work opportunities.
Users	Includes users of highways No. 80 and 45 who move between points connecting both trunk axes.

After defining the activities of the work such as environmental factors, the identification of the relations existing amongst them was performed, which does not mean this interrelation necessarily causes a significant positive or negative impact; it only indicates that there shall be change that in some cases shall not have any relevance to the SAR. Relations may be positive or negative; justifications of such relations are provided in Table V.5.

**Table V.5. Identification of relations existing between the activities of the work and the environmental factors**

Factors \ Activities	Surface	Surface drippings	Geoform	Soil	Vegetation	Fauna	Landscap e	Populations	Users
Release of the right of way									
Clearing									
Stripping									
Leveling									
Placement of minor and major drainage Works									
Construction of the embankment body									
Activities at the asphalt plant and excavation of material Banks									
Movement of machinery and personnel on the area									
Vertical and horizontal signaling									
Vehicle traffic									
Maintenance									

Once the relations between activities and environmental factors have been identified, we defined if that such relation was positive or negative, and the affectation was discussed determining if it was

notable or not to the SAR, in case it was determined not relevant, it was ignored and in Chapter V it was not considered as impact. Table V.6 shows the results of the relations identified.

**Table V.6. Discussion of modifications identified being relevant or not**

Release	Description	Discussion	Relevance
Release of the right of the way – Population	The release of the right of way is of <i>ejidal</i> property and private, current owners will be indemnified as the cabin state.	A stretch of 60 m will be released and the neighboring lands will continue being of their current owners, who will be located now on the borders of the boat increasing their appreciation of the land that was not sold for construction.  In interviews performed we didn't find any opposition to the project.	Not relevant
Clearing - soil	Trees and shrubs will be removed from the area in between zeroes (from 22.5 up to 40 m wide), leaving the soil exposed during a maximum of 3 weeks until the next activity.	Slopes at the SAR are slide and most erodible soils (vertisoles) will not be touched by the project.  The only edaphic type that may be lost is the xerosol which is located over the mountain skirts ramp, considered of low erodibility. Since the time in which the soil is exposed is too short, it is possible that this is performed during the dry season, and even if it is otherwise, we consider that the risk of loss of edaphic material is minimal. Given that the areas showing small signals of erosion within the SAR have spent some years without any plant cover, they are compacted and exposed to excess grazing activities, they still do not show bad lands, only "cow food steps".  For the notable erosion process to take place, it would be necessary to increase the plasticity of the soil (through water saturation, and have slopes greater than 15%) in order to have the saturated material moving. This cannot happen at the SAR.	Not relevant
Clearing - vegetation		Wild vegetation to be removed is grazing lands-Huizache. UNA 7 will not be touched since it is the <u>only polygon with</u> more original elements of the mezquital. All clearing will be performed in UNA 3 (disturbed) and for (reserved)  Vegetation communities dominated by Chinese huizache ( <i>Acacia schaffneri</i> ) will not be altered since this a secondary species that is favored by cattle raising (since the seed are dispersed by the cattle)	No relevant

Release	Description	Discussion	Relevance
		and when it forms closed communities it limits the development of the original elements of mezquital. All the affectation shall be on this type of vegetation and farmlands. The trace shall not touch UNA 7 which is the polygon with the largest amount of pure spots of mesquite.	
Clearing - Fauna	Wild vegetation to be removed shall be grazing lands - Huizache in the area in between zeroes (from 22.5 up to 40 m wide)	The field study found wild species associated with grazing land – huizache and from migrating birds that are attracted by the ponds formed over vertisoles and planosoles. There also some amphibians and small mammals of home habitats that could be affected during the clearing due to the loss of their habitat	Relevant
Clearing – Landscape	Trees and shrubs will be removed from the area in between zeroes (from 22.5 up to 40 m wide), leaving the soil exposed during a maximum of 3 weeks until the next activity.  On open and closed communities with predominance of Chinese huizache.	According to Forman and Godron (1986) for a semi-arid zone a separation of 1 km is required to consider a patch fragmented. This is a situation that will not occur due to the clearing. In areas as disturbed as the SAR, roads favor the creation of a habitat on the border (on the right of a way that is left without use, and less susceptible species move over to border joining or patches that are already separated <sup>1</sup> .	Not relevant <sup>1</sup>

<sup>1</sup> Specifically, in the SAR the construction of the project shall not be the direct cause of increasing fragmentation in the area. As stated above, economic growth is the change factor for the whole system. This leads to an increasing the economy translating into an extension of urban areas (trade, industry, human settlements), with the subsequent fragmentation and degradation of the environmental system. This fragmentation would lead of a collapse of the system, due to the reduction in the size of the patches, their disappearance, and therefore the break of continuity. Translated into species, there would be an unavoidable loss of biological diversity, as well as of plant cover, which, by being of desert type is more sensitive than any other type of cover, because its recovery period is too high.

In general terms, literature reports that roads are factors that start fragmentation of the landscape (Forman and Godron 1986). However, it is also reported that they are the main sources for creating new habitat, considered as bordering habitat. Specially, in highly fragmented systems, bordering habitat is necessary for survival of general species. In fact, considering favorable or not the creation of bordering habitat as the consequence of the construction of road involve more than one factor, i.e., the effect most be considered according to: the scale and context of the landscape involved, the socio-economic situation (anthropologic, of course), the urgency of ecologic preservation, the environmental management objectives and, specially, vulnerability of ecosystems and species within their explicit space-time context (Delgado et al 2004).

Therefore, it is reaffirmed that the construction of the road shall not be a triggering factor for increasing fragmentation of the SAR, since:

1. Economy is the key factor (see trends) to increase anthropogenic activities
2. The system is considered as semi-alter, indicating a high population of generalist species that will be benefit with the border effect.
3. The road shall not cross larger extension or larger ecologic preservation patches, an in point nearby, all the necessary measures will be taken to minimize alteration (see mitigation measures.)

Release	Description	Discussion	Relevance
Clearing –Soil	An average of 30 cm depth of soil will be removed	<p>Impact on the soil, shall be due to removal of 208,242 m<sup>3</sup> of horizon A of the soil profile. Only the line in between zeros will suffer (area where the embankment will be built), and there shall not any border effect for the neighboring soil that is not cleared, on the one hand due to the flat land and on the other because the vessels cover that growths on the area shall avoid washing the soil.</p> <p>Once cleared, 2 weeks shall elapse before laying the basis, and this stone material shall occupy the volume that was previously occupied by the soil removed, those reducing the pressure over the soil close by the excavation.</p>	Not relevant
Clearing -landscape	208,242 m <sup>3</sup> of organic soil will be wasted	<p>Wrong disposal of a clearing material may affect agricultural lands, wild vegetation, fauna habitat and, if it is in the rainy season, the surface drippings due to the wash of the material, affecting a landscape level.</p> <p>It is necessary to have a management plan for the soil removed from the clearing in order to avoid associated damages.</p> <p>In the pass, this material used to be dropped into gullies affecting the down skirts, the quality of the water and vegetation. Currently this is forbidden, however it is still performed in rural roads with little supervision.</p>	Relevant
Leveling - geofoms	The project developed in an area with slight slopes, therefore most of the land shall be at subbase level. Only 10 points requiring cutting excavation have been considered, must of them (8 of 10) shall be cuts of 3 m in their highest point.	<p>So small and localized cuts within the landscape, are not considered as altering or changing the structures of the geoform. The structure and dynamics shall continue intact even after the leveling, which, as stated, in must cases will enabled the body of the embankment to stay at the level of the subbase.</p> <p>The sites where the cuts are required shall be 0+640, 5+440, 5+510, 5+700, 5+800, 9+498, 13+960, 14+023, 14+440, and +578 an of these, only 5 shall be higher than 3 m in their highest point, and of the 5 only 2 higher than 4 m. The area affected by the cuts is less than 0.02% of the SAR.</p>	Not relevant
Leveling-land	There are a 5 point where the cut shall be greater than 3 m and	This are specific cuts, on feozem and xerosol type soils, and it consider that there will not be any erosion risk for the border effect, since in	Not relevant

Release	Description	Discussion	Relevance
	only at Km 14+578 shall be a little more than 8 m	order to have movement of the soil, it need to become plastic (by water saturation). This is not probable in feozem or Xerosol types soils since, due to their medium and coarse texture and rapid infiltration (through them) it is difficult to have saturation, besides it is necessary to consider that they have to rest on lithology (conglomerate or sands) which infiltrates water very fast in a vertical manner.	
Leveling -landscape	Out of the cuts of 137,912 m <sup>3</sup> of type B material will be obtained which must of it will be used and only 1,650 m <sup>3</sup> will be wasted.	Even though must of the material from the cuts will be used, the wasted volume if not adequately disposed of may cause damages on neighboring lands, which may change the habitat for fauna and secondary vegetation. If this impact is added to the waste coming from the clearing, affectations may be important for the landscape.	Relevant
Placement of minor and major drainage works – Surface drippings	In all intermittent minor drippings, slab will be placed allowing continuing the dendritic pattern of the superficial drip that the SAR has without any alteration. In perennial drippings, there shall be a bridge, 5 bridges have been planned.	<p>These types of works are performing during the dry season. Bridges are made by pre-build structures, and what is performed at the site is minimal. The risks of losing material are not significant for altering the quality of the water since these are minimum quantities.</p> <p>In perennial drippings the gallery forest is located, considered as a preserved and very fragile area (Item IV.3.3), however such forest (a maximum stretch of 15m) will be left under the bridge, at the light of the structure, and it will not be necessary to remove the tree or damage the forest growing on the sides.</p> <p>In the case of temporary drippings, since the work will be performed during the dry season, if there is material loss when placing contention walls of the slap, it will dry on the bed of the drip and become one more rock in the river, without perceptible affectations.</p> <p>It's important to mention that drainage works decrease the impacts that may be cause to the construction of the embankment specially referred to the effect of barrier for the fauna and dendritic pattern of the water surface dripping, since it allows it continues without alteration.</p>	Not relevant
Construction of the embankment body - air	Formation of lower layers of paving (base, sub-base) followed by	During the line of the bases, if it is performed during dry season, there is must dust added to the dustclouds that already occur inside the	Relevant

Release	Description	Discussion	Relevance
	the application of paving and irrigation of the final seal.	SAR, temporarily adding a large amount of suspended particles in the atmosphere along the fronts of the work.	
Construction of the embankment body - fauna	Besides the basis and the asphalt, there are other accessories works to the embankment, such as borders, shoulders and counter-shoulders, washers, and fencing.	<p>The body of the embankment in its middle strip and fences, becomes a physical barrier for the crossing of wild fauna that walks or crawls, from one side to the other of the road. It is almost impossible to have any change between both sides. This situation is decreased by the minor and major drainage works, as well as fauna crossings.</p> <p>So that fauna crosses trough such sites, we need almost 2 years to reestablish movement routes.</p>	Relevant
Construction of the embankment body – landscape	Formation of lower layers of paving (base, sub-base) followed by the application of paving and irrigation of the final seal. Plus the accessory works.	<p>The body of the embankment, as stated in the relation clearing – lanscape<sup>1</sup> shall not worsen the fragmentation of the habitat (since a separation of one km between patches is necessary to consider fragmentation); however, there shall be a barrier effect for wild fauna which need to restore movements routes between patches separated by the tracing of the road through the drainage works and cattle crossings.</p> <p>One line (with asphalt) on the landscape, even if it is already very disturbed (as the SAR) means a change which magnitude depends under criterion of the person measuring it. It is subjective to say that it shall alter the scenic value of the landscape, since according to specialist that participating in this work, the SAR does not have such scenic value<sup>2</sup>. The road will not worsen the problems that the landscape already has and will not affect any of its scenic values.</p>	Not relevant
Activities in the asphalt plant and excavation of material banks – Air quality	<p>4 material banks will be excavated, all of the private and in trade.</p> <p>The asphalt plant shall be placed on Banco el Cerrillo and the asphaltic mix shall be purchased to this business by the</p>	<p>Gases coming from the asphalt plant are product of combustion. We consider such emissions not relevant since they rapidly disperse in the air, given that the area has not confinement problems, or pollution due to such type of gases.</p> <p>On the other hand, the excavation of material banks will generate dust that will add to those produced by the dust clouds (if it is dry</p>	Relevant

<sup>2</sup> Landscape has not unit elements that provide it any escenic value; The original plant cover has been lost; it has no specific combination of geofoms-water-vegetation that could be landscape value within the SAR. Finally, the functionality of the landscape has been altered by the fragmentation.

