

MAIN HYDRAULIC PARAMETERS OF THE CANAL AND THEIR ANALYSIS

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Аннотация

Очиқ сув ҳавзаларидаги сув оқими динамикасининг детерминли (детерминированные) турли моделларини ишлаб чиқиш ва ушбу моделларни сонли экспериментларни амалга ошириш усуллариини такомиллаштириш етарлича ўрганилган. Дарё ва каналларда табиий ёки антропоген омиллар таъсирида сув оқимининг гидравлик параметрлари эҳтимоллик қонуниятлари бўйича ўзгаради. Шунинг учун гидравлик жараёнларни моделлаштиришда стохастик моделлардан фойдаланиш самара беради деб ҳисоблаймиз. Каналлардаги беқарор сув ҳаракатини ифодалашда стохастик тизимлар усуллариини фойдаланиш масалалари етарлича ўрганилмаган.

Калит сўзлар: математик модел, стохастик моделлар, магистрал канал, беқарор сув ҳаракати, оқими тезлиги, гидравлик жараёнлар, сув сарфи, сув сатҳи, табиий ёки антропоген омиллар, гидравлик параметрлар.

Introduction

Аннотация

Разработка различных детерминированных (determinirovannie) моделей динамики водного потока в открытых водоемах и совершенствование методов проведения численных экспериментов с этими моделями достаточно изучены. В реках и каналах под воздействием природных или антропогенных факторов гидравлические параметры водного потока изменяются по закономерностям вероятности. Поэтому мы считаем, что использование стохастических моделей эффективно при моделировании гидравлических процессов. Недостаточно изучены вопросы использования методов стохастических систем при описании неустановившегося движения воды в каналах.

Ключевые слова: математическая модель, стохастические модели, магистральный канал, неустановившееся движение воды, скорость потока, гидравлические процессы, расход воды, уровень воды, природные или антропогенные факторы, гидравлические параметры.

Abstract

The development of various deterministic models of water flow dynamics in open water bodies and the improvement of methods for conducting numerical experiments on these models have been sufficiently studied. In rivers and canals, under the influence of natural or anthropogenic factors, the hydraulic parameters of the water flow change according to probability laws. Therefore, we believe that the use of stochastic models in modeling hydraulic processes is effective. Issues regarding the use of stochastic systems in describing unsteady water movement in canals have not been sufficiently studied.

Keywords: Mathematical model, stochastic models, main canal, unsteady water flow, flow velocity, hydraulic processes, water discharge, water level, natural or anthropogenic factors, hydraulic parameters.

Introduction

These technical parameters indicate that the Tashkent Main Canal is a large and complex hydraulic system. The canal is 61.1 km long, covering a wide area and having the capacity to convey a large volume of water. The design discharge of the canal is 87 m³/s, indicating its high conveyance capacity. However, the variation in the actual discharge from 7.5 m³/s to 86 m³/s indicates that the hydraulic regime of the canal is non-uniform. This condition may result in additional loads on the canal structures and accelerate their deterioration.

The main technical parameters of the Tashkent Main Canal are presented in the following table.

Table 1. Main Technical Parameters of the Tashkent Main Canal

№	Parameter	Value
1	Total canal length	61,1 km
2	Total length of the canal network	105 km
3	Canal bottom width	8–10 m
4	Canal depth	4,75–5,0 m
5	Longitudinal canal slope	1,5 ‰
6	Design discharge	87 m ³ /s
7	Actual discharge	7,5 – 86 m ³ /s
8	Irrigated area	~68 000 ha
9	Canal service life	85 years
10	Amount of sediment	~0.3 %

Materials and Methods

The canal bottom width is 8–10 m and its depth is 4.75–5.0 m, indicating that the canal is designed to convey a large volume of water. In canals of this size, the accumulation of sediment (silt deposits) is more pronounced.

One of the main problems of the canal is the amount of sediment (approximately 0.3%). This leads to sediment accumulation along the canal bottom, a reduction in its water conveyance capacity, and an increase in operation and maintenance costs.

In addition, as a result of long-term operation of the canal, cracks and deformations have developed in the concrete lining. This increases seepage losses and reduces the canal's efficiency coefficient. These conditions indicate the need to develop scientifically based measures to improve the technical condition of the Tashkent Main Canal, increase its efficiency, and ensure reliable operation.

