

**MINISTRY OF NATURE PROTECTION OF ARMENIA
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**RESTORATION OF LAKE GILLI
Intermediate Report**

YEREVAN 2001

1. A summary of the biodiversity expected after the restoration of the lake. I need this to be a concise and precise report and NOT a paper for a journal in taxonomy.

The current vegetation in the territory of former lake Gilli has nothing in common with the vegetation described in 30-ies. Water-marsh vegetation is preserved until today in the river Masrik and canals for changing its course, as well as drainage canals created for drying the territory. It is necessary to mention that all main edificators are represented in its composition, despite the floristic composition becoming very poor as a result of small areas. Considering the extremely high competitive qualities of edificators of water-marsh vegetation, such as reed, cattail, rush etc., it is possible to state that if the corresponding highly swamped conditions are created they will create the succession basis of vegetation, close to the previous one, in a very short period of time.

According to the data from scientific records and herbariums, beginning from 1920-ies, there were 320 species from 57 families of vascular plants registered on the territory of lake Gilli. On the basis of conducted studies and analysis of existing data it would be possible to state with certain confidence that in case of restoration of lake Gilli many species of plants, preserved in the neighbourhood of the territory would restore their populations in the new ecosystem in through the natural way. Some species (include the rarest and most important for biodiversity conservation), becoming extinct on the territory of lake Gilli, have been preserved in other habitats on the territory of Armenia. For the restoration of their population it is necessary to conduct exploration and collection of their seeds or seedlings for reintroduction purposes. Some species have become completely extinct on the territory of Armenia, but have been preserved in neighbouring countries. For these species, it would be necessary to receive seeds or seedlings, using contacts with local botanists or employees of environmental organisations. Some species are extinct completely. For them it is necessary to organise detailed explorations, because it is possible that they are preserved in some sanctuary. These species are of special interest.

Falcaria falcarioides (Bornm. et Wulf) Hoffm. - the species has been included in the Red Book of Armenia. Was widespread on the territory of lake Gilli in salinated areas. Recently it has been found in the salinated swamps near Ararat town (Armenia) and easily can be reintroduced on the territory of Lake Gilli.

Peucedanum zedelmeyerianum Manden. - extremely rare species, included in the International Red Book and the Red Book of Armenia. Was described from the territory of lake Gilli, and after its drying has not been collected any more. Apparently has completely disappeared from the territory of Armenia. According to records, in recent years two small populations of this species have been found in Turkey. It is necessary to receive seeds from Turkey.

Eleocharis transcaucasica Zinserl. - the species has been included in the Red Book of Armenia, apparently has disappeared from the territory of Armenia. There are a few populations known in Talysh, European part of Russia and Turkey. It will be not too difficult to receive seeds and seedlings from Russia.

Ranunculus lingua L. - a rare species in Armenia, was known from the territory of lake Gilli, from where it has disappeared, but has been found on mountainous plains of Lori, and easily can be reintroduced.

Puccinellia grossheimiana Krecz. - the species has been included in the Red Book of Armenia. Was known only from the territory of lake Gilli, presently has disappeared from the territory of Armenia. According to records, a small population has been found in north-eastern Anatolia. It is necessary to receive seeds from Turkey.

Astragalus goktschaicus Grossh. - Extremely rare species. Other than the territory of lake Gilli, presently only one other population is known in Turkey. It is necessary to receive seeds from Turkey.

Isatis sevangensis N.Busch - Extremely rare narrow endemic of lake Sevan basin. Has been spotted on the territory of lake Gilli. Presently, three populations are known on the Areguni shore of lake Sevan. These species should be reintroduced on the territory of Lake Gilli.

Isatis arnoldiana, *Draba bryoides*, *Sonchus sosnovskiy* - three endemic species. Special investigations have to be organised for finding these species in Armenia. In this case there is possibility to find and reintroduce them on the territory of Lake Gilli.

From ornitofauna (fauna of birds) of lake Gilli 200 species of birds were identified. From them more than 100 species were nesting birds, others were known to be migrating and visiting. It is possible to return the majority of bird species previously nesting on Gilli (minimum 65 species) to their nesting places just by restoring the lake. The key to the justification of this argument is the location of the Republic of Armenia on one of the flying routes of near-water and water-marsh birds, flying toward the north from the Tigris and Euphrates valley, as well as lakes and seashores of Central Africa and Asia minor. All the species, which previously nested on the territory of Gilli until its drying, are spotted here each year as migrating birds and nest in more northern parts of their areal. The most important from them are: Dalmatian and Great white pelicans, Glossy ibis, Corn crane, Black-winged pratincole, White-tailed and Sociable lapwings, White-headed duck, Ferruginous pochard, Red-breasted goose, Lesser white-fronted goose, White-tailed and Booted eagles, Great snipe, Red-necked grebe, Great cormorant, Common crane, Little egret, Great bittern, Greater flamingo, Collared pratincole, Pied avocet, Black-winged stilt, Eurasian oystercatcher, Armenian gull, Black, Gull-billed, Little and Common terns, Grasshopper warbler, White-winged scoter.

Data on previous entomofauna (fauna of insects) of lake Gilli are not recorded. Parts of the present water-marsh vegetation include, apparently, the remains of the initial entomofauna of the lake. Here 37 species of beetles have been identified, from which 3 species (*Dyschirius sevanensis*, *Amara tricuspidata strandi*, *Gymnaetron germari*) are endemic to Armenia. The restoration of Gilli will bring an increase in their areals and provide some guarantee for their preservation.