Release	Description	Discussion	Relevance
	constructing company.	season) and those generated during the line of the bases of the embankment body. It will temporarily contribute with a large amount of suspended particles in the atmosphere.	
Movement of machinery and personnel on the area- vegetation	Refers to movements of machinery and labor on the work fronts	Even though machinery and the personnel may penetrate outside the area of the line in between zeros, we consider that the affectation shall not be perceptible, since it is a very impoverished area (UNA 7 is the only one that has original elements which will not be touched). Vegetation is used to continuous burning, compacting of the soil and constant anthropic activity, therefore we consider that some labor during short period shall not worsen the prevailing situation.	Not relevant
Movement of machinery and personnel in the area- fauna	Refers to movements of machinery and labor on the work fronts	Different from vegetation, fauna may be affected by the stay of personnel, since there are some species that are susceptible of anthropic activities and which are associated to hizachal, or ponds that are created during the rainy season on vertisoles and/or planosoles.	Relevant
Movement of machinery and personnel in the area- population	Refers to movements of machinery and labor on the work fronts	As it has been stated, must of the labor shall be local, therefore they will not be any need to build camps, or event to rent houses for overnight stays outsides their towns.  No shops or infrastructure to support the machinery will be built.  Compliance with NOM-081-Semarnat-2004 with regard noises shall be in force and no excavation on type C material will be performed, therefore no explosives will be used.	Not relevant
Horizontal and vertical signaling - users	The corresponding signals will be placed, both regarding information and traffic along the road as required.	Signaling allowing user to know the route of the road and, in general, to avoid accidents by knowing that curve may be dangerous, where fog can be founded, etc. Traffic is friendly, even though they can use the road without such signaling.	Not relevant
Vehicular traffic - population	The road is not to service intermediate settlements, its purpose is to unite with fast road highway No. 80 and 45.	Even though the road is built to service this settlement, they will decrease pressure on the current road San Juan –Encarnación, decreasing the speed in which pots are formed and the great traffic that such road absorbs, reason why the movement between towns will	Relevant

Release	Description	Discussion	Relevance
		<p>be faster and safer.</p> <p>On the other hand, must of the labor for constructing the road will come from such towns, with the corresponding benefit although it is not significant for the local economy.</p>	
Vehicle traffic - users	This project will directly unite the trunks Manzanillo - Tampico with Mexico - Nuevo Laredo.	<p>This is original impact, even though outside the SAR, since it links together to trunk access afore mentioned.</p> <p>Users may join in a faster and safer way highways 45 and 80.</p>	Relevant
Movement - Population	Maintenance will allow a better functioning of the road for a longer time.	As has been mentioned, this road is not for the direct use of the towns it crosses, therefore its maintenance and good functioning does not visibly benefits such towns.	Not relevant
Maintenance - Users	Maintenance shall allow a better functioning of the road for a longer time.	A fast way as that of this project requires periodical maintenance, including pot covering, cleaning, repainting, restoring asphalt layers, among others, for its optimum functioning.	Relevant

### V.3. Trend Scenario of the SAR with Environmental Impacts

Based on the trend scenario described in Chapter IV (Point IV.4), all the environmental impacts that were identified in item V.2 as relevant (Table V.6), were added, those impacts that are at among them and/or accumulate with trends already identified in the SAR shall be identified as accumulative, and those which were sent with the project (in such away that the impact is greater than the simple additional events), are called synergic (Table V.8).

Table V.5 provides the trend scenario of the SAR adding a column to identify if the situation described worse with the project.

Afterwards, in item V.4 all impacts identified as accumulative or synergic are provided. Residual impacts are included in Chapter VI, since the result from applying mitigation measures to trend scenario of SAR with impacts caused by the project.

**Table V.7. Trend scenario of the SAR with environmental impacts due to the project and without mitigation measures**

Change Factor	Trend of SAR without project	Change factor contributed by the project	Situation in 20 years with the project and without mitigation measures
Urban Infrastructure	<ul style="list-style-type: none"> <li>-Trend is and shall be as low increase of population. However, the effects on the systems shall not be proportional.</li> <li>-There shall be a trend to increase trade, construction or broadening of industry and housing development.</li> <li>-Better and more basic services for the population would be required.</li> </ul>	<ul style="list-style-type: none"> <li>- No changes are expected in demographic growth of the region due to the project.</li> <li>-Movements from the city of Aguascalientes to San Juan de los Lagos will be faster and safer, therefore it is possible that there is a decrease in a non perceptible degree for the SAR in dwelling demand, since workers may travel on daily basis from such city to San Juan.</li> </ul>	<ul style="list-style-type: none"> <li>- The trend of the urban infrastructure at the SAR shall depend of the economic and political situation of the country. This is due to the fact that, while depending basically on industry, fluctuations in imports and exports of products may affect or help the economy of the area. However if the current situation is considered and it is foreseen that it will keep the same development pace, then it is possible to increase the functioning of industry, trade and cattle breeding generating more jobs, therefore requesting more services.</li> </ul>
Extensive cattle raising	<ul style="list-style-type: none"> <li>- Exceeds grazing activities</li> <li>- Even though cattle raising is limited to UNAs aforementioned, number 5 has a strong cattle raising activity, which even though at this time has not cost to severe damage, it could. In case of UNA 6 and 7, they are fragile, little tolerant to disturbance (especially UNA 7, which has preserved areas). Therefore, the same degree of cattle activity continues, they shall lost their naturality</li> <li>-There is a trend to loose natural cover of scrublands, for grazing lands in use and forage species, as a consequence of the incorporation of cattle raising activities –</li> </ul>	<ul style="list-style-type: none"> <li>The project will not increase its trend to exceed grazing lands. In a degree which is not perceptible it will decrease because it shall increase the secondary economic sector over the primary, due to the link of the 2 trunk axis.</li> <li>- In the meantime while the fauna routes for crossing from one side of the road to the other is reestablished, the barrier effect will adopt to the pressure exercise by the fragmentation of the landscape in decreasing fauna populations even though the barrier factor will not cause local extinction, only a temporary negative pressure (2 years while the route are reestablished.</li> </ul>	<ul style="list-style-type: none"> <li>- Due to the excess grazing, part of the primary herbaceous cover is and will be substituted by secondary vegetation. With regard compacting of the soil, it causes that part of the seeds bank does not germinate and lastly, the excretions that are deposited on the soil with seeds that disseminate to the places where they were not originally located, modifying the distribution of plant species, therefore this is not the scenario which in twenty years would be expected to have dominion almost absolute by huizache over the rest of the associations</li> <li>-In the long term, cattle would not be sustainable but by this system.</li> </ul>

Change in the use of land

compression of vegetation- which leads to the fact that if it is intensive there is no recovery period, which in the arid areas is slower than in other

- The trend of the local fauna is to disappear as a consequence of the competition, predation, illnesses, etc., caused due to the increase of fauna associated with cattle

- Affectation [sic] that will due to the increase of cattle, specially at UNAs 6 and 7, which shall be more affected by the type of soil it they have underneath (easy de-compactable)

- There is a clear trend to increasing agricultural border, mainly at UNAs 1 and 2, leading to the occupation of natural areas<sup>2</sup>.

- The trend to fragmentation is extremely strong, since it is the combined actions of different anthropogenic factors

- Nodes or connecting patches will tend to disappear as the response to the increase in human activities

- There is a trend to decrease wild fauna due to the alteration of the vital cycles as

- 34.64 Hectares of grazing land-Huizachal will be cleared, that will not be recovered, since the area will be occupied by the body of the environment.

- No compactation along the trace will be caused therefore there is no adverse effect on the soil.

- 34.64 Hectares of grazing land-Huizachal will be cleared, that will not be recovered, since the area will be occupied by the body of the environment.

- Given that it is highway with a high specifications, no intermediate accesses will be built, therefore accessibility will not be increased nor the change in the use land derived therefrom.

- There are no patches segmentation, on the contrary the road will create a bordering effect connecting while species that are less susceptible to

Therefore, affectation in twenty years of the SAR would not be directly cause of this activity, but of the change of the use of land.

However, current consequences and the future in ten years will lead to the fact that pressure on such activity shall be responsible for the alteration of the biological and physical system, leading to the intervention of other human activities.

- Local increase of desertification process

- Agriculture introduces into the system exotic vegetation species according to the crops involved, which serve as the food for animal species which modify their populations in an artificial form due to the abundance of food, also causing growth of native and exotic undergrowth. Exotic species displace native species.

- Consequently, plant cover in the area is shall be limited to induced grazing land, pasture, agricultural areas and other type of infrastructure

- As a consequence from the isolation of

<sup>2</sup> 4. According to the report of the environmental situation in Mexico (2005) the increase of the agricultural frontier does not imply that it is a growing or better paid activity as other sectors –secondary and tertiary-, and that such extension means the using of the fields. Very frequently there is a report of an increase of agricultural areas even though the economy of the region does no depend on such activity.

the consequence of the isolation between patches favored by the agricultural frontier as in the case UNA 8, or the intrusion of cattle raising activities

disturbance.  
The road will create a barrier effect for wild fauna, until restoring the route through drainage works.

the populations due to defragmentation and lack of connecting nodes, fauna populations living in the area will decrease.

As it is clear with Table V.8, even though the project contributes with certain changes in the trend scenario of the SAR, they are not sufficiently strong to change the situation in 20 years with or without project, **therefore the 2 trend scenarios for the SAR with or without project are identical** (last column of Table V.8). The impact considered by specialists as the most significant (vehicle traffic – users, Table V.12) shall not change the SAR since, as it has been repeatedly stated, the impact is beyond its scope, by improving transit moving between these 2 trunk axis, benefiting the central and north region of the country; this benefit does not cause any major changes in the municipalities of Encarnación de Díaz or San Juan de Los Lagos.

## V.4. Identification of accumulative or synergic impacts

Once the relations between activity and environmental factor have been predicted in the SAR, and therefore were considered as relevant, then those that could be accumulative or synergic were identified. Table V.8, presents some of these properties and analyzes the result, residual impacts are included in Chapter VI, once mitigation measures have been applied.

**Table V.8. Accumulative or synergic impacts**

Relation	Description	Discussion	Synergic accumulative
Clearing fauna	- "Wild" vegetation shall be removed from the grazing land-huizachal in the line between zeros	<p>Lost of grazing lands-hizache (34.64 Ha.) with isolated elements of <i>Prosopis</i> added to the losses due to cattle raising and the opening of new agricultural fields and urban areas.</p> <p>Fauna living in these sites and displaced due to the activities shall press neighboring populations that are already established, an impact that will prevail until there is a new balance.</p>	Synergic
Clearing landscape	- 208,242 m <sup>3</sup> of organic soil will be wasted due to clearing	<p>The wrong disposal of the clearing material may affect agricultural lands, while vegetation, habitat of the fauna, and if it is during the rain season, superficial drippings due to the washing of material. This will affect at landscape level.</p> <p>The joint result of all impacts is greater if they are separately observed. This impact multiplies with the following.</p>	Synergic
Leveling landscape	- Out of the cuts of 137,912 m <sup>3</sup> of type B material will be obtained which must of it will be used and only 1,650 m <sup>3</sup> will be wasted.	<p>The waste from the cuts (material type B) adds to the damages caused by the wrong disposal of the material product of clearing, even though the volume of waste is small.</p> <p>The affectionation even small may get to the agricultural lands, habitat for fauna and wild vegetation.</p>	Synergic
Construction of the body of the embankment – air	Formation of lower layers of paving (base, sub-base) followed by the application of paving and irrigation of the final seal.	During the line of the bases, if it is performed during dry season, there is must dust added to the dustclouds that already occur inside the SAR, temporarily adding a large amount of suspended particles in the atmosphere along the fronts of the work.	Accumulative
Construction of the body of the embankment –	Besides the basis and the asphalt, there are other accessories	The body of the embankment in its middle strip and fences, becomes a physical barrier for the crossing of wild fauna that walks or	Synergic

fauna	works to the embankment, such as borders, shoulders and counter-shoulders, washers, and fencing.	crawls, from one side to the other of the road. It is almost impossible to have any change between both sides. This situation is decreased by the minor and major drainage works, as well as fauna crossings.  So that fauna crosses trough such sites, we need almost 2 years to reestablish movement routes.	
Activities of the asphalt plant and excavation of material banks – air quality	4 material banks will be excavated, all of the private and in trade.  The asphalt plant shall be placed on Banco el Cerrillo and the asphaltic mix shall be purchased to this business by the constructing company.	Gases coming from the asphalt plant are product of combustion. We consider such emissions not relevant since they rapidly disperse in the air, given that the area has not confinement problems, or pollution due to such type of gases.  On the other hand, the excavation of material banks will generate dust that will add to those produced by the dust clouds (if it is dry season) and those generated during the line of the bases of the embankment body. It will temporarily contribute with a large amount of suspended particles in the atmosphere.	Accumulative
Movement of machinery and personnel in the area – fauna	Refers to movements of machinery and labor on the work fronts	The activity at work fronts will have additionally those antropic activities existing in the area. The UNA mostly affected shall be 1, 2, 3, 5, 6 and 8 of which only 5 and 6 have habitat for fauna with restricted habits and 5 is associated with spots of mesquite and gallery forests, while 6 is specially related to ponds that are created during the rain season.	Accumulative
Vehicle traffic – Population	The road is not to service intermediate settlements, its purpose is to unite with fast road highway No. 80 and 45.	Tabla Pag. 118	Simple impact
Vehicle traffic – Users	This project will directly unite the trunks Manzanillo - Tampico with Mexico - Nuevo Laredo.	The impact is at regional level, even outside the SAR, since it joins to trunk axis.  The benefits of this road at up to the extension plants of such trunk axis, creating an exponential effect.	Synergic
Maintenance – Users	Maintenance shall allow a better functioning of the road for a longer time.	This is a unique type of maintenance and only for the road to be in good service, there is no other similar or equivalent activity that has the same objective and that adds up to the maintenance activities.	Simple impact

## V.5. Identification of significant impacts by quantitative evaluation of the relevant activity – factor relations

### V.5.1 Description of the method for the quantitative evaluation and identification of significant impacts

A multi-criteria evaluation method is used which consists in converting the qualitative description of certain criteria (quality, magnitude, duration, etc.) into numeric values and then integrates such values in an indicator that will allow differentiate relevant impacts. By assigning numeric values of qualitative descriptions of the criteria conventions used were those defined in Table V.9.