Results and Discussion

The Tashkent Main Canal is a complex hydraulic system along its length, and its effective operation largely depends on the technical condition and hydraulic characteristics of individual sections. For a comprehensive and in-depth analysis of the canal, it is conditionally divided into separate sections. In this study, based on the canal scheme, only Sections 1–5 representing the main canal were considered, while Sections 6 and 7 were excluded from the analysis because they are inter-branch sections.

The division of the canal into sections is carried out based on the following main factors:

- Changes in the hydraulic regime;
- Location of hydraulic structures;
- Differences in the geometric parameters of the canal;
- Degree of sediment accumulation;
- Operating conditions.

Section 1, which represents the initial part of the canal, covers the area from PK0+00 to PK41+76 downstream of the head structure. Since the water flow in this section is directly regulated through the head structure, the hydraulic regime is relatively stable and controllable. In this section, the right bank is reinforced with concrete lining from PK0+00 to PK15+50, while the left bank is reinforced from PK0+00 to PK8+90.

The discharge in this section has relatively high values, and the flow velocity is also higher than that observed in other sections. According to the scheme data, the flow velocity in this area may be approximately $v \approx 1.0\text{--}1.2$ m/s, while the discharge may range from $Q \approx 80\text{--}87$ m³/s.

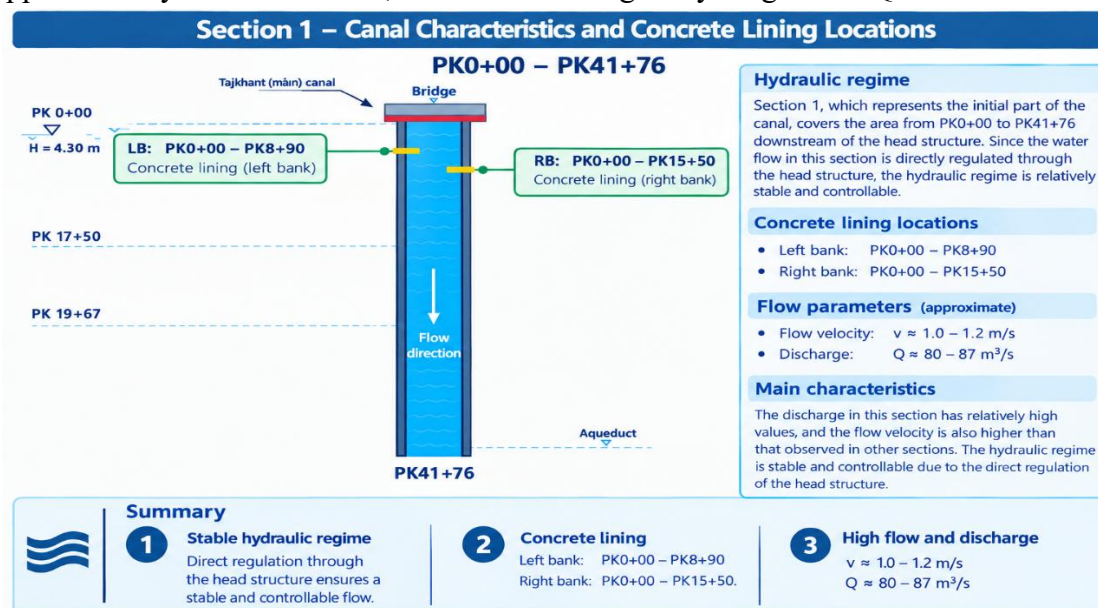


Figure 1. Tashkent Main Canal. Linear Scheme of Section 1

The main characteristics of the section are as follows: high discharge, relatively high flow velocity, a relatively stable hydraulic regime, and a dense distribution of hydraulic structures. Under the influence of high flow velocity and hydraulic pressure, erosion processes may occur in the canal bed and side slopes. In particular, when defects are present in the concrete lining, their rapid expansion may be observed. This negatively affects the long-term operation of the canal.

Section 2 covers the area from **PK41+76 to PK200+00**. As the canal flow moves farther away from the head structure, it gradually becomes more stable; however, the influence of external factors on the hydraulic regime increases in this area. In particular, the flow parameters are affected to some extent by water intake structures and distribution systems. In this section, concrete lining has been provided at the following locations: on the left bank from PK54+89 to PK71+85; on the right bank from PK54+89 to PK126+00; on the left bank from PK96+11 to PK97+21; on the right bank from PK120+00 to PK125+50; on the right bank from PK139+83 to PK177+20; and on the right bank from PK167+00 to PK168+80.

