GRAVEL PIT RESTORATION AND ASSOCIATED LAND USE CHANGE IN THE JARAMA RIVER VALLEY (MADRID, SPAIN)

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ABSTRACT

It is described and analysed the restoration proposal of a property placed in the Jarama river valley, where the available mineral resource (gravel) is tried to exploit. The general geohydrological structure in this zone reveals a hydraulic connection between the water of nearest Jarama River and the groundwater alluvial aquifer placed in the exploitable materials, as well as closeness of phreatic level to the land surface in this area. All this makes unavoidably the appearance of new free water surfaces.

As soon as the aim is to minimise the final free water surface and to use only the materials proceeding from the exploitation rebound for the restoration. The final aim is to restore those areas of the property with less gravel thickness as emerged areas. In those areas, most of the rebound materials would be used, maintaining as lagoon areas those with bigger gravel thickness to exploit. Therefore, that surface could be reduced to less than a third of the total surface of the sought exploitation, distributed into three lagoons easy to be naturalised.

The two third parts of the land surface to be exploited could be able to return to the traditional agricultural use. However, it is possible to change the global use of the property, liable now to make a recreation area, taking into account the proximity of recently urbanised residential areas in the zone, as well as the shortage of this kind of land in the same. The proposed restoration can be considered as an available alternative for the retrieval of other similar sites affected by the same problems, all included in the framework of the regulatory pertinent decrees in the protected area commonly known as "Southeast Regional Park", where the above-mentioned property is placed.

INTRODUCTION

The operation of barren in alluvial fertile valleys causes there at least the modification of environment where the mining activity takes place, being this modification in many occasions synonymous of degradation, as a result of nonexistent or mistaken activities of recovery of the affected area.

The fertile valley of the Jarama river in its low sector can e considered like paradigmatic of the extractive activities of barren in alluvial fertile valleys, due to the facility of operation of the substratum, to the good quality of the barren one and to the remarkable tickness that the deposit presents -although often located to a large extent below the phreatic level-, which makes its operation very profitable. The proximity of the mining area to great population centers between which it emphasizes Madrid and its metropolitan area, with a demand every greater time of this kind of materials and a good road infrastructure in the region for the transport of such until the consumption points, are other factors that have contributed to that this region is formed like one of the most affected by this type of mining activi-

ties of our country. The importance of the extraction of barren in the study area sustains in numbers such as a volume of annual operation around the 15,500,000 metric ton, with considered income of about 15,000 million pesetas.

It has caused the appearance of numerous gravel pits scattered by the zone, in some cases left without a minimum previous management and, in others, with an inadequate processing. Since the substratum to explode is constituted by deposits of fluvial origin, that as well constitute a good aquifer one as much by their hydrogeological characteristics as to be connected hydraulically with the river. The phreatic level is placed near to the topographic surface in many locations already operated or susceptible to be it, because the gravel operation has generated the appearance of numerous residual lagoons – gravel pit lagoons- whose water surface must be considered like the manifestation of the phreatic level where generate.

To all previously said it is added that the zone selected for this study is in its totality integrated within the Regional Park around the axes of the low courses of the Jarama and Manzanares rivers (commonly known like Southeast Regional Park), being this one of the arguments most important to consider in the processes of operation like in the restoration workings in the future. Nowdays any project of gravel operation that sets out in the zone, must take built-in the consequent project of restoration of the quarry (B.O.E. 1982, B.O.E. 1986, and B.O.E. 1986), as well as the protective and corrective measures that will be taken to reduce to the maximum the environmental impact that, unavoidably, causes the extractive activity. The restoration alternatives that are watched like more are those in which as only materials used to carry out them are the sterile ones coming from the own operation (ITGE, 1994). Under this perspective, when the gravel extraction is made below the phreatic level, the restoration of affected area must assume the unavoidable permanence of gravel pit lagoons (ITGE, 1995) and, therefore, the change of the original use of the totality or at least of a part of the operated territory.

In this work it is presented the restoration model of restoration proposed for a property of medium dimensions located in the central sector of the Southeast Regional Park in which the operation will be carried in its practical totality below the phreatic level. The model that is described contemplates solely the use of the sterile ones generated in the own operation, proposing for the property a global change of land use. The recovered area would become this way a wetland that it could as well be used as a ludic area for the towns nearest to the property.