It is worth mentioning that the relation between values and description has the double purpose to facilitate differentiation in the degree and perform mathematical operations to calculate a numeric value of the impact, which considers the different criteria.

**Table V.9. Allocation of numeric values to the activity-factor relation that were considered qualitative relevant**

Magnitude		Duration		Extension	
Description	Value	Description	Value	Description	Value
Very low (not between preserved UNA)	1	By weeks	1	Up to 2% SAR	1
Low (up to 10% in preserved UNA)	2	By month	2	Up to 6%	2
Moderate (up to 25% in preserved UNA)	4	By year	4	Up to 15%	4
High (up to 40% in preserved UNA)	7	By decades	7	Up to 35%	7
Very high (more than 40% in a preserved UNA)	9	Longer	9	More than 35%	9

Interest		Context		Synergy	
Description	Value	Description	Value	Description	Value
Absent	1	Disturbed site	0.81	Not detected	1.0
Few person	2	Low disturbance	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 by multiplying importance (i), synergy (s) and context (c). Synergy and context values are assigned as explained in Table V.9. The importance of the impact was calculated by dividing by nine the square root of the product of numeric values of magnitude, duration, extension and interest criteria. By extracting the square root of the product of the values related to magnitude, duration, extension and interest, geometric mean has been calculated, which is the measure of the central trend<sup>3</sup>. By dividing by nine, which is the maximum possible (in the case all criteria had the value of nine), the important values are between zero and one. Context and synergy, on the other hand, at the factor to increase or decrease the value calculated for importance.

Based on the above Table V.12 expresses the evaluation of such impacts, which may be classified in four groups according to the value of the indicator. The first group includes non-relevant impacts, allowing to concentrate the attention in the analysis of those that are most relevant (Table V.10), which is consistent with what is requested by the regulation of the LGEEPA with regard Environmental Impact Evaluation, as stated in Chapter III.

**Table V.10 Limit values of the impact indicator.**

Interval	Category	Relevance <sup>4</sup>
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.5.2. Evaluation of activity - environmental factor relations that are considered as relevant***

Based on what has been presented in items V.2 and V.4, ten possible environmental impacts were detected for the project given that in the qualitative evaluation they were considered as relevant. The impacts that are described in a qualitative manner in under five criteria which are: quality (if its adverse or beneficial for the processes of the natural and social environments of the SAR) intensive or magnitude (how relevant is the effect for the environmental factors involved), geographic extension (part of the surface of these effects are evident), duration (order of magnitude of the period in which such impact could be remediate, if the causes giving rise to it would stop or the order of magnitude that the project will have an impact (and accumulation). This last criterion relates to the occurrence at the SAR of other sources of disturbance which effects could act jointly with the impacts that are created by the project. The accumulation and synergy are usually defined as the generation of additive effects (in the case of accumulation) or of superior order (in the case of synergy). The results are presented in Table V.9, and once described, they are assigned a numeric value in Table V.9 using the method (Table V.12) with

<sup>3</sup> The measure of a central trend provides values that, under a set of considerations, is descriptive of a set of values that participate in its generation. The average or arithmetic mean is a measure of a central trend widely extended. The geometric mean is also a measure of the central trend and is considered most adequate for the purposes of an environmental impact study, due to its higher sensitivity towards low values in the set considered.

<sup>4</sup> Under the terms of section IX of Article 3 of the Regulation of the LGEEPA in environmental impact evaluation matters..

which it is identified if the impact is relevant or not. According to the definition set forth by fraction IX of Article 3 of the Regulation of the LGEEPA an environmental impact evaluation matters it is considered that a relevant or significant environmental impact is that which causes alterations to the ecosystems and its natural resources or to held, hindering the existence and development of man and any other living beings, as well as continuity of natural processes.

**Table V.11. Description of relevant environmental impacts for the SAR under the quality, intensity, geographic extension, duration and accumulation criteria**

Activity – environmental factor relation	Quality	Intensity (magnitude)	Geographical extension	Duration (term)	Accumulation <sup>5</sup> (0, 1, 2)
Stripping – fauna	Adverse	21% preserved UNA	Up to 6% of SAR	By years	Synergic
Clearing – Landscape	Adverse	27% preserved UNA	Up to 6% of SAR	By months	Synergic
Leveling – Landscape	Adverse	27% preserved UNA	Up to 2% of SAR	By years	Synergic
Construction of embankment body – Air	Adverse	32 % preserved UNA	Up to 15% of SAR	By months	Accumulative
Construction of the embankment body – Fauna	Adverse	27% preserved UNA	Up to 35% of SAR	By years	Synergic
Activities at the asphalt plant and excavation of material banks – Air	Adverse	0% preserved UNA	Up to 6% of SAR	By months	Accumulative
Movement of machinery and personnel in the area – Fauna	Adverse	27% preserved UNA	Up to 6% of SAR	By years	Accumulative
Vehicle traffic – Population	Beneficial	32% preserved UNA	Up to 35% of SAR	By decades	Simple impact
Vehicle traffic – Users	Beneficial	32% preserved UNA	More than 35% of SAR	By decades	Synergic
Maintenance – Users	Beneficial	32% preserved UNA	More than 35% of SAR	By months	Simple impact

<sup>5</sup>The key is 0= simple impact, 1= accumulative but there are no disturbance sources in the region, 2= accumulative, there are other disturbance sources.

Once each of the qualities of the relations have been described as relevant for the SAR (point V.2) they were converted into a numeric value, according to the values in Table V.9. Those environmental impacts which result is low (Table V.10), were considered not significant or relevant, in terms of section IX of Article 3 of the Regulation of the LGEEPA on environmental impact evaluation.

**Table V.12. Quantitative description of environmental impacts on SAR due to the project**

Relation activity – Environmental factor	Magnitud e	Duration	Extension	Interes t	Importanc e	Context	Synergy	Indicator	Category	Relevance
1. Stripping - Fauna	4	2	4	2	0.314	1.15	1.3	0.470	Moderate	Relevant
2. Clearing – Landscape	7	2	2	2	0.361	1	1.3	0.470	Moderate	Relevant
3. Leveling - Landscape	4	4	4	2	0.374	1	1.3	0.486	Moderate	Relevant
4. Construction of the embankment body – Air	7	2	4	4	0.430	0.8	1.1	0.378	Low	No relevant
5. Construction of embankment body – Fauna	4	4	7	4	0.511	1.15	1.3	0.764	High	Relevant
6. Activities of the asphalt plan and excavation of material banks – Air	1	2	2	4	0.222	0.8	1.1	0.196	Low	No relevant
7. Movement of machinery and personnel on the area – Fauna	7	4	2	4	0.430	1.15	1.1	0.544	Moderate	Relevant
8. Vehicle traffic – Population	7	7	7	7	0.778	1	1	0.778	High	Relevant
9. Vehicle traffic – Users	7	7	9	9	0.882	1	1.3	1.146	Very high	Relevant
10. Maintenance – Users	7	2	9	9	0.645	1	1	0.645	High	Relevant

### ***V.5.3. Analysis of relevant environmental impact on the project***

Ten activity-environmental factor relations were analyzed, considered as relevant by specialists due to the changes they cause in the SAR (item V.5.1). Afterwards, such relations were applied a quantitative method (item V.5.1), and from such results, 10 impacts were obtained of which two are not relevant or significant. From the remaining eight, five are adverse and three beneficial. From the adverse impacts, four correspond to the *moderate* category and only one is *high*. From the beneficial impacts, 2 are in the high category and one *very high*.

According to the definition established by section IX of Article 3 of the Regulation of the LGEEPA in environmental impact evaluation matters, a Relevant or significant environmental impact is that which causes alterations to the ecosystems and its natural resources or on held, hindering the existence and development of man and other living beings, as well as continuity of natural processes. In this case, a *high* relevant impact is due to the barrier effect for the displacement of wild fauna, which results from the presence of the body of the embankment and accessory works, which together act as a barrier that avoids or makes it difficult to maintain the displacement routes of wild fauna in the Regional Environmental System (SAR). The impact is increased due to vehicle traffic, since it adds up to the risk of being ....

.... on graze land-huizache, possible fire to hit up meals and movement of machinery in case it is outside the zero line.

However, there are procedures that could be used to avoid or reduce such impacts. These mitigation measures will be explained in the following Chapter VI.

With regard beneficial impact of the project, three were determined, one of which is *very high* and the other two *high*, resulting from the nature of the project itself, since it will improve land transportation, both within the Regional Environmental System as well as between the 2 trunk axis it connects (Manzanillo – Tampico with Mexico – Nogales). The construction o this road will reduce transit on the San Juan de los Lagos – Encarnación road and, consequently, may provide a better service to the town it connects; on the other hand, users of the road will avoid traveling up to Lagos de Moreno to join from highway No. 80 to 45 or vice versa.

## CHAPTER 6

### STRATEGIES FOR PREVENTING AND MITIGATING ACCUMULATIVE AND RESIDUAL ENVIRONMENTAL IMPACTS ON THE REGIONAL ENVIRONMENTAL SYSTEM

Seven mitigation measures were identified that must be performed in order to reduce, remediate or avoid relevant environmental impacts and guarantee that the environmental cause of the project is as small as possible.

The hierarchy and importance of mitigation measures derived from the different environmental and economic considerations. Preventive measures are priority because their correct execution will avoid or reduce significant or relevant adverse impacts, as described below.

The synthesis of the measures, their stage of application and impacts it prevents or mitigates are state din Table VI.1. The order followed was according to the type of measure.

The definition of mitigation measures was oriented towards adverse impacts that were assessed as relevant, either high (1) or moderate (3) (Table V.12, Item V.5.2). Mitigation measures may have mitigated low impacts, but attention should be placed on its main intent, which is to avoid, reduce or remediate major impact at regional scale, consistent with the modality of this Manifest.

Also, measures which do not mitigate any significant impact were included which are mandatory due to their consideration by any law, regulation or Mexican Official Standard (Chapter III), and when this is the case, along with the impact they mitigate there is reference to the standard, law or regulation it complies with.

**Table VI.1. Synthesis of mitigation measures**

No.	Measure	Application Stage	Impacts on which it acts, or compliance with environmental Standard or Law
<b>Preventive Measures</b>			
1	Guidelines during the stay of personnel at work site	Before starting preparation of the site	Compliance with NOM-081-SEMARNAT-1994
3	Frighten fauna, recover nests and species living buried and in holes in the clearing and stripping area	Preparation of site	
		Tow day prior to removing shrubs and trees	
5	Handling of material produced by stripping, clearing and leveling	5 hours prior to clearing, advancing with work front	1. Stripping – Fauna
		During stripping, clearing and excavations for laying the bases of the embankment	2. Clearing – Landscape 3. Leveling – Landscape
<b>Compensation measures</b>			
4	Recovery of juveniles and mesquite seeds for reforestry works along borders of the road	Collecting seeds shall be prior to clearing	5. Construction of embankment body - Fauna
7	Reforestry program	During the signaling of the work, once the body of the embankment has been built, with accessory works	5. Construction of embankment body - Fauna

No.	Measure	Application Stage	Impacts on which it acts, or compliance with environmental Standard or Law
<b>Reduction Measures</b>			
2	Monitoring of emissions form machinery and equipment	During all stages	Measure to comply with 3 Mexican official standards: NOM-045-SEMARNAT-1996, NOM-085-ECOL-1993 and NOM-050-ECOL-1993
6	Construction of drinking fountains for fauna in the minor drainage works to favor their movement routes	During placement of minor and major drainage works	5. Construction of embankment body - Fauna

## Mitigation measure 1. Guidelines during the stay of personnel at work site.

Type of measure: Prevention.