In this section, the discharge partially decreases, and the flow velocity also tends to decrease. According to the scheme data, the flow velocity in this area may be approximately $v \approx 0.7\text{--}0.9$ m/s, while the discharge may range from $Q \approx 60\text{--}75$ m³/s.

The main characteristics of the section are as follows: a gradual decrease in discharge, a reduction in flow velocity, and an increased likelihood of sediment accumulation. As the flow velocity decreases, sediment particles suspended in the water begin to settle on the canal bed. As a result, the cross-sectional area of the canal becomes narrower and its water conveyance capacity decreases. If this process continues for a long period, it may lead to a significant reduction in the efficiency of the canal.

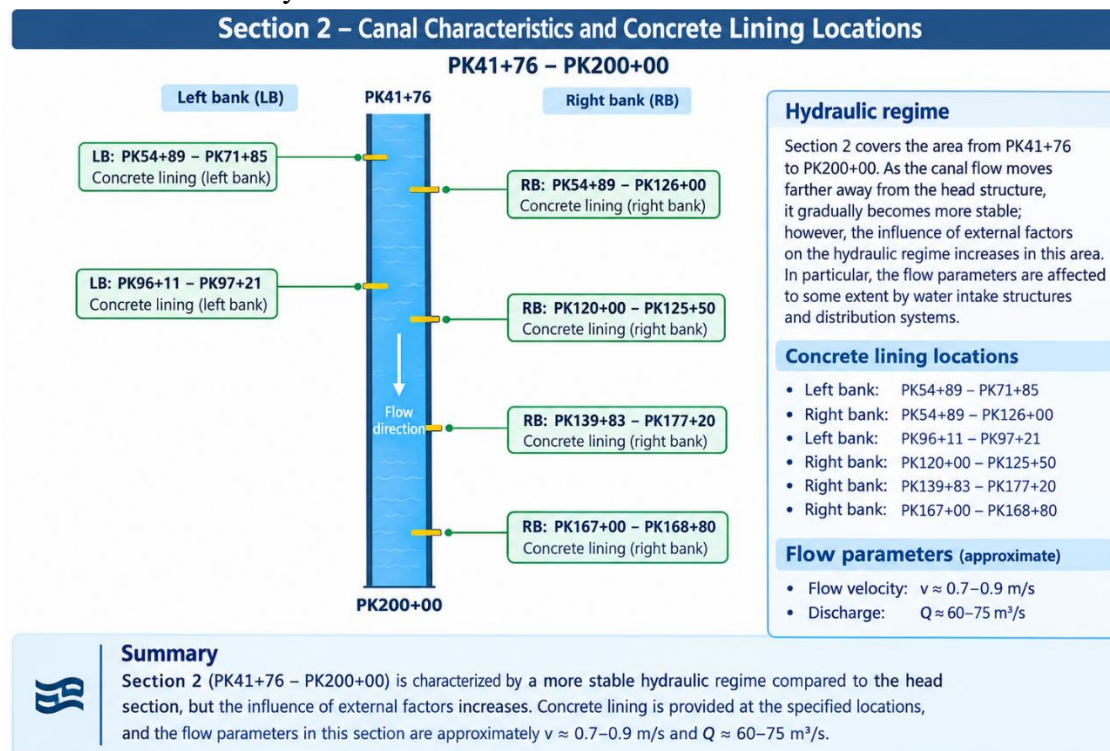


Figure 2. Tashkent Main Canal. Linear Scheme of Section 2

Section 3 covers the area from **PK200+00 to PK340+00**. Section 3 represents the middle part of the canal, where the natural transformation of the flow is clearly manifested. In this section, the operating regime of the canal becomes more complex under the influence of hydraulic structures, water intake points, and changes in flow conditions.

In this section, concrete lining has been provided at the following locations: on both the left and right banks from PK268+70 to PK270+20; on the left bank from PK283+50 to PK284+00; on the right bank from PK283+00 to PK289+00; on the right bank from PK312+90 to PK320+00; and on the left bank from PK315+00 to PK320+00.

In this section, the discharge and flow velocity are variable to some extent. According to the scheme data, the flow velocity is approximately $v \approx 0.5\text{--}0.8\text{ m/s}$, while the discharge ranges from $Q \approx 50\text{--}70\text{ m}^3/\text{s}$. Such conditions create a favorable environment for sediment accumulation.