LOCATION

The property at issue is located in the physiographyc domain of the fertile valley from the Jarama river to its passage by the municipal term of Rivas-Vaciamadrid (Madrid) (Figure 1), giving rise to an open landscape with a current residual agricultural use, favoured this by the facility to accede to the water and the well support that form the fertile valley lands which configures the immediate substratum of the property. The landscape, intensely humanised and with a whole domain of the horizontal lines, outlines the gypsum slope of the right bank of the Jarama river, that forms its scenic bottom, besides to act like hardware of the peculiar birds that find well conditions of insolation and security to nesting.

The mentioned property constitutes an estate of not much extension but that can play an interesting role in the environmental management of the municipal terms of Arganda and Rivas Vaciamadrid. Belonging, however, to this last term, the territory of the property an outstanding location like area of playful and sport expansion of the population of Arganda glimpses to him. Also, the remarkable expansion of the urbanization in Rivas Vaciamadrid could find here a ludic area that is demanded every time with greater intensity the population.

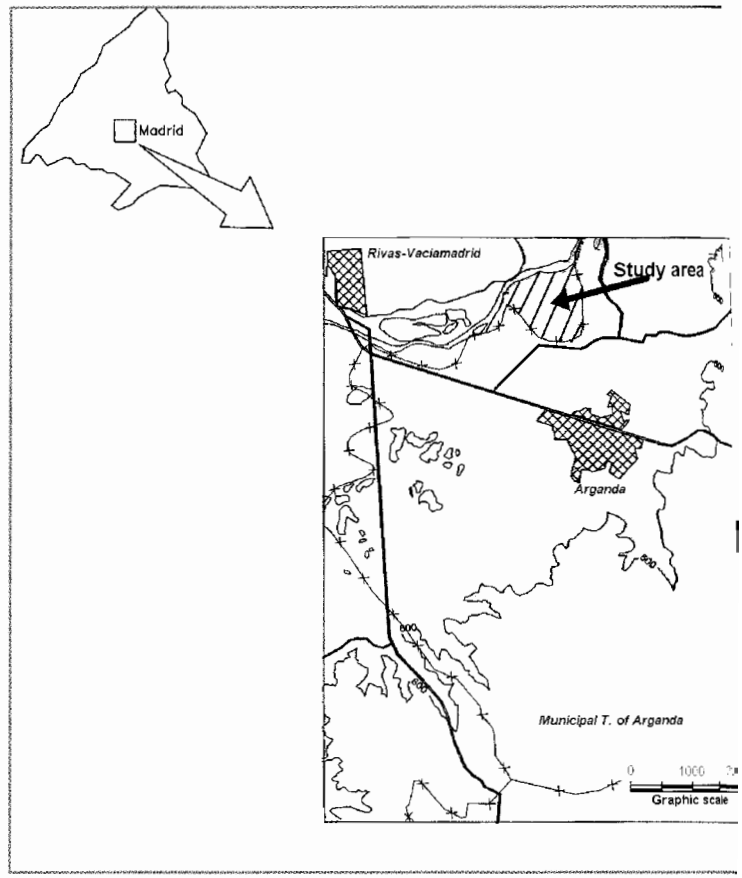


Figure 1. Location map.

The substratum of the property is dominated by two main lithologyc kinds of different nature and age (Martínez et al, 1996): of a side, the quaternary materials corresponding to the flood plain and terraces of the Jarama river,are this is, gravel and polygenic stones, sand and siltclay sands; of another one, the gypsum and gypsum marl of Miocene, on which is developed the important slope that appears in the right bank of the Jarama river and that constitutes the bottom of the alluvial unit.

The quaternary materials constitute a remarkable aquifer joined hydraulically with the Jarama river, being the materials susceptible to be exploded.

METHOD

The object of the present work is to present/display the model of restoration proposed for a property of something more than 106 hectares of surface located in the fertile valley of the Jarama river, in which the operation of the barren one is predicted. This model considers starting off of the basic premise of the single use of the materials by ricochet obtained in the operation to undertake the restoration.

Considering that most of the deposit is arranged below the phreatic level, the propose restoration contemplates the permanence of three gravel pit lagoons that after their naturalisation will become a wetland.