Space location: along the trace.

Application stage: Once the bid takes place and the work is awarded, as of the time of the preparation of the site and during construction.

Relevant impact it mitigates: 7. Movement of machinery and personnel in the area – Fauna.

Purpose: that personnel knows the restrictions to be complied with during the construction and handling of machinery, the reasons for such restrictions, as well as penalties that shall apply in case of non compliance.

Procedure: Three days prior to starting the activities for preparing the site, all personnel for the construction and supervision of the work shall be called to a meeting at an adequate place, such as the auditorium of the town hall of San Juan de los Lagos or Encarnación de Díaz or any other in the city of Aguascalientes. In that meeting workers shall know the following information:

- It is forbidden to move away from the work site and only the line in between zeros may be used.
- Portable restrooms of the sanidry type will be used, located on work fronts must be used to defecate. These facilities will be emptied every month by the company that rents them, the product shall be mixed up with the clearing material.
- Each work front shall have one litter bin with lid where all wasted must be deposited (domestic wastes). Internal bags containing trash shall be delivered to the garbage collecting system of San Juan de los Lagos or Encarnación de Díaz, the responsible shall be the supervisor of this measure.
- Burlaps with any solvent, oil, fuel or any other substance must be places in the drum for hazardous wastes in the bag with a label indicating is contains "Hazardous Wastes )oils and solvents)". Even though for their volume these wastes are not considered hazardous according to the NOM\_052-Semarnat-1993, they must be delivered to the closest gas station, prior agreement for their treatment with their own wastes.
- It is forbidden to make any type of repair outside the authorized workshops, the machinery requiring any type of maintenance must be taken to a commercial workshop in Aguascalientes (20 minutes away from the site) or Encarnación de Díaz and San Juan de los Lagos. Note even oil changes, washing of vehicles or any other minor arrangement to vehicles or machinery may be performed outside shops, gas stations and/or car washes.
- It is forbidden to work during the night and/or remain at the work front during the night (from 6:30 pm to 7:00 am).
- Machinery may not stay overnight at UNA 3, 4 (Letter 9, Annex 2), it must be left on the immediately previous or following stretch (the current trace only crosses UNA 6, 9 and 17 of the fragile ones).

- No plant from the surroundings may be collected. It shall only be possible to collect those that have been cleared during such activities. No unnecessary damage must be deliberately caused to natural vegetation.
- It is forbidden to hunt or harass wild fauna.
- In case of seeing a poisonous or threatening animal, one of the biology trainees who will remain in the work during the clearing activities must be informed immediately for him/her to catch it with the serpent-cane and relocate it.
- Any food consumed at the work front shall be in cold, it is forbidden to put on a fire to cook or for any other purpose. All wastes derived from such activity shall be placed in the litter bins located at the work front.
- It is expected that the construction works and the operation of vehicles for transporting materials to the work fronts shall not exceed, in the first case (construction works) the 68 dB(A) and in the second (vehicle operation) the 90 dB(A) as maximum in exposure times not exceeding 15 minutes. If the noise level is high, 5 min breaks must be alternated every 15 min of work. Excavations at cuts during the rectification will possibly exceed the 90 dB(A). This activity must be performed only during the day, between 9 and 18 hrs. Machine operators must use hearing protection, which is to be provided by employer. The areas located at less than 1 km from the villages, activities will be restricted to 9-18 hrs. This point complies with NOM-081-SEMARNAT-1994. Close to UNA 7, no heavy machinery may be used that causes noise above 68 dB(A), i.e., in km 16+500 to 16+900 (At UNA 3, Letter 8, Annex 2).
- Once the construction works are finished, all wastes generated during the different stages of the work must be removed, since it has been observed that some of the constructions leave wastes such as diesel drums, and other oils for machinery, irons, plates. Special attentions must be placed in avoiding spills of oil or other fuels, as well as to remove any toxic or potentially hazardous wastes.

In case this regulations is infringed, contractor shall be liable and will be penalized as the law states in this case.

## Mitigation measure 2. Monitoring of emissions by machinery and equipment.

Type of measure: Reduction.

Space location: Inside the right of way, outside the surface in between zero lines and on both sides of the right of way.

Application stage: During the preparation of the site, construction and maintenance.

Impact it mitigates: It does not mitigate any significant impact. Measure to comply with 3 Mexican official standards: NOM-045-SEMARNAT-1996, NOM-085-ECOL-1993 and NOM-050-ECOL-1993. Mitigates indirectly

Purpose: Verify machinery is at optimum conditions and that leaks, spills and repairs inside rights of way are avoided. Polluting gas emissions must comply with the official standards.

Procedure: Contractor must perform the emission check in mobile machines such as trucks, machinery and vehicles. Emission measurements must be performed in an authorized verification workshop. Plate and type of machinery must be specified. Emission limits are specified in Table VI.2. The general supervisor of the work shall verify that the machinery used in the work site has been verified and complies with this mitigation measure.

Trucks transporting material from one side to the other must be covered with canvas. It is suggested

that the canvas to be fastened on one side with the truck is being filled at the cut area or material bank, once full, the other side of the canvas is passed over the material and fastened on the other side. This is a simple and fast measure and avoids losses due to motion during the trip and dispersion of material in case of strong winds.

**Table VI.2. Limit emissions of the machinery**

Type of vehicle	HC (ppm)	CO % vol.	NOx (ppm)	Opacity
Gas engine	100	1.0	1200	***
Diesel engine	***	***	***	1.27 m-1
Gas engine to load material	200	2.0	1500	***
Natural gas or LP gas	200	1.0	1000	***

Note: Limits established are according to the following standards: NOM-045-SEMARNAT-1996 and NOM-050-ECOL-1993

The asphalt plant and the crushing machine, as well as any other fixed equipment must comply with NOM-085-SEMARNAT-1994, and the limits stated in its table 4 and 5. The owner of the banc shall provide its results to the supervisor every six months, indicating brand of the equipment, model, year, serial number and verification results.

Machinery and equipment will be reviewed every 2 months, to verify there are no oil or fuel leaks, this information will be noted in the log; in case of leaks, the machinery must be sent to the authorized workshop until such disappear and the responsible for the rent of the machine must remove the oil or fuel from the soil or asphalt layer and take it to the gas station to be treated along with their wastes.

### **Mitigation measure 3. Frighten fauna, recover nests and species living buried and in holes in the clearing and stripping area**

Type of measure: Prevention.

Space location: Throughout the trace of the study.

Application stage: During the preparation of the site, to be started one month prior to starting clearing activities.

Purpose: Avoid affecting wild fauna living in the area or that it is damaged during the preparation and construction of the road.

Procedure: Fauna that could be affected by the works mentioned is listed in Annex 7. Form the species mentioned therein there are no species listed in the NOM-059-ECOL-2001, given that the SAR presents such a degree of disturbance that the most sensitive fauna has already been displaced to less affected sites. Most of such species have home habits and only some reptiles and mammals as the coyote and the fox travel long distances.

It is difficult to classify up to specie level the fauna during its removal. therefore no measures aimed at protecting any species in particular will be undertaken, but the activities shall be to frighten and relocate all wild fauna, since the measures are effective for all the individuals regardless of their classification. ON the other hand, in the case of sighting wild fauna, its precise identification implies causing a damage<sup>6</sup> which may go from moderate stress to death going against the purpose of this

<sup>6</sup> When prospecting fauna, usually the zoologist has to kill one animal to take it to the lab and identify it with codes, since even specialists in each animal level in general do not know all its specific composition with an analysis of the field sample.

measure.

Particularly, highly mobile species, with are the ones susceptible to be disturbed, as soon as the notice motion they run away outside the area with the activity is more intense.

In order to frighten and relocate the wild fauna, the following points are recommended:

1) Count with a crew of three biology trainees that are willing to do their social service with this activity. The crew members must frighten the fauna located on the trace of the road towards neighboring areas. For this, they must travel the route in a perpendicular manner, on both sides and into the grazing land- huizachal and agricultural lands. The crew must work with three days in advance to the work front that is clearing the area.

During the travel, vegetation should be hit with sticks and make noise to frighten the animals that could be in the area; these travels must be performed on early hours of the day (5:00-8:00 am) and at dusk (6:00-7:00 pm) to frighten amphibians, birds and small, medium and big mammals, since during these hours they are most active searching for food; for reptiles, mainly lizards, tours should be performed between 9:00 and 16:00 (Uribe-Peña et al., 1999,; Aranda, 2000). The reason why such travels must be performed in advance is to avoid the animals going back to the road trace before the clearing works start.

This measure is most effective in birds and small and medium mammals (flyers), since amphibians, reptiles and small, not flying mammals tend to quickly return to their place of origin (item 2 explains the removal of fauna with home habits).

For medium-size mammals, it is recommended to support the activities only with traps in the areas between UNA 5 (km 0+000 to 4+000), 6 (km 11+000 to 15+242) and 8 9km15+242 to 15+998) in between the zero line: traps must be used I such a way that they may be reasonably sure of having frightened the fauna that could be affected by the project. Trapping will be performed at dawn, 3 hours before starting the clearing works. Traps recommended to be used are the Havahart traps:

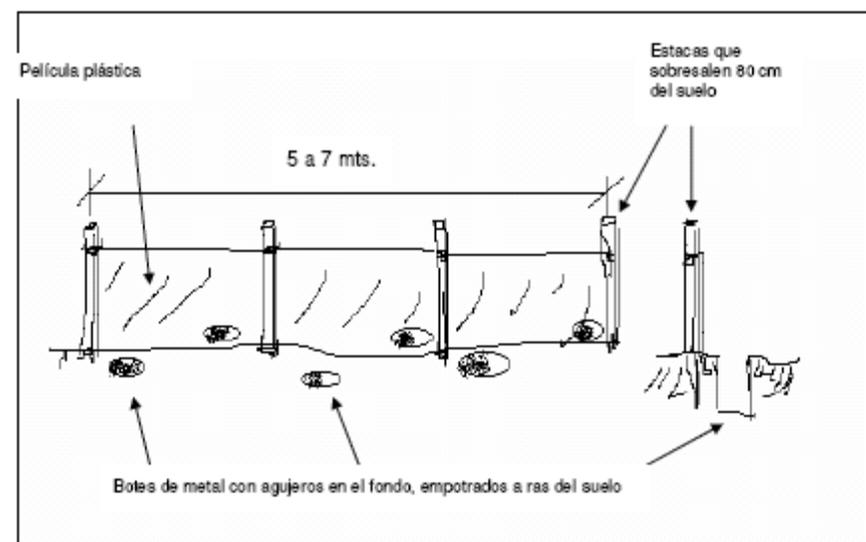
- Havahart cage type trap, simple with two entrances, its design hinders animal's movement once it is inside in order to avoid it gets hurt; it is made of stainless steel, model 2074001, dimensions 10" long, 3" wide and 3" high, weight 2lb, ideal for mice, shrews and *tlacuaches*
- Havahart cage type trap, simple with two entrances, its design hinders animal's movement once it is inside in order to avoid it gets hurt; it is made of stainless steel, model 274000, dimensions 16" long, 6" wide and 6 ½" high, weight 4lb, ideal for rats, weasels and squirrels
- Havahart cage type trap, simple with two entrances, its design hinders animal's movement once it is inside in order to avoid it gets hurt; it is made of stainless steel, model 274002, dimensions 24" long, 7" wide and 7" high, weight 6.5lb, ideal for skunks and ferrets
- Havahart cage type trap, simple with two entrances, its design hinders animal's movement once it is inside in order to avoid it gets hurt; it is made of stainless steel, model 274006, dimensions 36" long, 11" wide and 11" high, weight 19.5lb, ideal for porcupines, *tlacuaches*, vixen and coyotes

Along with the traps on the same stretches nests will be located which branches will be cut and fastened at more than 100 m of distance from the work site, on a tree with the same coverage as the hosting one and the same height. The log shall have the record of the location and relocation sites, and pictures taken must be placed or printed in the log.

Any holes on the land will be checked for reptiles, rummaging with a serpent cane. If a reptile is

found, it will be introduced with the help of the cane into a canvas bag labeled "danger- possible poisonous animal." The reptile shall be released one kilometer away from the work site at a similar plant formation and cover. The log must include the UTM coordinates where the animal was found and those where it was released, pictures must be taken of both processes.