The main characteristics of the section are as follows: variability of discharge, regulation of flow through hydraulic structures, and intensified accumulation of sediment. In this area, sediment layers gradually form along the canal bed. If cleaning works are not carried out in a timely manner, the increasing thickness of the sediment layer reduces the canal cross-section and leads to a decrease in its water conveyance capacity. As a result, the overall operational efficiency of the canal deteriorates.

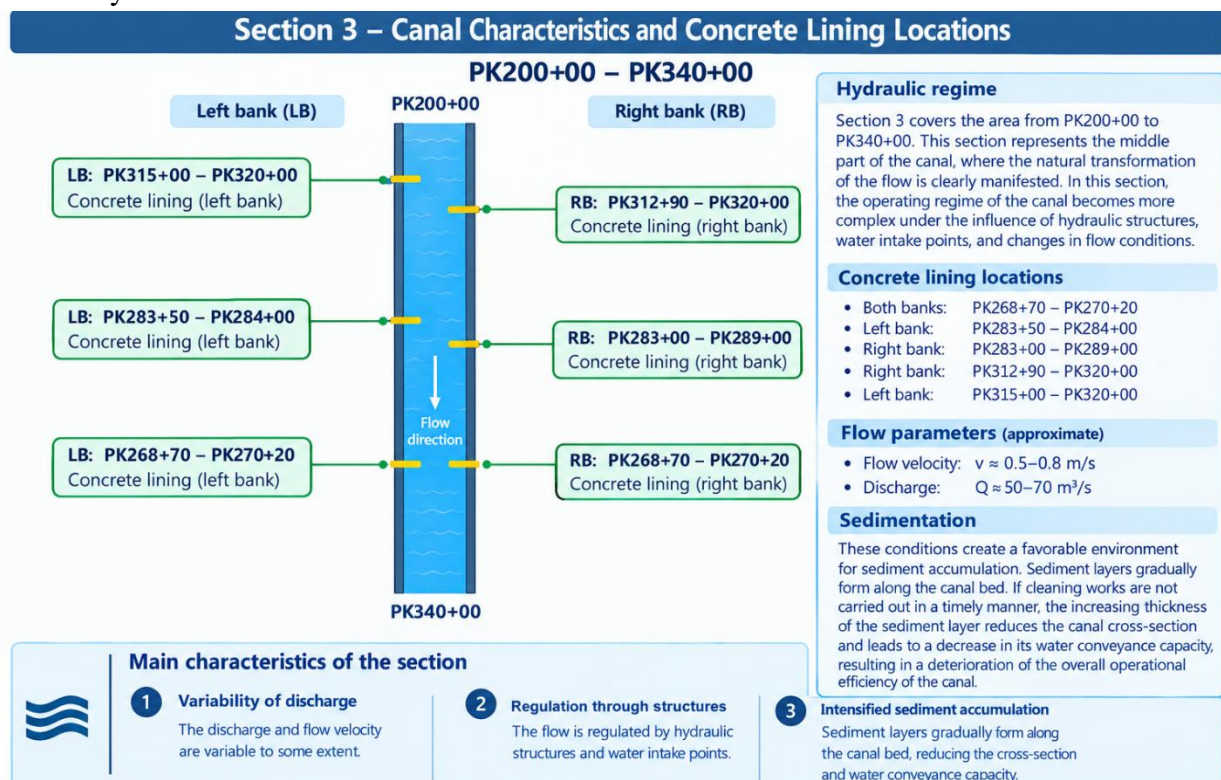


Figure 3. Tashkent Main Canal. Linear Scheme of Section 3

Section 4 covers the area from **PK340+00 to PK483+85**. It is located in the area close to the lower part of the canal, where a significant reduction in flow velocity is observed. The hydraulic regime in this section is non-uniform, with flow velocity and discharge values developing at relatively low levels.

In this section, concrete lining has been provided at the following locations: on the left bank from PK347+00 to PK395+00; on the right bank from PK347+00 to PK401+10; on the right bank from PK410+00 to PK425+00; on the right bank from PK444+90 to PK472+55; and on both the left and right banks from PK483+78 to PK483+85.

According to the scheme data, the flow velocity in this area may be approximately $v \approx 0.3\text{--}0.6$ m/s, while the discharge may range from $Q \approx 40\text{--}60$ m³/s. Such conditions create a favorable environment for sediment accumulation.