Operateable natural resource

The deposit consists of a massive deposit of detritic materials of alluvial origin. From a geophysical recognition by means of vertical electrical soundings made in the property, can be inferred that its power is variable between three and seventeen meters, with an average power of nine meters. The agricultural soil layer has a variable thickness between one and five meters, amounting itself the average value between one and two meters. Most of the deposit is arranged below the phreatic level, that is located to a depth of the included/understood topographic surface between two and three meters.

The operation of barren in the property is considered in three concatenated phases in the time that would occupy ten years of extractive activity - the operation average annual is about 55,000 m^{3-}, distributed this in four years for the first stage, three years for the second and other three for third. The property is divided in the three zones that are in Figure 2 and which they are described next.

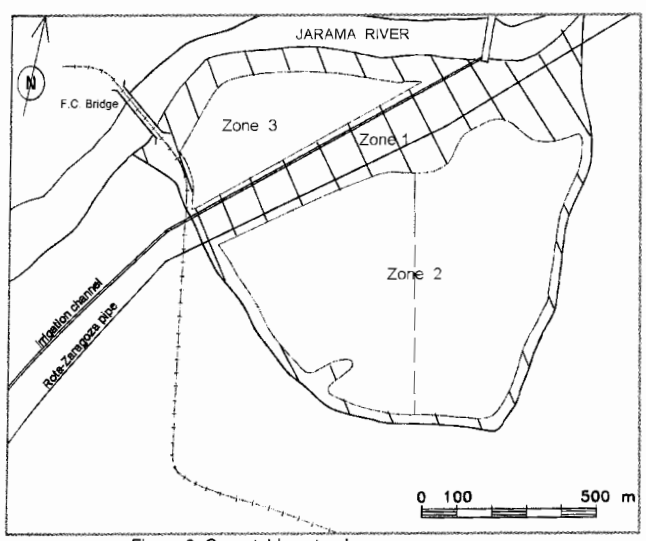


Figure 2. Operatable natural resource zones.

Zone 1.- Non alterated zone. The altered zone mentioned previously would not include a strip of fifty meters wide that such borders all the perimeter of the property and from the margin of the Jarama river constituting the perimeter of protection of the same one; a zone of approximately 20,000 m^2, located to the west of the property, whose thickness is smaller of five meters; and, finally, a zone in the middle of the property that will constitute a corridor nonaltered that divides the property in two operated subsectors, in which a irrigation chanel is conserved intact, as well as the Rota-Zaragoza pipe line that happens through the same one.

Zone 2.- Operated zone, whose total surface is of 565,000 m^2. In this zone the 2 first phases of the three will be developed in which it is going away to divide the operation of the barren one.

Zone 3.- Operated zone whose total surface is of 134,000 m^2 (13,4 Has). In her the third stage of operation will be carried out.

Natural resource is considered all the obtainable of the operation of barren, which only implies to consider that one that is in zones aforementioned 2 and 3, not considering, therefore, the pertaining one to zone 1 not being operation object. The util reserves have calculated considering a total surface of operation of seventy hectares and supposing a maximum depth of performance of eleven meters, as well as considering a thickness of soils of two meters. These reserves are amounted in about 5,500,000 m^3, considering that the average thickness of the operateable resource is of eight meters in zone 2 and of seven meters in zone 3. The thirty six hectares remaining would stay like non operated area and, therefore, non altered, as it has been said.

The deposit appears with a vegetal earth covering, of an average power of two meters, as has stayed saying, that constitutes the support of the agricultural workings. These materials are sterile and they do not serve like barren, reason why they are destined to storing for its later use in the works of restoration of the operated zone or for the preparation of finished surfaces or.

Proposed restoration

In agreement with the alternative of proposed restoration, after the operation of the barren one and the pertinent works of restoration, the territory of the property will appear discretizado in the four types of subspaces that are in Figure 3.

A non affected area, integrated by a strip of approximately 50 meters in width, drawn up parallelly to the course of the Jarama, as well as a strip of about 100 meters in width that crosses the property of the Northwest to Southwest and that protects the zones where locates the pipe line and the irrigation channel. Also zones non affected as well are considered the 50 meters that limit with the adjacent property and the zones where the thickness of gravel is inferior to 5 meters.