2) It is recommended to rescue fauna which home environment is too small and/or with little displacement capacities, such as almost all amphibians, many reptiles and small mammals, mainly from the Rodentia and Didelphimorphia types, which even though the latter are known for their fast movements, most of the times their home environments are not greater than 60 m. (Sanchez-Cordero et al, 1997; Sanchez-Cordero y Canela Rojo, 1991; Baker, 1968). At UNA 5, 6, 8 and from Km 16+500 to 16+900 t UNA 3 (charters 8 and 9, annex 2); it is advisable to use traps since it is the potential habitat of such species.



**Figure VI.1. Barrier trap for amphibians reptiles and small mammals.**

For removing amphibians, reptiles and small mammals of home habits, Sherman foldable, aluminum traps may be used. They come in three models:

- LFA foldable trap in 0.020" aluminum, weight 0.8 lb, measuring 3" high[sic] x 3 1/2" high x 9" long.
- LFATD6 foldable trap in 0.020" aluminum, weight 1 lb, hook that operates the door is of galvanized steel, measuring 3" x 3 1/2" x 9".
- XLK foldable trap in 0.025" aluminum, weight 1.8 lb, door and hook that operates the door is of galvanized steel, measuring 3" x 3 3/4" x 12".

There are other traps for small mammals, such as:

- Sherman non-foldable trap, model LNA, 0.020" aluminum, weight 1 lb, measuring 3" high[sic] x 3 1/2" high x 9" long.
- Sherman non-foldable trap, model 3310A, 0.025" aluminum, weight 1 lb, measuring 3" high[sic] x 3 1/2" high x 9" long.

Even though these traps are not exclusive for amphibians and reptiles, said organisms many times are trapped in them. Other useful traps for reptiles and shrews are the barrier traps with floor traps, as shown in figure VI.1. Animals trapped this way must be moved approximately 500 m to

1 km from the road trace (within the same UNA), in order to have enough space for the balance of wild populations to be reestablished.

3) A general recommendation to the construction company is the implementation of an environmental education program aimed at its workers prior the start-up of field works, since the attitude of persons is well known when they find native fauna, specially in the case of reptiles which are sacrificed on the site where they are found due to the general idea that all species are poisonous, and the same happens with lizards which are classified as poisonous species.

throughout the construction period, a trainee in biology must be present to avoid workers sacrificing animals to eat them or that they feel threatening. Rescue of serpents, if any, must be performed with canes or hooks for such activity and the Azel serpent-trapper from Forestry Suppliers or any similar company; once immobilized with such devices, they are placed inside closed canvas bags to avoid their death due to asphyxia. These animals must be moved to a distance more than 1 km away from the work site, perpendicular to the trace. In any case, there shall be crew members frightening fauna, and each of them must have one serpent cane to perform the rescue. The supervisor must also be equipped with such cane.

4) One of the most sensitive stages in the life cycle of the species is the reproductive season. There are migrating birds that get to the SAR during this season and which habitat are the ponds that are formed in UNA 6 and 7 (charts 34 and 35, annex 3). In this stage there should be less disturbances in the areas where reproduction activities take place, sin that will have a direct impact on the recruiting of populations. The birds arrive in November and leave in March. The low stratum of the forest (less than 3 m) is the one mostly used for the placement of nests and they also usually use huizachales and mezquites. Therefore, it is recommended not to perform works that alter the natural conditions of habitats such as clearing during such months, not other types of activities that modify the areas of the undergrowth in this season, since that compromises the reproduction success of the species that are reproducing in the altered area.

In case the clearing works may not be postponed in those months, clearing shall be prohibited in the following stretches: km 11+000 to 15+242 (UNA 6, since the trace shall not cross UNA 7). If activities for preparing the site were to be performed exactly on those dates, work may be performed on other work fronts, respecting these sites, until the end of the reproduction season of the birds, once they have left.

#### Mitigation measure 4. Recovery of juveniles and mesquite seeds for reforestry works along borders of the road.

Type of measure: Compensation.

Space location: At UNA 5 (km 0+000 and 4+000), 6 )km 11+000 to 15+242) and 8 (km 15}242 to 15+998)

Application stage: 4 days before clearing according to the advance of each work front.

Impact it mitigates: 5. Construction of embankment body - Fauna

Purpose: Have juveniles and seeds for the reforestry program coming from the same area, thus avoiding the introduction of exotic genome.

Procedure: Two botanists will be hired.

a) In the foregoing sub-stretches, 100% of *Prosopos laevigata*, *Juniperus erythrocarpa* and

*Opuntia joconostle* juveniles found will be collected. As little regeneration of these species was observed, a maximum collection of 120 juveniles is expected,

The common criterion for collecting juveniles of mesquite and junipero is that they are healthy specimens with a maximum height of 80 cm, and a diameter less than 4 cm. they should be removed from the soil including the balled root, taking care to excavate in such a way that roots are not affected; avoiding physical damage or exposure to the air or to the sun. Juvenile should be freed from any weeds or other plant implying competition at the time of being transplanted. In the case of joconostle, all juveniles that may be transplanted according to their size will be removed, according to the field botanist.

All juveniles collected will be taken to a leased land with isolated trees and grazing land- huizache. It is advisable that such plot is found at UNA 5 and 6 (charter 8 and 9, annex 2), which are considered little fragile (the constant presence of humans in the site shall not affect and the place does not have high disturbance that may compromise the survival of juveniles).

Inadequate transfer and storage may considerably shrink the bath of plants to be used for recovery, therefore it is important to have special care in the way this activity is performed. In any case, transportation must make sure that juveniles suffer the minimum damage, either mechanical, due to dryness and/or heat. So, it must be performed in covered, well ventilated vehicles. Maximum capacity of plant storage should not be exceeded; they must be adequately placed in the vehicle in order to reduce the number of trips, given that this may cause irreversible damages to the plants. It is possible to stow two layers of plants, provided the containers of the plants are resistant and of similar dimensions in order to achieve an homogeneous array that allows stowing two layers. Do not stow more than two layers since the plants in lower layers may be damaged.

Plans must be stores in the leased land, provisionally to be used for the reforest of the sides of the road, favor connectivity between patches that currently have no communication thereat, and this shall compensate even if not totally, the barrier effect caused by the construction of the embankment.

Preferably, flora should be rescued during the months from June to October; which are months with more cloudy days, and the weather favors survival of small and young plants.

A survival rat of 70% is expected. A lower value would indicate a bad handling of juveniles and it would be necessary to collect again genome and perform the germinations until recovering the death individual. In this situation, the company in charge of the mitigation measures shall be responsible for organizing such activity and a program will need to be filed before Semarnat.

b) The botanist assigned to the collection of seeds must carry a paper or canvas bag. Shall wear gloves and collect mesquite (*Prosopis laevigata*) seeds only, since this species is the basis for the arrival of the rest of *original* colonizers. 2 kg of seeds will be collected.

The recovery of seeds should be performed during November so that they can dry under the sun and the time they spend at low temperatures, considered as winter, will avoid their cycles are affected.

Once collected, the seeds will be immersed during three days in an HCl 0.5 M solution at 36°C<sup>7</sup>. Then, they are extended over a blanket and left dry during three days under the sun, placing the blanket on the floor, then the seeds, dividing them by the bags they were collected. Then each blanket is covered with mosquito net to avoid losses due to wind or animals. They are left until completely dry.

<sup>7</sup> This seed usually have to pass by the digestive system of the animal which serves as a vector, hydrochloric acid simulates such step and scarifies the seed, favoring its breaking and germination.

Once the seed is dry, it will be mixed with the clearing material coming from UNA 5, 6 and 8, at the same dump bank. This volume will be separated in a different hump, and once mixed will remain a maximum of 2 weeks at the dump bank (MM5) before being used to cover with it the borders of the road (MM7).

### Mitigation measure 5. Handling of material produced by stripping, clearing and leveling

Type of measure: Prevention.

Space location: Throughout the trace of the study.

Relevant impact it mitigates: 2. Clearing – Landscape; 3. Leveling – Landscape.

Application stage: During the preparation of the site and leveling.

Purpose: Avoid waste material to be left abandoned along the road or pack up at sites that are not adequate and that with time ends at the water bodies and/or incorporated to suspended particles in the air. Likewise, have material that serves for reforesting the side of the road, and if the owners of the banks want, to remediate exhausted fronts.

Procedure: a) Before starting the clearing, the Forest Engineer must travel the stretch marking with a forest hammer those mezquital or huizachal trees. This must be performed in the stretches km 0+560 – 0+925, 1+540 - 3+650, 4+370 – 4+385, 4+460 – 5+750, 7+340 – 7+380. 8+550 – 10+370 and 10+500 – 14+850; which are the areas where there could be trees marked and the timber-yielding volume expected (annex 6). The supervisor shall count again the trees marked, amount which must coincide this that written by the Forest Engineer. The trees removed from Km 0+000 to 10+990 shall put a red mark and from km 10+990 to 18+637 shall have a blue mark besides that of the hammer.

Supervisor must be present at the time of clearing, shall care that all trees marked with red (from which rolled timber may be obtained) are delivered to the supervisor of the municipality of San Juan de los Lagos and those marked in blue to the municipality of Encarnacion de Diaz. At the time of delivering them it shall receive an official instrument where the number of trees marked and the volume of rolled timber volume will coincide; such instruments will be included in the log. Trees with the forest mark may be traded or used in the municipality for local works, and the moneys of the sale must be verified or if the timber is for the benefit of the municipality.

b) In order to locate the dumping banks, 2 sites will be chosen; it would be preferable to have it open and abandoned in any of the material banks disseminated in the site, that has access road; only if no abandoned site is obtained, then a plot of land may be rented of an area of 2500 m which complies with the following:

- Located in UNA 1 and 2; (charter 8, annex 2)
- Slope less than 15%
- Be of private or ejidal property (which rental is stated in a minute of the shareholders' meeting)
- Located close to an access road.

c) The material product of the clearing that it not used for timber will be taken to the leased plot of land, where it will be chopped and piled.

After the clearing the stripping takes place, all the material of the clearing coming from the stretches in UNA 5, 6 and 8 shall be piled up separately from the clearing material of the rest of the stretches.

They will be covered with canvas to avoid losses due to rain and air. It will be piled up in that plot of land.

Few material will be generated from the excavations due to the fact that the land is flat, it is a modernization and part of that material will be compensated during the construction of the body of the embankment; however, a waste of 1,650 m<sup>3</sup> is foreseen of material type B. This material will be taken to the rented plot to be piled up. In case that an exhausted front has not been used as dump site, once the construction is finished, material type B and that from the clearing not coming from one of the UNA 5, 6 and 8 may be donated to the community as gravel for leveling lands at the urban area, such material shall be available to municipal authorities.

The material from the clearing of UNA 5, 6 and 8 shall be used for reforest work on the sides of the road. This material will be mixed with the chopped product of the clearing.

### **Mitigation measure 6. Construction of fauna crossings and favor they continue with their movement routes.**

Type of measure: Reduction.

Space location: Throughout the trace of the study.

Application stage: Between the laying of the bases and the paving, the construction may be simultaneous to such activities.

Relevant impact it mitigates: 5. Construction of embankment body - Fauna.

Purpose: Favor animal motion through the works of drainage (establishing new routs) and avoid them crossing over the asphalt layer with the risk of being run over.

Procedure: In all drainage works to be located in the stretches from km 0+000 to 4+000 and from 11+000 to 15+998, rustic drinking fountains must be placed on both sides of its light. One third of the drainage works in said stretches must have the technical specifications for a expense greater than 50% of what is specified by the hydraulics of the project. Besides, in the rest of the stretches, one out of three drainage works will also be built as drinking fountains, to avoid fauna more resistant to disturbance crossing by the asphalt layer but that they establish routes through the drainage and cattle crossings.

Drinking fountains shall be rustic in construction, 20 cm deep, 30 cm long and 20 cm wide. It will be built at floor level beside the light of the drainage works at some 50 cm and immediate to the surrounding vegetation. The drinking fountain will be filled with rain water and will last enough before the water is exhausted (due to the shadow of the surrounding vegetation). This water reserve will invite animals to move along these routes and avoid crossing over the asphalt cover.

During the full trace the road shall have a fence of barbed wire of other material that hinders the crossing of medium-size animals over the asphalt layer (at 1.2 m from the floor), in the areas where the drainage works are over the natural land (figure VI.2). This will favor the establishment of movement routes between patches divided by the road, these barrier will not be maintained, because once the routes have been changed they will still use them even if there is no physical barrier.



**Figure IV.2 In this sites fences will be created creating a funnel effect that directs the animals towards the drainage works.**

### Mitigation measure 7. Reforestry program.

Type of measure: Remediation and Colompensation.