There were in the lake 3 endemic species of fish (two races of Sevan trout, Sevan koghak and Sevan barbel). Their area included Gilli and Sevan lakes. From them one race of the sevan trout can be classified as extinct, the restoration of which is impossible because of its almost total absence in other water bodies and in captivity. The other race can still be found in singular examples in other rivers pouring into lake Sevan and in artificial conditions created by private entrepreneurs. Sevan koghak has decreased in numbers and shows the tendency to continue this decrease, mainly because of its insignificant natural reproduction due to fishnets in rivers and water withdrawals for irrigation purposes in the period of spawning migration. The number of population of Sevan barbel was at a comparatively stable level in recent past (early 90-ies).

Thus, it should be mentioned that the extremely high biodiversity of the territory of lake Gilli, which includes 16-19 species of mammals, 170-200 species of birds, 5-8 species of reptiles, 2-3 species of amphibians, 3 species of fish and not less than 80 species of invertebrates, as well as about 300 species of vascular plants and 100 species of algae. For most of the representatives of this biodiversity no artificial measures are necessary during the restoration of the lake, since the species for which the restored biotope is not suitable will leave the territory, and species which belong to water-marsh biotope and live in neighbouring territories will replace them. For others it is necessary to organise some technical works (reintroducing some species of plants and mammals, artificial fishbreeding, creating artificial conditions for the increase in the number of the population of bats, etc.).

- the maps of soils and others such as hydrological, topographic

2. A more detailed information about the three restoration options discussed

N	Altitude above the sea level m.	Maximum depth, m	Average depth, m	Depths more than 1.5 m, ha (per cent)	Flooding area, ha	State owned lands, ha		Privatised lands, ha
						State land fund	Community land	
1	1914,0	1,3	0.5	0 (0.0)	240	119	97	24
2	1914,5	1,8	0.7	1 (0.2)	396	215	115	70
3	1915,0	2,3	1.0	107 (18)	586	295	185	106
4	1915,5	2,8	1.2	241 (30)	800			

N	Positive sides	Negative sides
1	<ul style="list-style-type: none"> • Small area of privatised land • Restoration of ecosystem with small volume of water 	<ul style="list-style-type: none"> • Depth not enough for ichtyofauna (fauna of fishes) • Total area not enough for preservation of ornitofauna • Rapid growth of water reservoir • Low stability of ecosystem
2	<ul style="list-style-type: none"> • Depth and area enough for restoration of flora and ornitofauna • Depth and area enough for a part of ornitofauna (dabblers - puddle ducks). • In case of good water outflow the lake would not grow rapidly and fully • Large area of land around the lake, which will be irrigated from the lake 	<ul style="list-style-type: none"> • Depth not enough for normal development ichtyofauna (fauna of fishes) • Depth and area not enough for waterbirds • Significant increase of the area of privatised lands • Low stability of ecosystem • Large area of swamped lands
3	<ul style="list-style-type: none"> • Depth and area enough for restoration and preservation of flora and fauna • The lake would not grow rapidly and fully • Large area of land around the lake, which will be irrigated from the lake • High stability of ecosystem 	<ul style="list-style-type: none"> • Significant increase of the area of privatised lands • Large area of swamped lands
4	<ul style="list-style-type: none"> • Depth and area enough for restoration and preservation of flora and fauna • Option closest to the ecosystem before the drying of the lake • The lake would not grow rapidly and fully • Even larger area of land around the lake, which will be irrigated from the lake 	<ul style="list-style-type: none"> • Very large area of acquired lands • Natural growth processes (and naturally sanctuary for ornitofauna) are slower • Deteriorating epidemiological situation and increase in danger for socio-ecosystem

Option 1 – does not comply with the conditions of biodiversity preservation and restoration and, correspondingly, with the main objective of the project. During the discussion, none of the experts supported this option, and it was not reviewed in greater detail.

Option 4 – in terms of its advantages, this option is practically no different from Option 3, but it has some additional disadvantages. Based on their common sense (and primarily, considering the increase in the project cost), the experts mostly focused on Options 2 and 3. Option 4 was considered only as an “option that would not be bad but does not have a particular significance”.

- map with the drawing of the restoration option

3. A description of human activities expected after lake restoration

The use of the restored ecosystem by the population

The following options are proposed by experts:

Ecotourism, Sports hunting, Fish breeding, Bird breeding, Crab catching, Molluscs breeding, Useful plant collecting and growing, Scientific studies, Excursions for students, Buffalo breeding, Other economic activity (for example, grazing, haying, mowing, collection of technical plants and organising small factories, etc.)

During the discussion in the Pathfinders meeting, it was determined that any measures generating revenues are possible, but they can in no case threaten the biodiversity and wholeness of the ecosystem to be restored. In connection with this, it was proposed to refuse Molluscs breeding because of the high likelihood of spreading epizootics, since many species of Molluscs are intermediary “owners” of numerous kinds of parasites. Thus, practically all the proposed options of using the restored ecosystem are possible, but they lack marketing data. One of the first measures of project implementation should be the implementation of marketing research to determine the most feasible measures in terms of economy. From the standpoint of biodiversity preservation and non-violation of ecosystems, the most feasible ones are eco-tourism (including birdwatching), scientific studies and excursions for students and schoolchildren. Below, one can find the main advantages and disadvantages of various types of activities.

Eco-tourism

Recreation, scientific investigations and excursions. Recreational facilities should be managed by the members of local communities. Special training courses to increase the culture of service should be planned as part of educational program. It is very important that indigenous people first of all must see and feel the benefits of Gilli restoration project.

Tourism. Aimed on people from abroad, tourism is very profitable in perspective. Development of tourism needs enormous financial investments in such kind of expensive facilities, as well equipped hotels, service, etc. Far location from main tourist’s zones and cool climatic conditions doesn’t arrange leisure tourism development in the area.

