Sharing water: managing water use conflict and building relationships, the case of the city of Brazlândia - Descoberto Basin

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Summary
The city of Brazlândia, located in the Descoberto Basin, has approximately 54,000 inhabitants and stands out for being one of the largest horticultural producers in the Federal District. The city is supplied by the Capão da Onça, Barrocão and Bucanhão streams. Historically, in periods of drought, there are disruptions in the water supply to the city, resulting in the suspension of irrigation. The practice of negotiated allocation had the objective of mitigating the conflict over water use between irrigation and the water supply to the city of Brazlândia. The allocation of water, implemented in a participatory manner, assured the minimum flow required by the Water Supply Concessionaire in the catchment point without interrupting irrigation activities.

Keywords: water sharing; allocation practice; benefits sharing.

1. Introduction

1.1. Context of the region

The region of the Federal District and its surroundings is divided into seven water basins: Corumbá river, Descoberto River, Paranoá river, São Bartolomeu river, São Marcos river, Preto river and Maranhão river. In the western portion of the Federal District lies the Descoberto basin, which drains 12.5% of the area of the DF and its surroundings. This basin is divided into seven units of water management, whose main tributaries are the Descoberto River itself and the brooks Rodeador, Currais, Pedras, Melchior, Engenho das Lajes and Samambaia.

In 1974, the Dam of Descoberto River was inaugurated, which created a lake of 17 km² in area and capable of storing 102.3 hm³ of water. This reservoir is responsible for the supply of 60% of the population of Brasília. The lake of Descoberto River is located in the northern part of said Descoberto basin and its tributaries are the Descoberto River and the Rodeador, Currais and Pedra streams.

The Descoberto River, in turn, is formed by Bucanhão, Barrocão and Capão da Onça streams. These three streams, in addition to forming the Descoberto River, and consequently contributing to the supply of 60% of the population of Brasília, also supply the city of Brazlândia, which has approximately 54 thousand inhabitants.

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Brazlândia is close to the lake of Descoberto River and is supplied by the Brazlândia System, which comprises two surface catchment points (Figure 1). The first, at the Capão da Onça stream, is a gravity-fed system; and the second, at the meeting point of Bucanhão, Barrocão and Capão da Onça streams, has a run-of-the-river catchment. They are responsible for a production volume of 3,290,326 m^3 / year, according to data from the Plan of Integrated Water Resources Management – PGIRH. These three streams, after catchment point, form the Descoberto River.

Figure 1 - Water catchment points of the Concessionaire, to supply the city of Brazlândia.

The city of Brazlândia also stands out for having highly developed rural activites and for being an important producer of fresh food, one of the largest producers of vegetables and fruits in the Federal District. According to information from the Management Plan of the Environmental Protected Area Descoberto basin, in 2010, approximately 25% of the population of Brazlândia lived in the countryside. Some of the farmers in the region collect the water needed for their production from Bucanhão, Barrocão and Capão da Onça streams and from its springs and tributaries. Notwithstanding the catchment of superficial water, a significant number of producers have groundwater collection wells for irrigation. It is important to highlight that urban development in various parts of the basin has led to intensive growth in the number of wells for groundwater catchment, which also influences the availability of surface water, with the depletion of groundwater.

Thus, we determined the multiple uses of the springs of Bucanhão, Barrocão and Capão da Onça streams, which are responsible for the human consumption in the city of Brazlândia, and later the city of Brasilia, as well as for the water supply for agriculture (Figure 2).

In the dry season, as is to be expected, the conflict over water use intensifies, in a manner that, historically, during the dry season, there are interruptions at the water supply for human consumption in the city of Brazlândia due to decreased flow of these streams.