Space location: Right of way on both sides of the road in stretches from 4+00 to 11+000 and from 15+998 to 18+637.

Application stage: Immediately after the signaling of the updated trace and once under operation.

Relevant impact it mitigates: 5. Construction of embankment body - Fauna.

Purpose: Favor the creation of the border effect on the side of the road that joins patches separated by agricultural lands and that the wild fauna may use such strip to move among them.

Procedure: a) the clearing material will be used with the seeds and everything homogenized with a shovel; as substrate for reforestry works, will be laid on both sides of the traffic bodies within the right of way of such material; the young trees that have been transplanted shall serve as wet nurse for the new small plants that will grow from the seed.

Juveniles recovered in MM4 will be planted in a disperse manner within the stretches that were indicated in the UNA 1, 2 and 3 in order to know to which area will the juvenile be sent, the following formula shall apply:

$$AJ = AR \text{ UNA10} / NC$$

Where AJ = Area to be occupied by each juvenile at the time of transplant

AR UNA 10 = Area remediated within the UNA 10

NC = Number of cactus recovered from surviving MM4.

For planting joconostle, a deep and narrow hole will be prepared (40 cm deep by 500 cm of surface), and for that a drill can be used. The root will be left to fall in an extended manner in the hole without touching it, it will only be removed from the bag and the balled root will be left into the hole in such a way that the root is extended, the body of the cactus must be held on the surface manually (with a glove), once the root is placed in the hole, it will be filled with the same material that was removed no matter if material B is mixed with material A. to be watered.

For planting mesquite and junipero, a hole of approximately 80 cm 3 will be prepared which depth shall be half of the extension of its roots, once in place, the hole is to be filled with the clearing material.

This same procedure will be followed for each individual to be planted. In general, areas with shadows at least half of the day will be chosen or hollows will be chosen for their placement, in order to decrease stress and avoid losses.

We do not recommend reforest but the borders, since the seed bank of the clearing with the seeds collected, with species as resistant as those in the SAR, we consider that spots would be created with features similar to mezquite, as those in UNA 7, that may be used by wild fauna as connecting nodes between patches.

Planting individual could favor the growth of certain populations over others, therefore we suggest to only incorporate cactus since these are of slow growth and the purpose is that the remediated zone to be as the other areas that suffered no change in a 7 year term

We do not suggest incorporating juveniles or adults in UGA 6 since the current association has a coverage of up to 100% with elements that support insolation (but do not favor from it) and rapid growth, considering that if the area is irrigated up to the expression of the coversoil, in 4 years maximum it shall have the features typical of said association.

b) to compensate the cleared area the reforestation of 34.64 Ha must be paid for, with is the graze lands-hizahal area that will suffer the clearing. SCT shall pay for the reforestation of these hectares. The responsible for the reforestation shall be CONAFOR with the money paid by SCT.

#### IV.3 Program and labor for mitigation and compensation measures.

Below are the amounts of labor for the bid (Table VI.3). It only includes those to be bid on. The mitigation measures that are forbidden and, therefore, not in the bid shall not be included in Table VI.3.

**Table VI.3. Amounts of labor for bidding mitigation measures.**

MM No.	Description	Amount	Unit
1	Guidelines during the stay of personnel at the work site	1	Session
2	Monitoring emissions of machinery and equipment	1	Lot
		4	Zoologists
3	Frighten fauna, recover nests and species that live buried or in holes in the stripping and clearing area	1	Set of traps
		4	Serpent canes
4	Recovery of juveniles and mezquite seeds for reforest works along the sides of the road	3	Botanists
5	Handling of material produced by clearing, stripping and leveling	2	Leased lands
6	Construction of drinking fountains for fauna in the minor drainage works to favor they continue their movement routes	1	Set of rustic drinking fountains
7	Reforest program	1	Lot of juveniles and seeds
		34.64 Ha	Payment for reforestry

The program must match the construction program provided by the company awarded the bid, however the program below states the time that each mitigation measure shall take in case of being in a bid.

Act	Bimester																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
Stage 1																											
MM1	█																										
MM2	█																										
MM3	█																										
MM4	█																										
CLEARING		█	█	█																							
STRIPPING				█	█	█																					
LEVELING					█	█	█	█																			
MM5		█	█	█	█	█	█																				
Drainage								█	█	█	█																
MM6								█	█	█	█																
PIV and cattle								█	█	█	█																
Enbankment body											█	█	█														
MM7													█														
Signaling body A														█													
Stage 2																											
MM1													█														
MM2													█														
MM3													█														
MM4													█														
CLEARING														█	█												
STRIPPING															█	█											
LEVELING																█	█	█									
MM5																█	█	█	█								
Drainage																					█	█	█				
MM6																						█	█				
PIV and cattle																							█	█			
Enbankment body																								█	█	█	
MM7																											█
Signaling body A																											█

#### VI.4. Residual impacts of the SAR

The mitigation measures that are shown in the following section are targeted in the reduction, compensation and remediation of the sites or environmental factors due to five impacts considered as significant or relevant and refer to all the affection of fauna due to clearing, movement of machinery in the work site and of personnel, for the inadequate disposal of material coming from the clearing, stripping and leveling activities; and the most important, the barrier effect of the disturbance to wild fauna by the construction of the body of the embankment.

The degree in which the mitigation measures achieve the reduction of each adverse environmental impact was assessed. Such evaluation was performed in a subjective manner, the value of the percentage was obtained by the average of the values assigned by the specialist participating in the study, after discussing the extension, magnitude, duration and context of the impacts, as well as the scope of each mitigation measure separately. In each case, a low value was taken for the efficiency of each measure in order to avoid overestimating the joint efficiency. Each measure was examined and considered feasible from the technical point of view. For the impacts 1, 2, 3 and 7 (considered without

mitigation measure as moderate) there is only one mitigation measure, for the impact 5 considered high, there are three mitigation measures.

The three impacts 1, 2, 3 and 7 passed to low, considered not significant or relevant (Table V.10)<sup>8</sup>, while impact 5 was reduce to moderate, as seen in Table VI.4.

**Table VI.4 Synthesis of the mitigation to adverse impacts**

Impact	Mitigation measures	Reduction degree	Residual impact
1 Stripping fauna	3	40%	0.282 Low
2, clearing – landscape	5	80%	0.094 Low
3 Levelings – landscape	5	80%	0.097 Low
5. Construction of the body of the embankment – fauna	4,6 and 7	40%	0.459 Low
7. Movement of machinery and personnel in the area – fauna	1 and 2	60%	0.218 Moderate

Then, the only adverse residual impact would be 5 corresponding to the relation Construction of the embankment body-fauna, this impact refers to the drilling effect that the embankment body shall have for the displacement of fauna on both sides of the road. As stated in Chapter V, there is no fragmentation of the landscape patches, but a limit in the distribution of fauna. This impact is reduced with the mitigation measure 6 which function is to attract wild fauna to use the drainage works and cattle crossings to cross to either side of the road; according to Jean-Christophe, L. 1991 fauna shall take maximum 2 years to establish movement routes on both sides of the road, therefore this impact shall prevail for two years after the embankment body is built. The other two measures /4 and 7( are for compensation and refer to favoring the border effect<sup>9</sup> on both sides of the traffic bodies, in order to create 2 connection nodes that join the corresponding patches to UNA 5, 6 and 8 that are currently divided by farmlands.

## VI.5 follow up and control

Monitoring or follow-up of the variables of interest of the project is critical to verify that mitigation measures have worked properly and, if necessary, to determine that any changes are required and which might they be.

The monitoring program and the structure of environmental supervision are aimed at being as simple as possible, and, at the same time, sufficiently efficient to comply with it objectives. It is important that the program is simple since it will be easier to implement it at 100% and for SEMARNAT and PROFEPA to verify that its components are in place and effective.

<sup>8</sup> Under the terms of section IX of Article 3 of the regulation of the LGEEPA on environmental impact evaluation matters.

<sup>9</sup> Delgado et al (2004) reports that road in disturbed environments (such as the SAR) are the main sources of creation for a new habitat, considering the border. Specially, in highly fragmented systems the bordering habitat is necessary for the survival of generalist species.

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

### Objectives of the monitoring program

- 1) Verify and document the correct implementation of the mitigation measures (and the project conditions, if any)
- 2) Examine the effectiveness and sufficiency of such measures (and conditions) to at least achieve the prevention, reduction and mitigation levels foreseen for adverse environmental impacts.
- 3) Determine, if necessary, the changes required or additional mitigation measures to achieve the aforementioned levels.

### Indicators of the monitoring program and compliance with the MM

For the correct follow-up, field supervision must be undertaken during the different stages for the construction, where the correct implementation of the proposed mitigation measures is verified. It is advisable to hire an environmental impact supervisor, who may have two assistants. The profile of supervisors is suggested as follows:

Supervisor coordinator (supervisor 1): Professional degree in biology, ecology, environmental systems, or other similar degree or post graduate studies or specialization in the study of ecosystems or management of natural resources, with experience in the activities related to the construction of roads and/or the preparation of the MIA for road projects.

Supervisor 2: graduate or undergraduate, with studies in botany

Supervisor 2: graduate or undergraduate, with studies in zoology

The supervisor shall be responsible for the supervision actions and compliance with the mitigations measures is documented, log books are carried, with photographs and video.

Supervisor must prepare monthly reports of compliance with all mitigation measures of SCT, which will incorporate annual reports of compliance to Semarnat.

Table VI.8 shows the responsible for supervising every MM, its indicators and what is expected from the indicators.

**Table VI. 8 Indicators of compliance with mitigation measures.**

Mitigation measure	Indicators	Expected value or Threshold
MM1. Guidelines during the stay of personnel at work site	a) number of attendance signatures at the startup meeting b) Number of sanctions	a) Equal number of employees b) None
MM2. Monitoring of emissions from machinery and equipment	a) Evidence of the verification at an authorized facility per each	a) Result in compliance with applicable standards, as stated

	piece of machinery and equipment that operate at the work site	in said MM.
MM3. Frighten fauna, recovery of nests and species that live buried or in holes in the stripping and clearing area	<ul style="list-style-type: none"> <li>a) Area where the activity was performed</li> <li>b) Number of months during which it was performed</li> <li>c) Number of rescued and relocated individuals</li> <li>d) After al the activities, number of individuals captured in verification traps</li> </ul>	<ul style="list-style-type: none"> <li>a) 34.64 Ha</li> <li>b) Between 2 and 4 months depending on the advance of work fronts.</li> <li>c) All found</li> <li>d) None, no clearing may be performed until this indicator is complied with</li> </ul>
MM4. Recovery of juveniles and mezquite seeds for reforestry works along road borders	<ul style="list-style-type: none"> <li>a) Number of juveniles recovered</li> <li>b) Survival percentage of juveniles before transplant</li> <li>c) Volume of seeds collected</li> </ul>	<ul style="list-style-type: none"> <li>a) more than 80 juveniles</li> <li>b) more than 70% of survivors</li> <li>c) 2 kg</li> </ul>
MM5. Handling of material from the stripping, clearing and leveling	<ul style="list-style-type: none"> <li>a) m3 of excess material piled up on both sides of the work</li> <li>b) m3 of excess material piled up on leased land</li> </ul>	<ul style="list-style-type: none"> <li>a) Nothing piled up on the sides of the work site</li> <li>b) 208,242 m3 of clearing material and 1,650 m3 of leveling material</li> </ul>
MM5 Construction of drinking fountains for fauna at minor drainage works to favor continuous movement.	<ul style="list-style-type: none"> <li>a) Number of minor drainage works at UNA 5, 6 and 8 that shall have drinking fountains.</li> <li>b) Number of drinking fountains along the rest of the trace.</li> </ul>	<ul style="list-style-type: none"> <li>a) all drinking fountains on both sides of light ends</li> <li>b) One third of the total works over the res of the trace</li> </ul>
MM7. Reforest program	<ul style="list-style-type: none"> <li>a) Reforest compensation area</li> <li>b) Features of the right of way in 2 years after the work is completed</li> </ul>	<ul style="list-style-type: none"> <li>a) 34.64 Ha</li> <li>b) with 2 stretches of bushy mezquital, on both sides of the road inside UNA 1, 2, and 3</li> </ul>

## CHAPTER VII

### ENVIRONMENTAL REGIONAL FORECASTS AND, IN ITS CASE, EVALUATION OF ALTERNATIVES

#### VII.1 Trend environmental scenario

This scenario was presented in Chapter IV, section IV. 4, transcribed below.