Bird watching is one of the rapidly developed branches of so-called eco-tourism. Bird watching also needs lodging facilities but diversity of birds and well advertising will attract real bird watchers soon after restoration of the lake.

Positive sides	Negative sides
<ul style="list-style-type: none"> • Full possible preservation of biodiversity • Preservation of natural ecosystems • Further development of tourist infrastructures of the region • Theoretically high margin of profit of the sector 	<ul style="list-style-type: none"> • Need for large investments • Lack of experience in ecotourism among the local population

Option	Positive sides	Negative sides
Scientific studies	<ul style="list-style-type: none"> • Absence of necessary and large investments • High positive image • Attraction for international scientific community • Preservation of natural ecosystem 	<ul style="list-style-type: none"> • Low margin of profit
Excursions for students	<ul style="list-style-type: none"> • High positive image • Social value - ecological education • Preservation of natural ecosystem 	<ul style="list-style-type: none"> • Low margin of profit

Sport hunting

In the past hunting had commercial character and autumn ducks drew top price. Trapping was prevailed among the local hunters. It is important to develop after restoration of the lake well-managed sport lead free shot-gun hunting as necessary source of incomes for local communities. It is expected that the main game will be dabbler and diver ducks, coot, snipe, etc. Hunting should be considered also as an important part of wetland management, particularly limitation of quantity of carnivores, such as wolf, fox and recently invaded from lower areas jackal. Game breeding/nursing including construction of artificial nests should be considered as part of waterfowl management.

Positive sides	Negative sides
<ul style="list-style-type: none"> • Comparatively high margin of profit with low investment • An important condition for managing water-swamp territories 	<ul style="list-style-type: none"> • Threat to biodiversity • Threat to ecosystem • Lack of real margin of profit estimation

Fish breeding and fishing

In the past fish harvesting had commercial character in the short and narrow canal between Gilli and Sevan. Fish from Lake Gilli itself had very strong flavored test. It is evident that restoration of Lake Gilli will increase fishing capacities of Lake Sevan first of all as nursing and breeding area for crucian carp and especially heat-loving carp. Sport fishing will be a necessary source of incomes for local communities, and at the same time a limiting factor for undesirable increase of crucian carp. Artificial fish breeding should be considered as part of fish stock management.

Breeding the rare species of fish that are included in the Red Data Book would be of a high significance in terms of saving the environment (preservation and restoration of biodiversity), but furthermore, the surplus of fish generated by good management of the areas could have a high benefit.

Positive sides	Negative sides
<ul style="list-style-type: none"> • High margin of profit in case of use of additional resources • High attraction in case of organising sports fishing • Positive experience in case of breeding of catch of species included in the Red Book • Possibility for restoration of populations of rare fish species 	<ul style="list-style-type: none"> • Necessity for comparatively high investments • Negative experience in case of breeding of catch of species included in the Red Book

Bird breeding

Breeding wild waterbirds could also have a high significance in terms of the economy and saving the environment. In this case, defective birds could be either simply sold or used in the frameworks of sport hunting.

Positive sides	Negative sides
<ul style="list-style-type: none">• High margin of profit• Possibility of restoration of populations of rare species• Positive experience in case of breeding of catch of species included in the Red Book	<ul style="list-style-type: none">• Necessity for investment• Negative experience in case of breeding of catch of species included in the Red Book

Growing and collecting useful plants

Collecting of edible and medicinal plants is traditional work of Armenian peasant women. Restoration of the lake will raise diversity and quantity of plants, which is perspective for development of small industry for primary refinement of edible and medicinal plants. The creation of special fields for growing useful plants could be very rewarding work; however, marketing research is necessary at first.

Positive sides	Negative sides
<ul style="list-style-type: none">• Non-saturation of market and possibility for development of small productions• Absence of necessary and large investments• Possibility of restoration of populations of rare species• Lowering the pressure on nature populations	<ul style="list-style-type: none">• Lack of experience and marketing• Disturbance of natural ecosystem

Crab catching

In the past, crayfish did not populate Lake Gilli. When the Lake is restored, it will definitely be populated by crayfish in a natural and unregulated way. The outcome of biological monitoring could allow one to determine the possible volumes of crayfish that could be caught without damaging the stability of the ecosystem to be created. On the other hand, the correct organization of catching crayfish could be a very rewarding economic initiative.

Positive sides	Negative sides
<ul style="list-style-type: none">• Good market• Decrease and control over the population of allochthonous species	<ul style="list-style-type: none">• Inadequately developed issues of marketing• Remoteness from market

Buffalo breeding

Breeding buffaloes has been a traditional branch of stock-raising around what used to be Lake Gilli. The restoration of this branch could be important in terms of both the economy and the history. However, numerous obstacles are evident, such as the necessity of creating a matrix cattle, the absence of specialists on breeding buffaloes, and so on.

Positive sides	Negative sides
<ul style="list-style-type: none"> • Positive image of restoring forgotten traditions • High margin of profit in case of correct approach 	<ul style="list-style-type: none"> • In case of inadequate control threat to biodiversity and ecosystem • The absence of specialists • The necessity of purchasing samples for the matrix cattle

Other activities

- **Grazing.** Surrounding wet meadows were used for grazing, especially in dry season. It is expected that after restoration of Lake Gilli the role of surrounding area suitable for grazing will increase due to water level increase. Grazing should be considered also as an important part of wetland management, particularly against expanding of reed stands, bog forming, arboreal species succession. However, prevent the spreading of especially dangerous infections in the area, it is absolutely necessary to organize strict veterinary control.
- **Haying.** Hay from wet area never had top price. However in arid zone hay from wetlands could be substantive additional source of forage for cattle. In limited areas haying should be considered also as part of wetland management, particularly against expanding of the reed stands and to prevent from succession. Prevent the spreading of especially dangerous infections in the population, it is absolutely necessary to organize special prophylactic measures.
- **Reed harvesting.** In the past reed was harvested for fuel, constructions, and bedding for cattle. The reed of Lake Gilli was mighty, up to 3-5 m height. The quality of reed is suitable for reed export, although Armenia is rather far from main importers (Austria, Germany, The Netherlands).
- The restoration of traditional crafts (braiding and so on) could be crucial in terms of not only improving the living standard of the people and rationally using the resources of the ecosystem to be restored, but also acting as an additional factor for the attraction of tourists to the region.