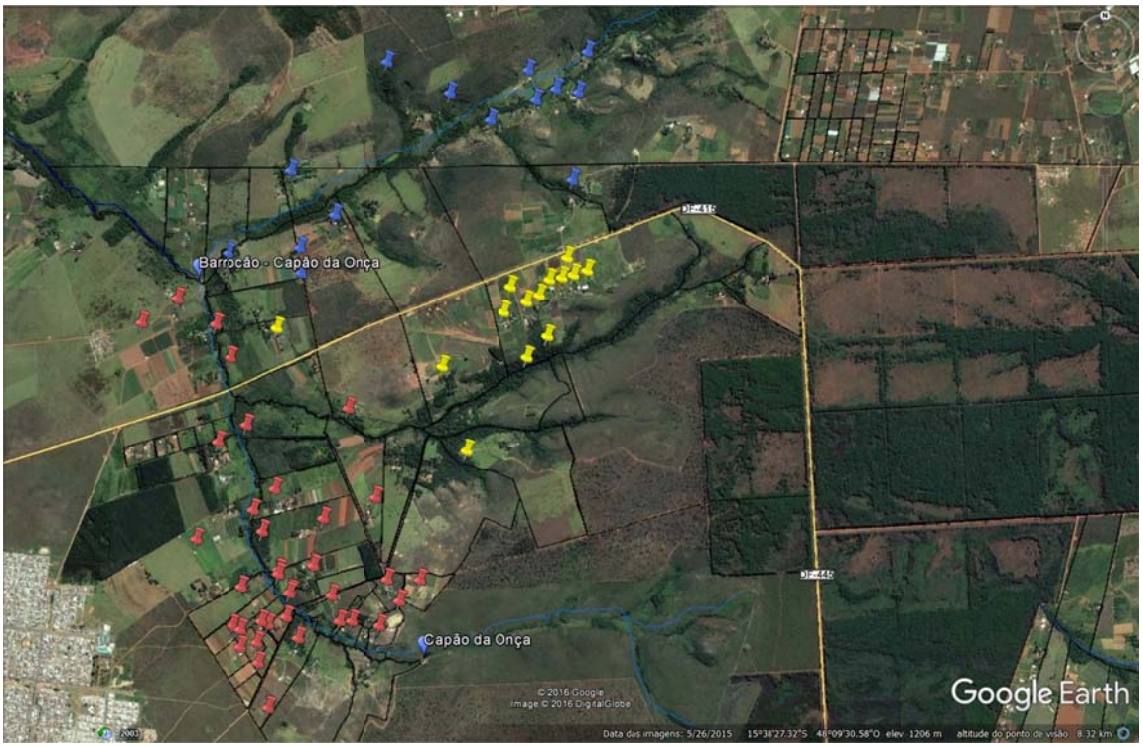

Figure 2 – Surface and underground catchment points identified in the region.

1.2. Negotiated allocation of water

In Brasilia, water demand has amplified significantly in past years due to economic development and increased population. Moreover, limited water availability is characterized by an inadequate geographic and seasonal distribution, which is insufficient to meet demand. This scenario calls for the implementation of water management tools. In this context, the allocation of water can contribute to a more efficient application of these management tools and may even be considered as a management resource.

With the implementation of new state and national water resources policies in the 1990s, the resolution of conflicts over the use of water in Brazil has become the subject of alternative models of water allocation and management, with participatory characteristics (Freitas & Lopes, 2007).

Water allocation is the establishment of rules for the use of water resources in order to carry out its distribution among users, for a certain period of time, negotiated between the government, stakeholders' representatives and users.

In this context, allocation mechanisms can be efficient management tools to discipline multiple uses in water systems affected by severe droughts, by

emergences or by a growing potential for conflict over water use. It is important to note that the National Water Resources Policy provides that, in shortage of water, priority to use is for human and livestock consumption.

A resource is efficiently allocated when it is used to maximize its value. A large number of different, and partly competing, uses can be evidenced for water - agriculture, human consumption, industrial use, tourism, leisure, aquaculture, etc. To achieve efficiency often means to make changes to how water is used, to reduce the used amount, to allocate and to reallocate it when needed.

Kelman and Kelman (2001) discuss four methodologies for water allocation between consumptive and non-consumptive users in situations where water demand exceeds water supply, i.e. in a rationing situation. In the so-called "wild" rationing, there are no pre-defined rules and the allocation begins upstream, favoring the best located users. In linear rationing, all users suffer rationing proportional to their demand in order to accommodate it to the water supply. In the chronological rationing, older users have priority in access to water. In the economic rationing, water access priority is given to the activity that generates greater economic efficiency, i.e., the activity that generates higher profits per unit of water, model proposed by Dinar et al. (1997).