The economical growth of municipality Encarnación de Díaz is the determining factor for change within the SAR. Therefore, the zone environmental situation will depend on it, as well as population growth and its relation with the system. On one side, population growth of the municipality involved in this project is null or relatively low (IV.2.4 Social Means, Demography). However, this does not imply that economy should fall. There are places, as Mexico City, with very low population growth, but very high economical growth (Report on Environmental Situation in Mexico, 2005). This is due to migration of people toward jobs, mostly observed in adults than in children. This is reflected in the SAR, where adults (persons between 15 and 64 years old) exceed the children population by 20%. The previous is consequence of job offer in the industry (pottery and knitting manufacture, basically dresses) and extensive-type cattle breeding that is handled in Encarnación de Díaz, so there are more adults (active PEA) than children.

Economical flourish of the zone is due to this industry and cattle breeding. As a result the area is receiving migration from other municipalities, as San Juan de los Lagos, and states as Aguascalientes. In fact, it is informed that migration status of San Juan de los Lagos is expulsion, i.e. migration to other places, as Encarnación de Díaz municipality. On its side, this latter municipality has a migration status of balance with slight trend to immigration, i.e. the municipality receives people from other sides, mainly adults, so its natural population growth rate has no significant variation and, in consequence, migration (important part of growth rate calculation) is not abruptly manifested. Nevertheless, industrial, commercial and cattle-breeding activities in the zone are excellent indicators of economical growth and job source, so it might be said that municipality migration status has with a slight trend to receive people.

Population growth as consequence of economical flourish causes increase of zones for establishment of industries, commerce, housing developments and pasture land and shepherd areas (this last in minor scale, but with great impact on the system). Due to higher economical profit obtained by aforesaid constructions, it is much probable that agricultural zones would be abandoned and use of land will change to urban zones. Analyzing the trend of years 1995-2000 regarding activities and PEA per activity, it is observed a clear slope to secondary sector activities (from 27% to 34%) and tertiary (from 24% to 31%), specifically to manufacturing and construction industry. Primary activities show a reduction, as in 1990 a 43% was informed and for 2000 it was 32% (Municipality Information System, 2006). These trends allow elucidating that next years will be similar, with diminishing of agricultural frontier and increasing of urban zone.

This increase will have important repercussions on SAR's environment. Currently it is considered a semi-altered system, with few great vegetation patches, and some small ones that serve as connection nodes with the greater ones for maintaining continuity in the system. In this type of systems, threshold or critical distance is not important (Caughley y Gunn 1996, Díaz 1996, Forman y Godron 1986, Keitt *et al* 1997, With y Crist 1995). This is because the separation among patches is the same being of 1 km as of 5 or 10 km, but if patch size is not effective enough to maintain inhabitant species or populations (Gardner et al 1987, Keitt *et al* 1997, Noss 1987). Consequently, isolation among patches must not be considered as an independent factor, as landscape functioning depends of the relation, size, form and connectivity amid them.

Even if distance is not a critical factor in this system, it certainly is the group of factors such as patch size reduction, limit changes (form) and total elimination of connection nodes (Forman y Godron 1986, Game 1980, Gustafson y Parker 1992, Keitt *et al* 1997, Noss 1987). In this way, fragmentation is an important element in SAR system. Basically, change in use of land and its expansion would be the trigger to augment fragmentation. This is, the increase of: pasture land, grazing zones for cattle-breeding, agricultural areas and change in use of land of: agricultural zones to cattle-breeding and urban infrastructure. Unavoidably, the preceding would distress remaining natural vegetation that in the best case would reduce its area without affecting species, but in the worst scenario – and maybe the most probable due to SAR's condition – would be total elimination of small patches that serve as connection among larger ones. This would cause a cut in species flow and rise probabilities of local extinction (Forman y Godron 1986, With y Crist 1995).

Specifically, in the SAR the project construction would not be a direct cause of increasing zone fragmentation. As stated above, economical growth is the main change factor in the entire system, causing an economic change that increases the urban zones (commerce, industry, human dwelling) resulting in fragmentation and degradation of environmental system. This fragmentation would cause a collapse of the system due to patch size reduction and disappearance, thus breaking continuity. Translated to species, there would be an inevitable loss of biological diversity and vegetal coverage, which being dessert type is much more sensitive as any other type because its recuperation period is very large.

In edaphological terms, soil degradation would be done basically by agricultural, cattle-breeding and change in use of land. By itself, the type of cattle-breeding performed in the zone is extensive, generating over-shepherd. This is one of major desertification reasons (Report of Environmental Situation in Mexico 2005) associated with soil loss and dessert system destruction. This damage is not only at local level, as there are also modifications in micro-climate, flora, as well as biochemical and hydrological cycles which have worldwide impact. Such activity, when no more productive, makes a change in use of land from cattle-breeding to urban. However, SAR lands, specifically those located within the geomorphologic system of erosive ramp (mainly xerosoles) would be most affected due to their physical characteristics and hydric erosion. Though, lands as the feozem (also located in this geomorphologic unit) would not suffer the same damage as the previous soil. Generally, the other edaphic types would not have a significant damage no matter the forecast of change in use of land.

**Table VII.1 Change trends in the SAR**

Change Factor	Affectation	Trend	Situation in 20 years
Urban Infrastructure	-Migration of the adult population to the employment sources in the Encarnacion Municipality	-Trend is and shall be as low increase of population. However, the effects on the systems shall not be proportional.	- The trend of the urban infrastructure at the SAR shall depend of the economic and political situation of the country. This is due to the fact that, while depending basically on industry, fluctuations in imports and exports of products may affect or help the economy of the area. However if the current situation is considered and it is foreseen that it will keep the same development pace, then it is possible to increase the functioning of industry, trade and cattle breeding generating more jobs, therefore requesting more services.
	-Increase in urban infrastructure	-There shall be an increase trend of commerce, construction or increase in industry and home developments.  -Basic services for the population will need to be improved.	
Extensive cattle raising	<ul style="list-style-type: none"> <li>- Cattle raising will be concentrated in UNA 5, 6, and 7.</li> <li>- Loss of natural plant coverage by pasture plant coverage.</li> <li>- Intrusion of external fauna to the system as ticks, rodents, etc.</li> <li>- Lack of recovery of natural vegetation due to occupation of cattle.</li> <li>- Soil compactation and loss of fertility.</li> </ul>	<ul style="list-style-type: none"> <li>- Over-pasturage</li> <li>- Even though cattle raising is limited to UNAs aforementioned, number 5 has a strong cattle raising activity, which even though at this time has not cost to severe damage, it could. In case of UNA 6 and 7, they are fragile, little tolerant to disturbance (especially UNA 7, which has preserved areas). Therefore, the same degree of cattle activity continues, they shall lost their naturality</li> <li>-There is a trend to loose natural cover of scrublands, for grazing lands in use and forage species, as a consequence of the incorporation of</li> </ul>	- Due to the excess grazing, part of the primary herbaceous cover is and will be substituted by secondary vegetation. With regard compacting of the soil, it causes that part of the seeds bank does not germinate and lastly, the excretions that are deposited on the soil with seeds that disseminate to the places where they were not originally located, modifying the distribution of plant species, therefore this is not the scenario which in twenty years would be expected to have dominion almost absolute by huizache over the rest of the

		<p>cattle raising activities – compression of vegetation- which leads to the fact that if it is intensive there is no recovery period, which in the arid areas is slower than in others.</p> <p>- The trend of the local fauna is to disappear as a consequence of the competition, predation, illnesses, etc., caused due to the increase of fauna associated with cattle.</p> <p>- Affection [sic] that will due to the increase of cattle, specially at UNAs 6 and 7, which shall be more affected by the type of soil it they have underneath (easy de-compactable).</p>	<p>associations</p> <p>-In the long term, cattle would not be sustainable but by this system. Therefore, affection in twenty years of the SAR would not be directly cause of this activity, but of the change of the use of land.</p> <p>However, current consequences and the future in ten years will lead to the fact that pressure on such activity shall be responsible for the alteration of the biological and physical system, leading to the intervention of other human activities.</p> <p>- Local increase of desertification process</p>
Change in the use of land	<p>-Decrease in the natural coverage (huizachal, scrubs, natural, pasture lands).</p> <p>-Decrease in the size of the patch, transformation of the form and significant alteration of the connectivity between patches.</p> <p>-Imminent alteration of the wild fauna population as well as reproductive and feeding cycles.</p>	<p>- There is a clear trend to increasing agricultural border, mainly at UNAs 1 and 2, leading to the occupation of natural areas<sup>10</sup>.</p> <p>- The trend to fragmentation is extremely strong, since it is the combined actions of different anthropogenic factors.</p> <p>- Nodes or connecting patches will tend to disappear as the response to the increase in human</p>	<p>- Agriculture introduces into the system exotic vegetation species according to the crops involved, which serve as the food for animal species which modify their populations in an artificial form due to the abundance of food, also causing growth of native and exotic undergrowth. Exotic species displace native species.</p> <p>- Consequently, plant cover in the area is shall be limited to induced</p>

<sup>10</sup> According to the report of the environmental situation in Mexico (2005) the increase of the agricultural frontier does not imply that it is a growing or better paid activity as other sectors –secondary and tertiary-, and that such extension means the using of the fields. Very frequently there is a report of an increase of agricultural areas even though the economy of the region does not depend on such activity.

- Displacement of the agricultural areas to natural zones as a pressure due to the increase in the urban infrastructure.
- activities.
- There is a trend to decrease wild fauna due to the alteration of the vital cycles as the consequence of the isolation between patches favored by the agricultural frontier as in the case UNA 8, or the intrusion of cattle raising activities
- grazing land, pasture, agricultural areas and other type of infrastructure
- As a consequence from the isolation of the populations due to fragmentation and lack of connecting nodes, fauna populations living in the area will decrease.

**Table VII.2. Environmental scenario with the project**

As of the trend scenario described in point VII.2, we add up environmental impacts identified as important in Chapter V (Table V.12). In Table VII.2 we present the SAR trend scenario and we add a column to identify if described situation is aggravated with the project.

**Table VII.2 Trend scenario of the SAR with environmental impacts due to the project and without mitigation measures**

Change Factor	Trend of SAR without project	Change factor contributed by the project	Situation in 20 years with the project and without mitigation measures
Urban Infrastructure	<p>-Trend is and shall be as low increase of population. However, the effects on the systems shall not be proportional.</p> <p>-There shall be a trend to increase trade, construction or broadening of industry and housing development.</p> <p>-Better and more basic services for the population would be required.</p>	<p>- No changes are expected in demographic growth of the region due to the project.</p> <p>-Movements from the city of Aguascalientes to San Juan de los Lagos will be faster and safer, therefore it is possible that there is a decrease in a non perceptible degree for the SAR in dwelling demand, since workers may travel on daily basis from such city to San Juan.</p>	<p>- The trend of the urban infrastructure at the SAR shall depend of the economic and political situation of the country. This is due to the fact that, while depending basically on industry, fluctuations in imports and exports of products may affect or help the economy of the area. However if the current situation is considered and it is foreseen that it will keep the same development pace, then it is possible to increase the functioning of</p>

Extensive cattle raising

- Exceeds grazing activities
- Even though cattle raising is limited to UNAs aforementioned, number 5 has a strong cattle raising activity, which even though at this time has not cost to severe damage, it could. In case of UNA 6 and 7, they are fragile, little tolerant to disturbance (especially UNA 7, which has preserved areas). Therefore, the same degree of cattle activity continues, they shall lost their naturality
- There is a trend to loose natural cover of scrublands, for grazing lands in use and forage species, as a consequence of the incorporation of cattle raising activities – compression of vegetation- which leads to the fact that if it is intensive there is no recovery period, which in the arid areas is slower than in other
- The trend of the local fauna is to disappear as a consequence of the competition, predation, illnesses, etc., caused due to the increase of fauna associated with cattle
- Affectation [sic] that will due to the increase of cattle, specially at UNAs 6 and 7, which shall be more

- The project will not increase its trend to exceed grazing lands. In a degree which is not perceptible it will decrease because it shall increase the secondary economic sector over the primary, due to the link of the 2 trunk axis.
- In the meantime while the fauna routes for crossing from one side of the road to the other is reestablished, the barrier effect will adopt to the pressure exercise by the fragmentation of the landscape in decreasing fauna populations even though the barrier factor will not cause local extinction, only a temporary negative pressure (2 years while the route are reestablished.
- 34.64 Hectares of grazing land-Huizachal will be cleared, that will not be recovered, since the area will be occupied by the body of the environment.
- No compactation along the trace will be caused therefore there is no adverse effect on the soil.

industry, trade and cattle breeding generating more jobs, therefore requesting more services.

- Due to the excess grazing, part of the primary herbaceous cover is and will be substituted by secondary vegetation. With regard compacting of the soil, it causes that part of the seeds bank does not germinate and lastly, the excretions that are deposited on the soil with seeds that disseminate to the places where they were not originally located, modifying the distribution of plant species, therefore this is not the scenario which in twenty years would be expected to have dominion almost absolute by huizache over the rest of the associations
- In the long term, cattle would not be sustainable but by this system. Therefore, affectation in twenty years of the SAR would not be directly cause of this activity, but of the change of the use of land.