Positive sides	Negative sides
<ul style="list-style-type: none"> • Positive image of restoring forgotten traditions • Rational utilisation of nature resources • Generating additional revenues • High margin of profit in case of correct approach 	<ul style="list-style-type: none"> • In case of inadequate control threat to biodiversity and ecosystem • Possible deterioration of epidemiological situation

4. A description of the pathfinder discussion and how and why the group selected the chosen restoration option.

The first question discussed at the Pathfinders meeting was the following: what ecosystem are we going to restore? Is it going to be one that existed in the past or a new one? Virtually all the experts immediately responded that it is impossible to create an ecosystem analogous to the one that used to exist. First of all, there is no precise and detailed data on the ecosystem that used to exist, on the relationships between its different elements, on a number of its components, such as the entomofauna, for instance. Second, some of the species, including plants, are considered to have disappeared. Of course, it is possible that they have survived somewhere in nature, and that they could be found again as time goes by; however, at the time of project implementation, it will hardly be possible to discover and reintroduce them. Third, there is extremely little data on succession changes that took place in the ecosystem of Lake Gilli. The data that exists in literature is scanty and

controversial. Taking this into consideration, experts have drawn the conclusion that it is necessary to attempt to restore an ecosystem close to the one that used to exist, provided that the impossibility of reaching absolute similarity be regarded. In this connection, the monitoring and management of the ecosystem to be restored becomes highly significant. It will be necessary to implement appropriate measures to provide for the natural restoration of the ecosystem to flow in the right direction and meet the main criteria, which is the maximum preservation of biodiversity.

The next question is whether the ecosystem to be restored should contain only species that previously existed, or whether rare, endemic, and highly interesting species of Armenia's biodiversity could be introduced. Both of these viewpoints were supported by certain people. One argument is that in any case, it will be impossible to impede the penetration of certain species that absolutely surely did not exist (for example, crucians or crayfish) into the ecosystem. In this event, the entry of new species could lead to all types of unpredictable consequences. Another argument is that if the ecosystem of the Lake is restored, this will provide a unique opportunity for preserving a wide range of water-marsh flora and fauna, which face a real threat in terms of disappearing in other habitats. Some expressed the opinion that according to the Convention on the Conservation of Biodiversity, it is forbidden to introduce into a nature ecosystem species from other countries that are not characteristic of the ecosystem. None of the experts supported this idea: the proposals to introduce new elements concerned only species that inhabit in Armenia and are, in most cases, endemic for the country. After a discussion, the experts drew the conclusion that the ecosystem should be restored in a form that is the closest to the form in which it used to exist. After it has been restored (in other words, after more or less sustainable communities have been formed), it may be possible to try to introduce some endemic species of animals and plants, provided that all the possible measures of caution be implemented (for example, plants should be grown on very limited space - their behavior should be monitored, or one could try to introduce some rare species of insects).

A question that was discussed more intensively was related to the surface area of the Lake to be restored. Naturally, all the experts recognized the fact that the smaller the territory to be alienated, the fewer the different obstacles faced by the project. This is why the following consensus was proposed: to determine the minimum surface area that would facilitate the fullest preservation of biodiversity. Requirements were expressed from the viewpoints of ornithologists, ichthyologists, botanists, and zoologists. The most acceptable option for the experts was that the level of the Lake would be at 1,915 m above sea level. In this case, the initial surface area of the Lake would be 586 hectares, while the maximum depth would be greater than two meters. This option satisfies the ichthyologists: the depth allows for the existence of all the fish that are of interest to us. It satisfies the ornithologists: the surface area of the Lake would allow to create conditions for various species of birds that need open water surface and relatively great depth, as well as sections covered by water-marsh plants. The botanists and zoologists did not object to this option, either.

As a follow-up to the previous question, the particularities of project implementation were discussed. Quite strict requirements were proposed in relation to the conditions (mentioned in reports of experts) for specific types of fauna. The option under consideration (altitude of 1,915 meters), the flowing capacity of water and the proposed hydro-engineering facilities meet the requirements of ichthyologists. From the point of view of ornithologists, it is absolutely necessary to create an artificial island in the Lake, as well as special shelters for birds, especially during the first few years (until thick water-marsh vegetation grows). The creation of a small island not too high above the level of the Lake would allow to create conditions for bats, which are an extremely active means of biological control of the quantity of blood-sucking insects. From a botanical standpoint, such requirements have not been set forth, because there is quite a large surface area, and the variations in depth would allow species with different ecological conditions to survive. This issue was resolved by means of setting out that when project implementation begins and the draft project

of engineering works is ready, the project of Lake territory design should be prepared. Its implementation must start parallel to the beginning of hydro-engineering works: according to an initial assessment, the cost of these works will not go above US \$10,000. In addition to this, all the experts have agreed that it is necessary to carry out monitoring of all the changes in the ecosystem, starting on the first day of implementing hydro-engineering works. The monitoring should cover not only all the biological objects, but also the abiotic objects nature, and primarily, hydrological. On the basis of this monitoring, measures on ecosystem management will be implemented.