The allocation process developed by the Regulatory Agency for Water, Energy and Sanitation of the Federal District (Adasa) is based on the users, and it involves the collective action of all stakeholders who are in some way affected by the allocation process (regulatory agency, users, public supply company, rural development companies, etc.). However, establishing property (or use) rights over water is a critical aspect of this process. The allocation focused on the users has the advantage of flexibility to adapt to different water uses and the high degree of public and political acceptability. Nevertheless, this process requires significant administrative and operational apparatus, in view of the need to monitor, simulate and conduct periodic revisions and discussions of previously negotiated allocation rules.

This allocation strategy is based on the principle of shared management, which aims to ensure transparency and credibility among its members, and to guarantee that water use rights are well defined and measurable, with an adequate knowledge of water availability. In this model, there is no property right over water, but the right to use water (Silva, 2004).

1.3. Water crisis in the DF, in 2016, and the Water Resources Enhanced Sharing Project

In 2016, the Federal District faced the worst water crisis ever recorded in its history. The Descoberto River Dam, the main reservoir of water supply for human population, reached levels lowers than 20% of its storage capacity. As a result, conflicts over water use have been established in several regions, mainly where the use for agriculture competes with the use of water for human supply.

In the Brazlândia region, as already mentioned, the conflict over the use of water and the interruption of supply to the city has happened frequently in recent

years. Knowing that, in 2015, Adasa created the Water Enhanced Sharing Project for the region. This project intends to implement water allocation actions in the basins that present conflicts over water, and establish parameters lower than those determined by law. In accordance with the Water Resources National Policy, processes have the participation of the government - Adasa – and of water stakeholders, particularly the concessionaire for public supply and farmers.

Measures proposed in this project seek to harmonize the multiple uses of water resources, by implementing technical studies and coordinating local users (monitoring committees), and to enable the regularization of water users with their registration and authorization to use the water.

It is a principle of governance applied to the management of water resources, in which Adasa assumes the commitment to promote actions to guarantee the supply of water with quantity and quality for human consumption, for irrigation, and for other uses that exist in the basin, as well as to ensure the environmental health of ecosystems that depend on the water bodies in the region.

2. Methodology

The Water Resources Enhanced Sharing Project has as a basic premise that the Regulatory Agency has knowledge over the water users in the basin, their location and their use of water - quantity, days and catchment schedules - and that there will be a subsequent formation of a monitoring group to follow the streams' flow by micro basin. The project, ideally, should follow several steps.

Initially, a project management commission is formed, with representatives from Adasa, the concessionaire (if a user of the basin) and the rural development company (Emater) as a representative of farmers, who use water for irrigation. It should be noted that the main uses of water in the Federal District, where the Project is applied, are public water supply and irrigation, with little participation of industrial use.

Subsequently, the management commission meets to define a schedule and an action strategy, dividing the project's interest region into smaller regions, defining the marketing strategy for registration campaigns and other necessary decisions.

Then, campaigns are carried out to register the authorizations for each region, according to planning, in order to know the uses of water in the basin. The registrations are sent to the technical area responsible for the analysis and release of authorizations, in Adasa, that evaluate them and grant the right to use water.

After registration campaigns, meetings are to be held with all the users of each region, to level the knowledge of users about water availability in the basin, to present data on rainfall, and to present ways to rationally use water in agriculture.

In the first meeting with users of each region, a committee is set up to follow up the actions, including in this committee some farmers. The monitoring committee mainly meets during times of water scarcity, at which Adasa and Caesb show the data on the flow in streams of interest for human consumption and irrigation; based on that data, water allocation proposals are made. The presence of water users in the commission is a way of guaranteeing that the interests of all parts of the society are duly attended to, as far as possible.

The proposal validated by Adasa and by the monitoring committee is then communicated to all the users of the basin, with a wide broadcasting by Emater, Adasa and the committee's own water users. The river flows are continuously monitored to observe the impact of the allocation on water availability and rural properties and the concessionaire are inspected to monitor compliance with established norms.

With the continuous monitoring of river flows after the allocation, if the rainy season delays its start causing an extension of the shortage period, the meetings can be resumed to discuss new proposals for allocation, which are more restrictive for users. Consequently, this should ensure minimum water levels in water bodies in order to meet their multiple uses.

Finally, the project also provides for the formalization of the proposed allocation with a resolution from Adasa, allowing for the supervision and accountability of users who do not adhere to established practices.