However, current consequences and the future in ten years will lead to the fact that pressure on such activity shall be responsible for the alteration of the biological and physical system, leading to the

Change in the use of land	<p>affected by the type of soil it they have underneath (easy de-compactable)</p>	<p>- 34.64 Hectares of grazing land-Huizachal will be cleared, that will not be recovered, since the area will be occupied by the body of the environment.</p> <p>- Given that it is highway with a high specifications, no intermediate accesses will be built, therefore accessibility will not be increased nor the change in the use land derived there from.</p> <p>- There are no patches segmentation, on the contrary the road will create a bordering effect connecting while species that are less susceptible to disturbance.</p> <p>The road will create a barrier effect for wild fauna, until restoring the route through drainage works.</p>	<p>intervention of other human activities.</p> <p>- Local increase of desertification process</p> <p>- Agriculture introduces into the system exotic vegetation species according to the crops involved, which serve as the food for animal species which modify their populations in an artificial form due to the abundance of food, also causing growth of native and exotic undergrowth. Exotic species displace native species.</p> <p>- Consequently, plant cover in the area is shall be limited to induced grazing land, pasture, agricultural areas and other type of infrastructure</p> <p>- As a consequence from the isolation of the populations due to fragmentation and lack of connecting nodes, fauna populations living in the area will decrease.</p>
	<p>- There is a clear trend to increasing agricultural border, mainly at UNAs 1 and 2, leading to the occupation of natural areas<sup>11</sup>.</p> <p>- The trend to fragmentation is extremely strong, since it is the combined actions of different anthropogenic factors</p> <p>- Nodes or connecting patches will tend to disappear as the response to the increase in human activities</p> <p>- There is a trend to decrease wild fauna due to the alteration of the vital cycles as the consequence of the isolation between patches favored by the agricultural frontier as in the case UNA 8, or the intrusion of cattle raising activities</p>		

As shown in Table VII.2, although the project provides certain changes to SAR trend scenario, these are not strong enough as to modify the situation in 20 years from now with or without projects, so the two SAR trend scenarios are identical with or without projects (last column of Table VII.2). The impact considered as most significant by specialists (vehicle circulation – users, Table V.12) does not modifies the SAR, as we have repeatedly mentioned, its impact is out of its limits, as it will speed traffic between the two main axis, thus benefiting the country’s central and north zones; this benefit will not cause important changes in the municipalities neither of Encarnación de Díaz nor San Juan de los Lagos.

<sup>11</sup> According to the report of the environmental situation in Mexico (2005) the increase of the agricultural frontier does not imply that it is a growing or better paid activity as other sectors –secondary and tertiary-, and that such extension means the using of the fields. Very frequently there is a report of an increase of agricultural areas even though the economy of the region does not depend on such activity.

### VII.3 Environmental Project Scenario and Impact Mitigation Measures

The trend scenario with or without impacts is the same, as indicated by Table VII.2. This is due to change processes that modify SAR are social and economic processes that carry a past synergy and are added to phenomena expected to keep continuing. These macro-tendencies will not be modified by the project, especially because the project is a road. Its construction does not pertain to any need of communication within SAR (for this end, there is already the type C road that connects both county capitals and intermediate towns); it pertains to the adjoining of 2 main roads to affect traffic of the center and northern part of the country. Although its construction would reduce traffic to the existing road—for the benefit of its users— this reduction will not modify trend scenario of SAR in 20 years.

Once the mitigation measures are applied, there is only one adverse environmental impact remaining that is considered as significant (according to the method discussed in issue V.5.1) and refers to the blocking effect it will mean to the embankment for the animal passing in both sides of the road. As indicated in Chapter V, a fragmentation of the landscape patches is created, but rather a limit to the animal distribution. This impact is reduced with mitigation measure 6, whose function is to attract wild animals that use drainage and herd crossing in order to make them cross both sides of the road; and is compensated with the creation of connection nodes of UNA 5, 6 and 8, by means of the effect of the edge. According to Jean-Christophe L. (1991), animals will take 2 years maximum to establish movement routes in both sides of the road. This means that said impact will remain at least 2 years after the embankment has been built.

The 4 adverse impacts considered in Chapter V as relevant were left as not significant. Even though they provide change factor to SAR, it is minimal and manageable due to the resilience and resistance of the system itself. Therefore, no change is expected due to the tendencies between them.

Table VII.3 presents SAR modifications that will provide the mitigation measures. Comparison is provided without the mitigation measures.

**Table VII.3. Modifications in change factors of SAR in a scenario with mitigation measures**

Change Factor	Project without MM	Project with MM and Remaining Impact
Urban Infrastructure	<ul style="list-style-type: none"> <li>- Traffic from Aguascalientes to San Juan de los Lagos will be faster and safer. Therefore, there is a possibility of an unnoticeable decrease in housing demand for SAR; workers will be able to travel daily from the city to San Juan.</li> <li>- The project will not increase trend to overgrazing. There's a possibility that the project will induce an unnoticeable decrease, because it will tend to increase the secondary economy sector over the primary due to adjoining of 2 main roads.</li> </ul>	<ul style="list-style-type: none"> <li>- The project with MM will not increase to overgrazing. There's a possibility that the project will induce an unnoticeable decrease, because it will tend to increase the secondary economy sector over the primary due to adjoining of 2 main roads.</li> </ul>
Extensive Cattle Raising	<ul style="list-style-type: none"> <li>-During the time it takes to reestablish the animal routes to cross from each side of the road to the other, the blocking effect will be added to the</li> </ul>	<ul style="list-style-type: none"> <li>-During the time it takes to reestablish the animal routes to cross from each side of the road to the other, the blocking effect will be added to the</li> </ul>

pressure exercised by the landscape fragmentation in the decrease of animal populations. Although the blocking effect will not be the cause of local extinction, it will be a temporal negative pressure of 2 years while roads are established

pressure exercised by the landscape fragmentation in the decrease of animal populations.

Once 2 years have passed, connection will increase by means of edge effect which will thrive on the road access of UNA 5, 6 and 8.

- 34.64 Ha of Huizachal pasture will be dismantled and will not be recovered due to the embankment occupying the area.

- 34.64 Ha of Huizachal pasture will be recovered by means of reforestation of same area. This process will be in charge of CONAFOR

- There will not be patching next to the tracing. Therefore, no adverse effect to the floor is expected.

- There will not be patching next to the tracing. Therefore, no adverse effect to the floor is expected.

Change of Land Use

- 34.64 Ha of Huizachal pasture will be dismantled and will not be recovered due to the embankment occupying the area.

- 34.64 Ha of Huizachal pasture will be recovered by means of reforestation of same area. This process will be in charge of CONAFOR. Additionally, right of way tracks will be reforested and will serve as connection nodes between UNA 5, 6 and 8.

- Because of its status as a high specifications road, no intermediate access will be built. This means there will be no increase in accessibility and, therefore, no change in the land use derived.

- There will be no increase of accessibility within SAR. Therefore, no associated impacts are expected.

- There will not be an increase of patching. On the contrary, the road will develop an edge effect by means of which wildlife species less susceptible to disturbances will be connected.

- The road will create a blocking effect for wild animals up until the route reestablishing through the drainage.

VII.4 Evaluation of Alternatives

Evaluation of Alternatives for this project was performed during the engineering phase as long as the engineering process complied with the specifications established by the Ministry of Communications and Transport for governing slopes, circulation speed average, maximum curve degrees, distance, etc. Tracing alternatives were examined taking into account aerial pictures and restitution. On the preliminary tracing a detailed topographic work was carried out to determine the points on the tracing, and disposition and tracing of curves. It could be said that evaluation of alternatives was based on engineering specifications and topographic conditions of the zone.

During the writing of this environmental impact manifest, disturbance and fragility within

SAR were analyzed by means of dividing it in 8 polygons called environmental units (UNA). The results were a most disturbed SAR presenting no high fragility conditions. The UNA which would be the most restrictive for construction of road was 7 due to state of original mezquital, Vertisol-type soil, and on them ponds that attract migrating birds. The project marked by the topographic brigade does not cross UNA 7. Because UNA 7 is the only UNA restricted to the construction, we considered that the actual route that does not cross it is a good alternative and will not cause significant impact associated to a particular route. The blocking effect will occur in any route with no other relevant impact (as long as it does not cross UNA 7).

## VII.5 Conclusions

Works and related activities related to construction of San de Los Lagos – Encarnacion de Diaz road, km 0 to 18+636.443 were presented herein. The project consists in the construction of a four-lane paved road (type A4-S-12-10.5). It will require release of 11.82 Ha (Chapter II). Plans and applicable regulations were indicated and examined (Chapter III), detecting that the project is compatible with the territorial ordering of the state and does not violate any county regulations, zone orders or official standards.

Regional Environmental System was delimited and characterized. Its environmental diagnosis was performed. Eight environmental SAR units were determined by means of status indicators. Findings were that a 31.6% of the area is located in preserved environmental units, 47.2% in disturbed environmental units, and 21.2% in highly-disturbed environmental units. Of all 8 environmental units, only number 7 was considered too fragile by presenting restrictive conditions for construction of road (Chapter IV). Nevertheless, the project will not cross this UNA.

By means of field and cabinet work the alterations caused by project activity on environmental factors were acknowledged (and natural and social media jointly.) Among them, the blocking effect alterations to movement of wildlife caused by construction of the embankment were highlighted.

Adverse and beneficial impacts associated to the project were evaluated by a multiple-criteria indicator (Chapter V) by means of application of an algorithm that takes magnitude, duration, extension, context and synergy criteria in account. The indicator allows for classification of impact in four levels: low, moderate, high and very high. The last three correspond to relevant impacts. For this project, 5 relevant adverse impacts were identified, 2 high and one very high. The latter associated to regional benefits due to an improved communication between main roads Manzanillo-Tampico with Mexico-Nuevo Laredo.

Seven mitigation measures of adverse impacts were determined (Chapter VI). They were considered as factual from a technical, social, environmental and economic point of view, and that they mitigate the relevant impacts. Thus, it is calculated that only a remaining adverse impact is significant—in the moderate category—related to blocking effect for wildlife caused by the body of embankment.

It should be highlighted that due to the terrain where the road will be constructed currently shows a high disturbance level (which includes total loss of original foliage and movement of wildlife species susceptible to disturbance), derived of fragmentation by economic activities of the zone (farming and cattle rising).

The project is distributed on geofoms of mount skirts and sinking block of mountain unit (which characterizes its soft slopes), which prevents impacts usually associated to these kind of works.

Forecasted duration of remaining adverse impact is approximately 2 years after construction of embankment body, until the new routes of animal movement are determined, by means of implementation of mitigation measures 4, 6 and 7. These refer to implementation of wildlife

crossings and creation of an edge effect in both sides of the road that allow movement of wildlife through environmental units 5, 6 and 8 (currently separated by farming fields).

After analyzing operation of SAR, project alterations and implementation of mitigation measures, we can assure that the project will not cause impacts that compromise SAR operation. On the other hand, it will cause significant beneficial impacts that will echo within SAR and outside for streamlining of transit between 2 important main roads for communication of center and northern zones of the country. Therefore, we recommend authorizing of construction and operation of the project, as well as implementation of mitigation measures.

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## CHAPTER VIII

### IDENTIFICATION OF METHODOLOGICAL INSTRUMENTS AND TECHNICAL ELEMENTS THAT SUPPORT RESULTS OF ENVIRONMENTAL IMPACT MANIFEST

#### VIII.1 Presentation of Information

##### *VIII.1. Cartography*

Annex 2 presents the thematic letters. Relation of topics is presented as follows.

Letter 1. Macro-localization (complete counties with access roads)

Letter 2. Climates.

Letter 3. Geological.

Letter 4. Geomorphology

Letter 5. Surface Hydrology

Letter 6. Underground Hydrology

Letter 7. Land Use and Vegetation

Letter 8. Environmental Units (UNA)

Letter 9. UNA Diagnosis

##### *VIII.1.2 Pictures*

Annex 3 presents relationship of land pictures ordered in slides. Annex 4 shows the aerial pictures.

#### VIII.2 Other Annexes

Annex 1. Legal Documentation

Annex 2. Topical Cartography

Annex 3. Land Pictures

Annex 4. Aerial Pictures

Annex 5. Calculation Memory

Annex 6. Sampling Method of Arboreal Species and Wood Volume in Forest Species Roll

Annex 7. Animal List

Annex 8. Plant Blueprints and Project Profile, with Work Volumes, Coordinates, Alluvium Volumes and Bank Relationship