The question concerning the need for planting forests also brought about debates. On one hand, the usefulness of forest plants providing protection (in terms of anti-erosion, reducing evaporation, increasing the variety of biotopes, allowing for additional economical utilization, etc.) is out of the question. On the other hand, forest plants are completely atypical for the ecosystem to be restored; they occupy additional space, require additional expenditures, could become a place of inhabitation for undesired animal species, and so on. Based on all of the foregoing, the proposal following the discussion is to plant forests in the frameworks of this project directly on the banks of the canals, using mainly bush species. Planting forests in more distant areas (in particular, in the watershed of River Masrik) should lead to positive results for Lake Gilli, as well, but obviously, its implementation should take carried out under a different project.

During the discussion, two inter-related issues were discussed: one of them related to the status of the future territory and the participation of the local population. All the participants of the meeting agreed that the restored ecosystem should generate revenues for the local population and improve their living. This is why the possibility of the creation of a reserve (in which any type of economic activity would be forbidden) was refused virtually immediately after it was proposed. The most interesting proposal was regarding the creation of a joint-stock company. This would have numerous advantages, such as the possibility of involving the local population, generating revenues, managing the territory well, and others. However, there are a number of disadvantages, as well (most of them could be removed by approving an appropriate charter for the joint-stock company). Nevertheless, one should consider that this issue is absolutely raw in terms of its economic and legal aspects. It was proposed that the adoption of a decision on this issue be postponed until a legal opinion is given. The following conclusion was drawn in relation to this issue: from the viewpoint of attracting the local population and preserving a high level of biodiversity, the creation of a joint-stock company could be the optimal scenario. However, at the initial stage of project implementation, the proposed status of the territory in question could be that of a reservate, with its possible later reformation into a state joint-stock company.

The question on the possible utilization of the territory and economic activity on it practically did not raise disagreements. Everyone agreed that it any activity is possible if it does not hurt the biodiversity, in the first place. Specific proposed actions were approved (with the exception of the artificial breeding of Mollusks; it was proposed that marketing research be carried out in the future to discover more prospective scenarios. In terms of conservation the biodiversity and supporting the sustainability of the ecosystem to be created, the priority should be given to activities aimed at facilitating the control of the quantity of the population of several species (for example, catching crayfish, collecting reeds, etc.).

A major discussion took place concerning the possible utilization of sand-pits near the Lake. It was proposed that they be changed into fish-breeding ponds (the owner of the sand-pits has given his agreement to this). This action would surely be beneficial. It would create conditions for breeding and restoring the quantity of endemic species of fish, with their further emission into the ecosystem to be created. This would generate additional revenues. Using the water flowing out of Lake Gilli in artificial ponds would allow to clean the water from a surplus of organic substances before it is transferred to Lake Sevan. Moreover, taking into consideration the large surface area of the aforementioned sand-pits, a part of them could also be used for artificial breeding of certain

waterbird species. However, the implementation of this measure faces quite heavy obstacles. First of all, there is no precise data on the geological structure of the territory in question; there is no trustworthy information on whether there is a water retaining horizon here. According to the geological map of the territory, there are only sand substrates here. In this event, before it is filled with water, special water retaining measures should be implemented. An advantage is that in Armenia, there is vast experience of such measures, which have been implemented during the construction of most of the artificial reservoirs. Another aspect is the need for construct an additional canal for the water to be removed from Lake Gilli into artificial ponds, and later, into Lake Sevan. Some water losses (due to evaporation and filtration) are possible here, as well. Additional research is necessary to assess the likelihood of the implementation of this measure and to measure its cost. This is why it was decided that this measure will not be included in this project; other sources of funding will be sought, provided that this measure be considered a separate project that is related to the one in question.

The other questions raised in the meeting did not lead to discussions, because they were related to purely technical aspects of project implementation. Moreover, the geological, hydrological, and hydro-geological aspects had been discussed and approved earlier, and when the hydro-engineering project was being developed, it was only checked whether the conditions necessary for biodiversity conservation (primarily, for fish and birds) are implemented.

5. A description of the engineering work needed to restore the lake

Hydro-technical structures regulating the flows of River Masrik and Lake Gilli

In order to remove the flood waters of River Masrik without impediments and to provide for the minimum environmental output, as well as to resolve the water issues related to the rehabilitation of Lake Gilli and to provide for its normal water circulation, the project intends to make structures of intake wells and drainage with appropriate fishways and watertight facilities in the bowl.

An intake well and drain with a fishway would be required on River Masrik.

In order to transfer a part of the water from River Masrik to Lake Gilli, a complex of intake well and drainage structures is designated in the section where the old and new currents separate. The complex would include:

A narrow spill way with an arch dam in series, in the form of a fishway;

- intake well double-transit gallery with regulative splash-boards; bank-protection and channel restorative facilities;
- Restoration of prefabricated ferroconcrete facing drainage slabs.

Based on the category of construction, the maximum amount of drainage is foreseen in correspondence with the 1% safety exit of the River – 42.6 m³/sec.

A part of the calculated output (37.0 m³/sec) is intended to be transferred by means of a water drainage fishway to ensure the permissible speeds on the dam in the range from 1.7 to 2.3 m/sec; considering the relief of the territory, the width of the water drainage fishway is foreseen as 10 meters.

At the same time, considering that the 97% security outflow of River Masrik is about 2.14 m³/sec, it is designated to allow 1.0 m³/sec in the old current and 1.14 m³/sec in the new current to provide the minimum conditions for the passage of fish in the end section of the old and new currents of River Masrik. The same outflow for average long-term purposes would be 4.14 m³/sec, and correspondingly, 2.14 and 2.0 m³/sec.