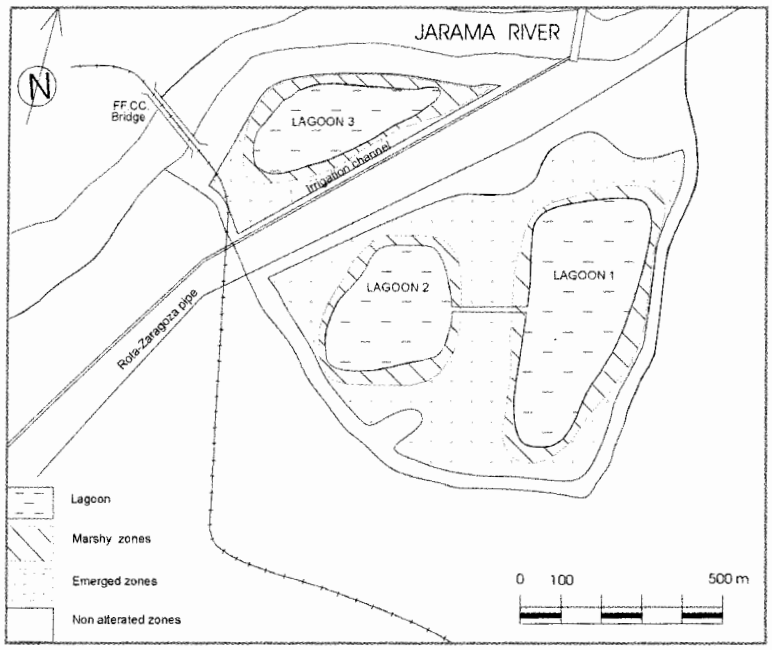


Figure 3.

An emerged area, integrated by that territory in which the wall of the operateable formation is arranged until a depth non superior to 6-7 meter below the phreatic level in the present circumstances. In such areas a filling with sterile derived from the operation or by the materials of rebound of the processing plant will be made, and they would be emerged permanently.

Three lagoons located in those areas in which the thikness of the graveldeposit is arranged to a depth superior to the 8 meters with respect to the average position of the phreatic level in the present circumstances. About such zones one does not think to carry out none type of filling, staying as flooded areas.

Marshy zones, located in which the thikness of the gravel deposit is arranged between 7 and 8 meters of depth below the phreatic level in the present conditions. In such areas a partial filling with the materials aforementioned will be made, so that the ceiling of stuffed saying is located to a depth between 0.5 and 1 meter below the present phreatic level. These zones would be located around the three lagoons.

The viability of the proposed model is justified on the basis of the volume of sterile available and to the surface recovering (ITGE, 1994; Ayala 1997). Table I (Martínez et al.; 1996) shows volumes necessary to undertake restoration proposed, in that in addition to the described zones the necessary volume for the construction of a slope around all the perimeter of the lagoons has considered; this last one is crucial to guarantee the stability of the edges of the lagoons (ITGE, 1995). This slope would be located including part of the recovered zone and part of the marshy zone and whose slope of the same one is 1v/4h, being v the height of slope and h the length of the same one.

The quantification of the usable material in the restoration has taken place considering that of the total of the resource extracted between 25 and a 30% are rebound materials (E.T.S. Ingenieros de Minas, 1994), which would throw a volume between 1,365,000 m^3 and 1,637,000 m^3 usable in the restoration (Martinez et al.; 1996). In addition, there are 1,400,00 m^3 of soil susceptible also to be used in the same one. Therefore, the total volume available for the restoration is considered to between about 2,800,000 m^3 and 3,000,000 m^3 as opposed to the 2,500,000 m^3 necessary for the proposed restoration, which guarantees the viability of the same one.

RESULTS

The operation barren and restoration will form a new landscape of wetlands for whose description the fictitious images obtained by a process of digital adjustment of images whit AUTOCAD code and ADOBE PHOTOSHOP code have been used. Themselves try to visualise the future landscap of the property once they have concluded the extraction tasks and, mainly, those of restoration of the affected area by those.

Zones		v (m)	h (m)	p (m)	Surface (m^2)	E_m full up (m)	V_T Restoration (m^3)
Emerged zones		--	--	--	306,000	5.5	1,683,000
Marshy zones		--	--	--	115,000	4.0	460,000
Slopes	Lagoon 1	8	32	1,280	128	--	163,840
	Lagoon 2	8	32	860	128	--	110,100
	Lagoon 3	7	28	930	98	--	91,140

Table 1. Necessary volumes for the proposed restoration (modified of Martínez et al., 1996).