In the case of the Project applied to the sub-basin of Capão da Onça, Bucanhão and Barrocão streams, two partners were instrumental in planning and decision-making: the Technical Assistance and Rural Development Company of the Federal District - Emater / DF and the Environmental Sanitation Company of the Federal District - Caesb, which is the concessionaire of public water services.

3. Discussion

It is known that the city of Brazlândia is supplied by a system comprising two surface catchment points. The first point, a gravity-fed system, is located just below the spring of the Capão da Onça stream, in a Permanent Preservation Area. Thus, this point is not under the influence of water catchment for irrigation or other uses, and, therefore, there are no conflicts over water use.

The second catchment point has a run-of-the-river system. Its water level is raised by means of a small height dam in order to provide the spring with the minimum water level necessary for catchment. It is located at the end of the three Descoberto River tributaries streams, which also supply the rural activities of the basin. This catchment point presents various water uses, being prone to conflicts. Thereby, the water allocation actions discussed in this article have been implemented in order to mitigate the conflict between existing needs in this second catchment point.

Initially, the studied population included all users located near Capão da Onça, Bucanhão and Barrocão streams, because it was necessary to know the different of water uses performed along these streams. The survey of authorized and non-authorized users and the identification of their water uses were undertaken by Adasa through inspection actions and through campaigns to register new users. During the inspection, water uses, both surface and groundwater, are identified on-site. Furthermore, during registration campaigns, water uses of the property are declared by the landowner at the time of registration. In both situations, an estimate is made of the amount of water collected by the user, considering the type of production and the characteristics of the catchment pump located in the well.

With these campaigns, it was possible to quantify and qualify the types of interventions that exist in this sub-basin. Thus, we identified along the streams: 26

users, in the Capão da Onça Rural Center; 13 in the Bucanhão Rural Center; and 13 in the Barrocão Rural Center. Regarding the type of catchment, 17 superficial and 20 underground were identified, in the Capão da Onça Rural Center; 11 superficial and 11 underground, in the Bucanhão Rural Center; and 11 superficial and 3 underground, in the Barrocão Rural Center. It was observed that the vast majority of the catchment was intended for human and livestock consumption.

At the end of this work, Adasa held meetings with the users to promote awareness of practices and behaviors to ensure the rational use of water and to establish Commissions to monitor Water Sharing in the basin. The monitoring committees have the task of encourage water users to act as agents in the water management process.

Since the goal of the negotiated allocation practice was to mitigate the conflict over water use, ensuring the water availability required at the catchment point by the concessionaire, it was necessary to redefine the studied population. Thus, there was a refinement of this population, as we only considered large irrigation users who directly collected from Capão da Onça, Bucanhão and Barrocão streams.

Hence, it was found that the Bucanhão and Barrocão Rural Centers had only small users; but, in the Capão da Onça Rural Center, eight major irrigation users who have catchment points in the Capão da Onça stream were identified. Because of this, these users have become the studied population.

Since the flow of the three streams was monthly monitored, and based on the information from the concessionaire that the minimum water flow rate arriving at the dam to enable catchment, with a single motor pump in continuous operation, was 80 L / s (eighty liters per second), it was possible to determine a month, during the dry season, to start the allocation process.

Thus, from the monthly monitoring of the total flow rate of Capão da Onça, Bucanhão and Barrocão streams directed to the catchment point of the concessionaire, it was decided that the start of the allocation process would take place in August, as the flow rate of 97 L / s (ninety-seven liters per second) was sufficiently close to the limit value of 80 L / s (eighty liters per second).

	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
FLOW (L /s)	242	129	111	97	84	86

Table 1 - Total flow of Capão da Onça, Bucanhão and Barrocão streams directed to the catchment point of the concessionaire (Measurements made by Adasa and Caesb).

As a result, Adasa and Emater met with the eight irrigation users from Capão da Onça Rural Center, who are fresh food producers, to expose the evaluation of water availability in the sub-basin and to propose allocation strategies to mitigate the existing use conflict between water supply for the population and irrigation. In this first moment, discussed allocation proposals also had the purpose of avoiding conflicts of catchment schedule to prevent the concurrent collection, which could result in reduced water availability, and affect the catchment operation by the concessionaire.