Considering the existing conditions and the normative documents on fishway, the technical parameters of the fishway are calculated.

The structure of the water drainage fishway is that of a multistage spillway.

Considering the flight height determined for trout ($h=0.45$) and size of the pond (2.5×4.5 m), the hydraulic parameters of the structure are calculated (Appendix d2).

To protect the sections leading towards and removing from the water drainage fishway from wash-outs, bank-protection and channel restorative activities are designated in the form of concrete dams and harbion layings (charts d2 and d3).

In order to regulate the outflow to Lake Gilli, an intake well is designated with a maximum outflow of about $13 \text{ m}^3/\text{sec}$ and a minimum outflow of $1.0 \text{ m}^3/\text{sec}$. The intake structure is a double-transit gallery with regulative splash-boards, size $1.7 \times 2.0 \times 12$ m, and a cushion pool. Considering the fluctuation in the outflows of the intake structure, splash-board valves are designated in its entry section.

A preliminary assessment of the maximum capacity of the designed hydro-structure has been made, which corresponds with the 0.1% security outflow of River Masrik, $42.6 \times 1.51 = 64.3 \text{ m}^3/\text{sec}$.

The hydraulic parameters of the water drainage fishway and the intake well designated on River Masrik for the minimum and maximum outflows are brought in appendices d2, d3, and d4.

The project also stipulates the reconstruction of the façade of the canal leading to Lake Gilli, for a length of 1.5 km, equal to 10% of the volume.

Drainage structure of Lake Gilli

The drainage structure is designated to be in the section where the old current of Lake Gilli and the road from Norakert to Tsovak intersect.

After Lake Gilli has been filled with the projected volume of water, it is possible that extra waters flows in during flooding ($12.8 \text{ m}^3/\text{sec}$), which would create a post-transformation additional outflow of $0.85 \text{ m}^3/\text{sec}$ and a spillway layer of 19 cm (appendix d7).

In order to remove transformed atmospheric and surface waters from the territory of the Lake, a drainage fishway in series is designated in the bridge section of the road connecting Norakert and Tsovak.

The structure of the drainage fishway would include:

- A spill way with an arch dam in series, in the form of a fishway;
- Bank-protection dams; and
- Regulatory equipment for the purpose of emptying the Lake.

Based on the water capacity of the existing bridge, the width of the water drainage fishway is designated to be 6 meters, which would provide for the removal of $12\text{-}15 \text{ m}^3/\text{sec}$ additional output and would create conditions for the operation of the water drainage fishway (charts d4 and d5).

The parameters of the water canal-fishway are chosen in accordance with the structure of the intake fishway well, to meet the hydraulic criteria concerning the maximum outflow and the designated norms (appendix d5).

In order to provide minimum outflow for the River when it is necessary to empty Lake Gilli in extraordinary situations or to fill it, 2 valves are designated in the side dams of the drainage fishway, each with a maximum water capacity of $2.0\text{-}2.5 \text{ m}^3/\text{sec}$.

Activities in the bowl of Lake Gilli

In order to reduce water losses from the bowl of Lake Gilli and to ensure its environmental protection process, it is designated:

- To remove the collection-drainage and irrigation canals from the bowl, provided that the waterproof clay and clay-sand layers are restored;
- To re-cultivate the sand-gravel mines that have emerged in the territory of the bowl;
- To remove all types of communications;
- To design the territory of the bowl and to remove vegetation from the territory;

- To implement measures to block the inflow of household waters into the Lake;
- To forbid the accumulation of household and construction garbage in the shore territories of the Lake;
- To implement bank-protection measures to protect the deformed slopes of the road in the section of the dam;
- To remove the bridge under the road following the bridge of the Norakert-Tsovak road, which cannot ensure the passage of expected outflows;
- To reinforce the current of the River under the bridge and within 10 meters following it.

In order to decrease water losses from the lake Gilli basin and ensure environmental protection it is planned:

- To cover collector-drainage and irrigation channels constructed on the territory of the basin, so that the clay and clay-sand water-rejecting layers are reestablished.
- To cover sand mines created on the territory of the basin.
- To cover all sorts of channels.
- To take measures for stopping the sewerage from pouring into the lake.
- To ban the accumulation of municipal and construction waste on the embankments of the lake.
- To take measures for the protection of road foundations made of sand from erosion and other negative influences.
- To remove the bridge constructed under the passage after the Norakert-Tzovak road, which does not have the capacity for designed flows.
- To reinforce the river bed under the bridge and 10 meters after that.

6. Economic evaluation of the different alternatives for a 10 and 25 year breakdown of benefits, cost, initial investment, etc. that were used in the preparation of the economic analysis.

The assessment has been done based on the following options: (in all options the calculation has been done for the 586 ha planned in the 3rd hydro-technical option) (also see attached Excel files):

a) According to legal-organisational status of management:

- Commercial organisation
- Non-commercial organisation

b) According to possible scenarios:

- Best option, when economic benefits are calculated for the entire volume of work, and expenditures (with the exception of expenditures related to the installation of hydro-constructions, restoration of biodiversity and monitoring), particularly compensation for land, for the lowest possible volume;
- Average option, when economic benefits are calculated for 75% of the volume, and expenditures (with the exception of expenditures related to the installation of hydro-constructions, restoration of biodiversity and monitoring), particularly compensation for land, for 2 to 5 times more than the lowest volume;
- Worst option, when economic benefits are calculated for 50% of the volume, and expenditures (with the exception of expenditures related to the installation of hydro-constructions, restoration of biodiversity and monitoring), particularly compensation for land, for 3 to 10 times more than the lowest volume;

For the mentioned options, the following economic assessment standards are calculated:

NPV – Net Present Value (or benefits) for 10 years

EIRR – Economic Internal Return Rate, i.e. the selected percentage rate, in case of which NPV=0.