The stage of operation 1 will tolerate the performance on an area of 304,000 m^2, which will generate a lagoon surface f 139,000 m^2 and one 115,000 m^2 recovered zone elevated one meter over the position of the phreatic level, as well as a marshy zone that will trim the lagoon. The stage of operation 2 will tolerate the performance on an area of 261,000 m^2; after the restoration phase, will be formed a lagoon of 78,000 m^2 of water surface, as well as a recovered zone of 152,000 m^2. The stage of operation 3 will tolerate to act on a surface of 134,000 m^2, that will entail the configuration of a free water surface of 61,000 m^2, as well as a recovered zone of 39,000 m^2 surrounded by its corresponding marshy zone. Finalised the restoration approximately 60% of the total surface of the property it will stay as emerged zone, remaining 40% rest like free water surface, although distributed in three lagoons.

This model has considered, also, the importance that has the naturalisation of the created wetland, which is favoured by the creation of marshy zones around the lagoons. It allows the fast colonisation of the borders of these lagoons by riverside vegetation, being able as well to become authentic biological reserves given the homing of the aquatic birds towards these wetlands derived from the human activity (M.O.P.U., 1991).

Figure 4 show the aspect that could have the property after the restoration. One imagines, also, the maintenance of a certain agrarian activity, with the intention of maintaining the circuits of feeding of the existing biotic communities in the surroundings, and that

depend on the agricultural activity. It has been wanted to represent, also, a certain revegetation of the territory recovered with the riverside native species and whose scheme is in figure 5.

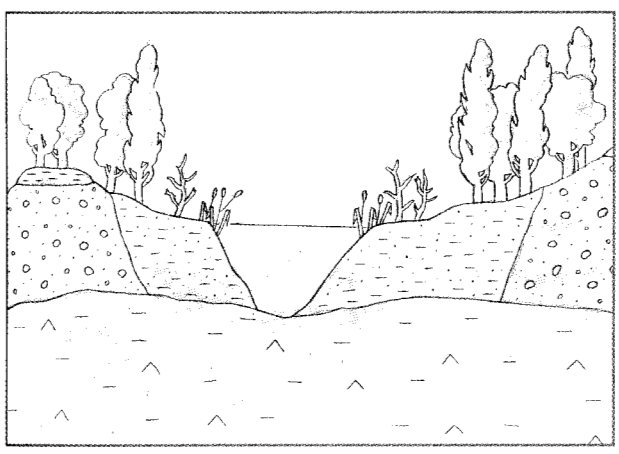
Figure 4.

CONCLUSIONS

The operation of barren in alluvial fertile valleys entails the modification of the natural landscape in the zones where it takes place. In many occasions this modification also tolerates the change of the uses of the ground.

When the operation of barren takes place below the phreatic level they appear gravel pit lagoons whose surface can be considered like the manifestation of the phreatic level in the zone. If the restoration of the affected spaces is conceived exclusively from the materials by rebound of the own operation, the proposed solutions happen inevitably through the consideration of the permanence of gravel pit lagoons. In these cases, the viability of the proposed restoration must be sustained in a study previous and precise of the material available to confront it as well as of the areas to recover.

The model of restoration proposed for a property of medium dimensions considers like only usable materials coming from the rejection of the operation, that supposes between 25% and 35% of the operated total volume. Also, the proposed model has tried to reduce to the maximum the free water surface, which has been obtained coming to the filling of those zones in which the thickness of the deposit is smaller, leaving like flooding zones those in which the thickness of the gravel package is greater. This way, finalised the restoration approximately 60% of the total surface of the property it will stay as emerged zone, remaining 40% rest like free water surface, although distributed in three lagoons.



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These recovered spaces are as well susceptible to become zones of leisure or observation of the nature of the neighboring populations. The property studied can this way play an important role like naturalised zone of relaxation of the populations of Arganda and Rivas-Vaciamadrid.

On the other hand, the proposed restoration can suppose an interesting via to facilitate the recovery of numerous sites of similar problematic in the Southeast Regional Park.

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