However, due to the scenario of water scarcity and the lack of rainfall in September, it was necessary to conduct a new allocation strategy discussion with the

users. Therefore, this second time, the negotiated allocation aimed to reduce the use and to reorganize certain times due to the occurrence of supply interruption peaks at 10 am, 4 pm and 11 pm.

USER	TIME USED TO COLLECT FROM THE STREAM	TIME ALLOCATED TO COLLECT FROM THE STREAM August 3, 2016	TIME ALLOCATED TO COLLECT FROM THE STREAM September 16, 2016
User 1	MORNING: 6 am-10 am	MORNING: 7 am-10 am	MORNING: 7 am-10 am
	AFTERNOON: 1 pm-5 pm	AFTERNOON: 1 pm-4 pm	AFTERNOON: 1 pm-4 pm
	NIGHT: 6 pm-10 pm	NIGHT: 6 pm-10 pm	
User 2	MORNING: 6 am-7:30am	MORNING: 6 am-7:30am	MORNING: 6 am-7 am
	AFTERNOON: 1 pm-5 pm	AFTERNOON: 1 pm-4 pm	AFTERNOON: 1 pm-4 pm
User 3	MORNING: 6 am - 8 am	MORNING: 7 am -9 am	MORNING: 7 am -9 am
	AFTERNOON: 1 pm-3 pm	AFTERNOON: 2 pm-4 pm	AFTERNOON: 2 pm-4 pm
User 4	NIGHT: 6 pm-8 pm (Reservoir)	NIGHT: 6 pm-8 pm (Reservoir)	MORNING: 6 am-10 am (Reservoir) They use the same reservoir
User 5	NIGHT: 6 pm-8 pm (Reservoir)	NIGHT: 6 pm-8 pm (Reservoir)	
User 6	MORNING: Tomato farm irrigation at any time	MORNING:9 am -10:30 (Tomato farm irrigation)	MORNING:9 am -10:30 (Tomato farm irrigation)
	MORNING AND AFTERNOON: Twice a week, irrigates lemon orchard	MORNING AND AFTERNOON: Irrigate the lemon orchard on Tuesdays and Wednesdays	MORNING AND AFTERNOON: Irrigate the lemon orchard on Tuesdays and Wednesdays
	NIGHT: 6 pm - 8 pm (Reservoir)	NIGHT: 6 pm - 8 pm (Reservoir)	NIGHT: 6 pm - 8 pm (Reservoir)
User 7	NIGHT: 6 pm - 8 pm (Reservoir)	NIGHT: 6 pm - 8 pm (Reservoir)	NIGHT: 6 pm - 8 pm (Reservoir)

Table 2 - Allocation schedule negotiated with the users of the Capão da Onça Rural Center.

4. Results

According to information from the concessionaire, a flow rate of 80 L / s (eighty liters per second) ensures that the dam keeps the quota of 0.8 meters, which is the minimum height required for the operation of the pumping system.

Thus, water allocation strategies carried in a participatory manner, since the month of August and by the time of writing this article, ensured the arrival of a flow rate of 80 L / s (eighty liters per second) at the point of catchment (Figure 1), which was not happening in previous years, when the interruption of catchment and supply to the city of Brazlândia was needed for a few days, when the levels of streams decreased.

In other words, the strategy adopted has ensured both the water supply to the city and the continued irrigation by local farmers, even at an advanced stage of water scarcity; in a period when use priority would be to ensure water supply to the city.