NPV calculations by option have produced the following results:

Present situation		Restoration options						Percentage rate
Land fertility unchanged	Land fertility decreases by 1%	Commercial organisation			Non-commercial organisation			
		Best	Average	Worst	Best	Average	Worst	
165354	154379	742639	752331	From 0 % NPV	From 0 % NPV	From 0 % NPV	From 0 % NPV	8 %
		953887*	87397*	becomes negative	becomes negative	becomes negative	becomes negative	
154240	144383	581376	From 9.58% NPV	From 0 % NPV	From 0 % NPV	From 0 % NPV	From 0 % NPV	10 %
		786334*	becomes negative 21 3745*	becomes negative	becomes negative	becomes negative	becomes negative	
144410	135526	443867	From 9.58% NPV	From 0 % NPV	From 0 % NPV	From 0 % NPV	From 0 % NPV	12 %
		642847*	becomes negative	becomes negative	becomes negative	becomes negative	becomes negative	
			From 10.7%* NPV becomes negative					

* without expenditures for biodiversity restoration (240000\$)

EIRR calculations by options have produced the following results (in %):

Restoration options						
Commercial organization			Non-commercial organization			
Best	Average	Worst	Best	Average	Worst	
22.04	9.58	0	0*	0	0	
10.31	4.73	0	0	0	0	Not including indirect expenditures
28.8	10.7	0	0**	0	0	Not including expenditures for biodiversity restoration

Analysis of the above-mentioned data shows that:

1. Economically, the project of restoration of the lake is generally beneficial, since it ensures a significant monetary growth of net economic benefits:

- In case of commercial organisation up to US\$ 27,511.1 thousand;
 - In case of non-commercial organisation up to US\$ 109.1 thousand.
2. Economically, as regards to the management system, the commercial organisation option is preferable, which assumes permission of economic activities in areas in question. In this option, implementation of commercial projects (fishery and other possible activities) are highly profitable and preferable. In case of fishery, even in the worst option the IRR=21.86%, and in the best option the IRR=41.85%. With a small amount of investment, in 4-5 years time it is possible to have US\$ 75-190 thousand net annual income.
 3. As regards to expenditure assessment, the most sensitive issue for the implementation of the project is the payment of compensations related to land use. These payments can amount to US\$ 28.7-832.4 thousand, which can substantially influence the beneficialness of the project.
 4. The other expenditures, which have a significant effect on the net benefits of the project are expenditures related to the restoration of biodiversity and monitoring. They can constitute 36.8% and 24.6% of non-commercial investments.
 5. The other expenditure, which has a significant effect on the net benefits of the project is the expenditure related to the management of the area.

In purely economic terms, the implementation of this project will provide possibilities for job creation in the given areas of Gegharkunik region, which are in unfavourable socio-economic conditions, for example in case of the commercial organisation: 115 jobs with an average monthly salary of US\$ 100 for 25 years, and in case of US\$ 50 monthly salaries twice more: about 230 jobs.

7. Report with a description of the communities affected (negatively and positively)

Near the area of what used to be Lake Gilli, there are several villages (Norakert, Larger Mazra, Smaller Mazra, and Tsovak), which represent typically agricultural firm socio-ecosystems with their characteristic features (backyards, cattle-yards, agricultural lands, pastures, etc.). Currently, the connection of the socio-ecosystem with the ecosystem of former Lake Gilli is a simple and direct one: the area of the former Lake is utilized by the population of the villages for agricultural and pasture purposes. The socio-ecosystem is characterized by a low socio-economic standard of the population. The poor harvests determine low revenues. The general socio-economic and energy crisis in recent years has also left a negative impact on the living standard of the people here.

The implementation of this project is considered by the population to be one of the factors that could facilitate an improvement of their living standards. From the point of view of the people living in the villages nearby, the implementation of the project on the rehabilitation of Lake Gilli would help improve their socio-economic condition and bring about a general improvement in the stability of the socio-ecosystem. First of all, new jobs would be created in the process of project implementation (labor force to be utilized during the construction of various engineering structures). Second, after project implementation, they would have the opportunity of working as service staff. Third, it would be possible to fish, hunt for birds, edible plants, and other bio-resources. And finally, the yield of agricultural land near the Lake would increase (due to better irrigation and the restoration of springs that have dried out, which would help improve the water supply to the villages). The agricultural land that individual farmers would lose in the territory of the surface of the former Lake could be compensated for by means of land in neighboring areas that are no different.

Thus, the results of the study show that the main negative consequence of project implementation for the local population would be the loss of privatized and rented land, which would be in the territory of the Lake to be restored. In order to solve this problem, it is necessary to provide equivalent land parcels (as a compensation) from the State reserve fund, as well as provide the farmers with fuel, seeds, privileges, and support in implementing agricultural activities. Another

negative consequence of restoring the Lake could be the complete change of the environment in the villages near the Lake to be restored. In particular, hearths of blood-sucking insects could appear, which would leave a negative impact on the moral condition of the people here. In order to solve this problem, the project designates the implementation of biological methods of insect quantity control.

The majority of the population is interested in the implementation of the project; as an input to project implementation, they propose various equipment and their own labor.

8. The type of political government in the project site (communities, regional government, etc.), and also a description of the work done with the governmental authorities and communities during the PDF-A.

The territory of Lake Gilli to be restored is in the Gegharkunik region, which is governed by a local administration. The head of the local administration (the “marzpet” or the Governor) is appointed by a decree of the Prime Minister. Currently, the Governor of the Gegharkunik region is Mr. Vahagn Hakobyan. The city of Vartenis, headed by Mayor Volodya Kheloyan, is quite close to the Lake. Moreover, the territory of the Sevan National Park is immediately near the territory of Lake Gilli (the director of the National Park is Mr. Lyova Tovmasyan).

During the PDF-A stage, national experts (on both public relations and other areas), the representatives of the UNDP and the GEF have had meetings with the government of the region, the management of the city of Vartenis and the Sevan National Park. During the meetings, the project, its importance for the basin of Lake Sevan, the region as a whole, and the local population were introduced to them. Meetings were held with the following officials:

1. Vahagn Hakobyan – Governor of the Gegharkunik region;
2. Rafik Grigoryan – Deputy Governor of the region;
3. Derenik Simonyan – Head of Agricultural Department of the region;
4. Hambartsum Hambartsumyan – Head of Environmental Protection Department of the region;
5. Arevshat Baghdasaryan – Head of Land Allocation Department of the region;
6. Ashot Grigoryan – Representative of the Governor in the Vartenis region;
7. Volodya Kheloyan – Mayor of the city of Vartenis;
8. Hamlet Gasparyan – Chief Architect of the Vartenis region;
9. Vazgen Barseghyan – Chief Land Allocation Expert of the Vartenis region;
10. Lyova Tovmasyan – Director of the Sevan National Park
11. Gnel Khecheyan – Chief of the Vartenis section of the Sevan National Park; and
12. Samvel Mkrtchyan – Representative of the “Haykoop” in the Vartenis region.

At all the levels of management, assurance was given as to their support and help during project implementation. When discussing the possibility of project implementation, the government of the region mentioned the following likely obstacles:

- The problem of land alienation: it is possible that the owners disagree to give up their land;
- If the owners agreed, the form and sufficiency of the compensation would be unclear;
- Problems related to the payment of taxes on ownership;
- The access of the local population to and their participation in the utilization of the Lake to be restored;
- The availability of long-term rental of the land of the State reserve;
- Objections of the leaseholders to receiving compensation; and
- The problem of changing the category of land from agricultural to nature-protect.

However, a lawyer has provided his expert assessment stating that all of these problems could be solved.

Near the Lake to be restored, there are three villages: Norakert, Larger Mazrik, and Smaller Mazrik. The privatized land in the territory of Lake Gilli belongs only to the villagers of Norakert.

The leased territory, as well as the Lake to be restored are possibly of interest to the villagers of the three aforementioned villages, as well as those of villages Tsovak, Geghamasar, Vanevan, Khachakhpyur, Lusakunk, Karchakhpyur, and Torfavan.

During the PDF-A stage, numerous meetings were held with local government officials, the heads of regional departments, and the seniors of the communities of the villages. During the meetings, these people familiarized themselves with the rehabilitation program of the Lake, discussed the problems that would emerge during its implementation, the forms of participation of the organizations, enterprises, and the population of the nearby communities in the rehabilitation activities and the activities to preserve the ecosystem of the Lake, as well as the prospects of economic development of the region and the local communities due to the emergence of new types of business activities, and increasing the level of employment.

Meetings with the following heads of village communities were conducted:

1. Garik Hakobyan – Head of the Community of the Tsovak village;
2. Vahram Mkhitaryan – Head of the Community of the Norakert village;
3. Noravand Argoyan – Head of the Community of the Geghamasar village;
4. Gagik Saroyan – Head of the Community of the Smaller Masrik village;
5. Norayr Harutyunyan – Head of the Community of the Vanevan village;
6. Hakob Gaboyan – Head of the Community of the Khachakhpyur village;
7. Khachik Khachatryan – Head of the Community of the Lusakunk village;
8. Taron Kocharyan – Head of the Community of the Karchakhpyur village;
9. Aharon Khachatryan – Head of the Community of the Torfavan village; and
10. Rafik Hunanyan - Head of the Community of the Larger Masrik village.

Moreover, numerous meetings with the seniors and the population of the villages were held; general meetings with the inhabitants of the villages were held. The majority of the local population approves the implementation of the project and offers support in the implementation (first of all, free of charge utilization of various construction equipment is offered: a list of the equipment is available).

9. Detailed budget

(Another attached file)

10. Results of the survey covering the communal lands

The results of a sociological survey of the local population (inhabitants of the Norakert village, which own or rent land in the territory of the former Lake Gilli) have been received. The survey covered a total of 190 people. 11 of them are only owners of land, 48 people both own and rent land, 54 only rent it, and 77 do not have land in the territory of Lake Gilli. All 77 of the people that have no land support the rehabilitation of the Lake and have a positive opinion concerning the implementation of the project. 13 of the people that either own or rent land expressed a negative opinion on the implementation of the project. The surface area of the privatized land owned by these 13 people is 4.9 hectares, and that of the rented land is 20.5 hectares. Of these 13, 8 are only renting land, while 5 people both own and rent land. Of the 13 people that expressed a negative opinion concerning the project, 5 would agree to receive land compensation in case of project implementation; 1 person mentioned that he would like to receive money, and 7 people expressed their interest in entering a joint-stock company (an interesting aspect of mentality is involved here: a person is against project implementation, but agrees to enter a joint-stock company). All the others expressed a positive opinion on the implementation of the project. Of the 46 people that only rent land and expressed a positive opinion, 43 are willing to enter a joint-stock company, while 3 wish to receive land compensation. Of the 11 people that only own land and expressed a positive opinion,

10 wish to enter a joint-stock company, and 1 person wishes to receive land compensation. All the 43 people that both own and rent land expressed their willingness to enter a joint-stock company.