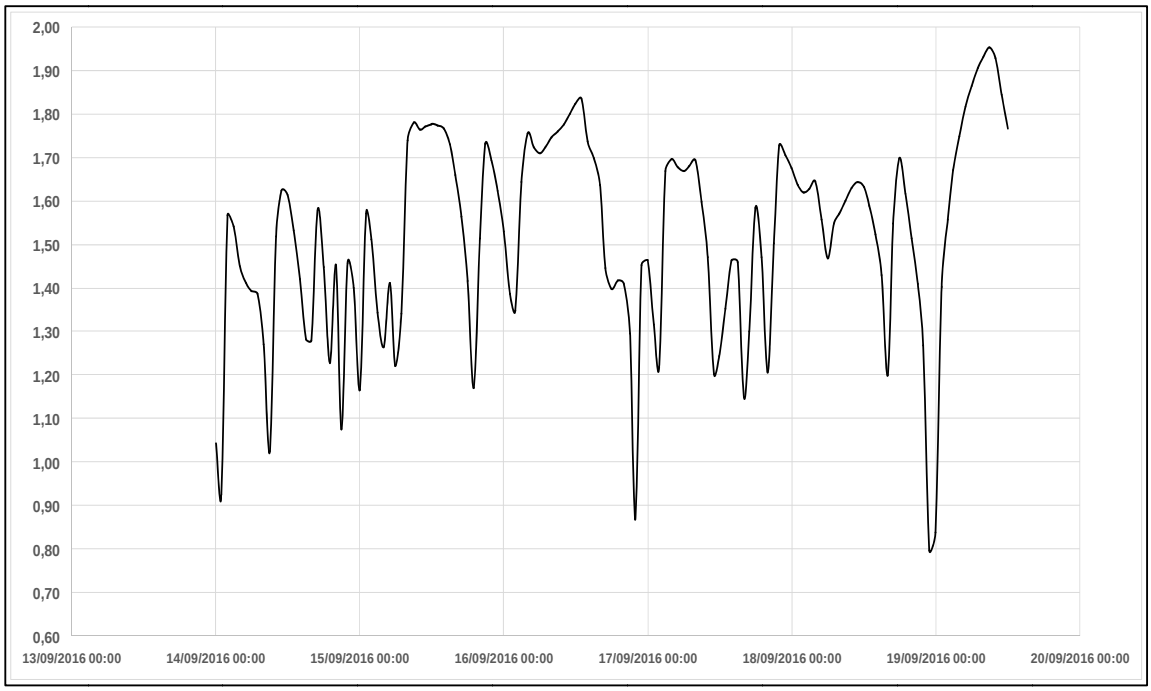

Chart 1 - Height (quota) in meters of water level in catchment dam in the period of September 14-20 (chart provided by Caesb).

5. Final considerations

The actions and proposals for shared use were developed through discussions and negotiations between water users and Adasa, decentralizing the decision-making process and empowering stakeholders with social participation in the management of water resources.

It is important to emphasize the importance of the involvement of institutions who work in the basin, such as the Rural Development Company and water users. The negotiating power of these organizations is fundamental to the progress of the Project in its beginning and during negotiations. In the case discussed, the concessionaire had a high degree of knowledge of the state of water use by agriculture and also played an important role during the planning stage of the actions.

It is worth noting that the use of coated reservoirs facilitates the negotiation of catchment schedule between irrigation users, in such a way that we recommend its implementation in rural properties. This is a medium-term solution that is already being discussed in the monitoring committees.

Notwithstanding the regularity of public supply to the city of Brazlândia with the adopted allocation strategy, there is a need to implement a continuous monitoring of this sub-basin, since the use of resources in a basin may vary greatly, because, at any moment, quantitative and qualitative changes in supply and demand may occur.

There may be a correlation between the decrease in surface water availability in the region, the progress of urban development - promoting soil sealing -, and the intensive use of groundwater resources. It is important to study this correlation.

Governmental actions must be carried out to contain the advance of urbanization as well as the high concentration of wells in the upstream areas of the basin.

In addition, uncertainties in relation to the volume of precipitation, to water availability, associated with the perishable nature of annual water allocation rules, can end up discouraging the continuation of farmers in the basin, because the allocated flows are yearly discussed. As a result, the government must foster environmental education programs to encourage the use of agricultural technologies, reforestation, and springs recovery, as an incentive for the preservation of the agricultural purpose of the Descoberto Basin. Thus, steps to ensure the recovery of green areas, especially in the upstream parts of the basin, should be considered a priority, given its importance to guarantee water infiltration into groundwater during the rainy season, and to ensure water security of the basin, acting preventively in relation to the allocation process.

Finally, notwithstanding the need for further developing the methodology applied, especially in respect to technical criteria, we can infer that the knowledge obtained with this experience can be used in other parts of the Descoberto Basin during the dry season. Thereby, it would be possible to increase the water availability of the tributaries of Lake Descoberto (reservoir responsible for supplying 60% of the population of Brasilia) and ensure the multiple uses of water.

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