The main characteristics of the section are as follows: a sharp decrease in flow velocity, an increase in the degree of sediment accumulation, and the potential occurrence of deformations in the concrete lining. In this section, if regular cleaning works are not carried out, large volumes of sediment layers may form along the canal bed. As a result, the canal cross-section becomes considerably narrower, and its water conveyance capacity decreases sharply. This negatively af

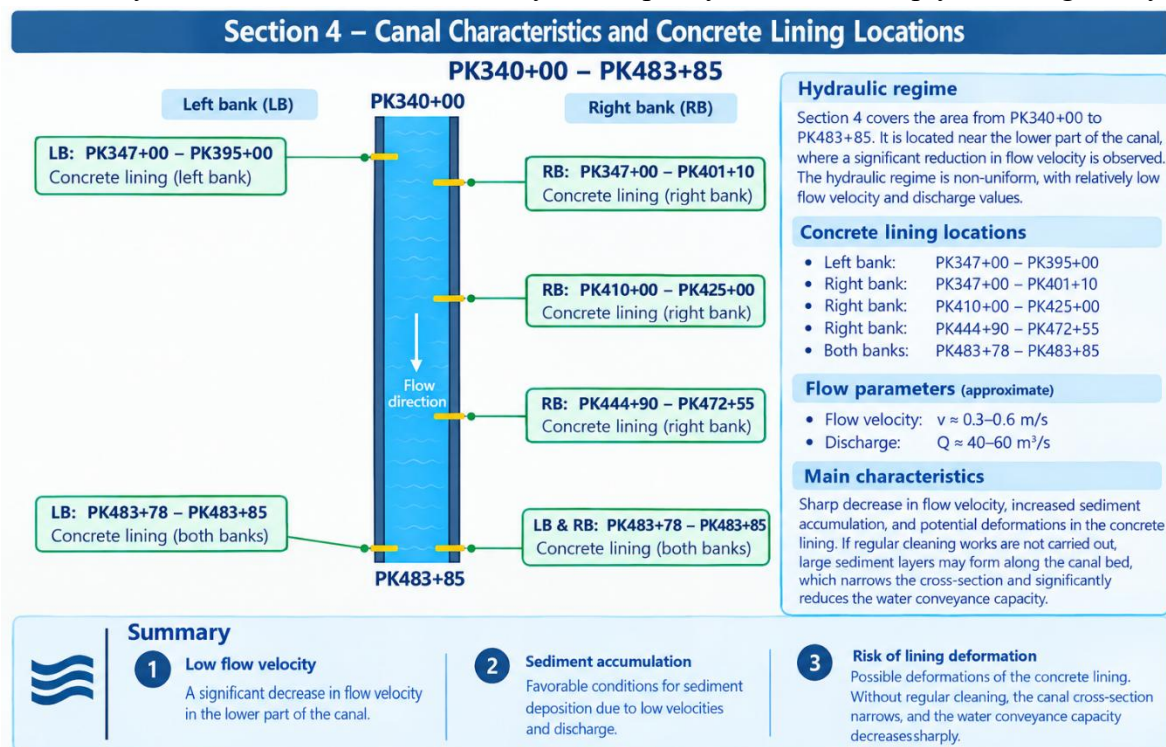


Figure 4. Tashkent Main Canal. Linear Scheme of Section 4

Section 5 covers the area from **PK483+85 to PK611+14**. It represents the final main section of the canal, where the flow energy decreases considerably. The discharge and flow velocity are maintained at relatively low values, and the hydraulic regime becomes less dynamic.

In this section, concrete lining has been provided at the following locations: on both the left and right banks from PK487+00 to PK488+50; on the right bank from PK516+00 to PK593+20; on the left bank from PK516+00 to PK522+00; on the left bank from PK542+50 to PK593+20; and on both the left and right banks from PK606+20 to PK611+14.

According to the scheme data, the flow velocity in this section may be approximately $v \approx 0.2\text{--}0.4$ m/s, while the discharge may range from $Q \approx 30\text{--}50$ m³/s. Under such conditions, sedimentation processes are most pronounced.

The main characteristics of the section are as follows: the discharge approaches its minimum values, the flow velocity is low, and sediment accumulation is observed to the greatest extent. As a result, the thickness of the sediment layer along the canal bed increases, leading to a reduction in the canal cross-section and a decrease in its water conveyance capacity. These processes have a significant adverse effect on the efficiency of the canal. Therefore, regular mechanical cleaning, monitoring of sediment layer thickness, and implementation of preventive measures are considered necessary in this section.

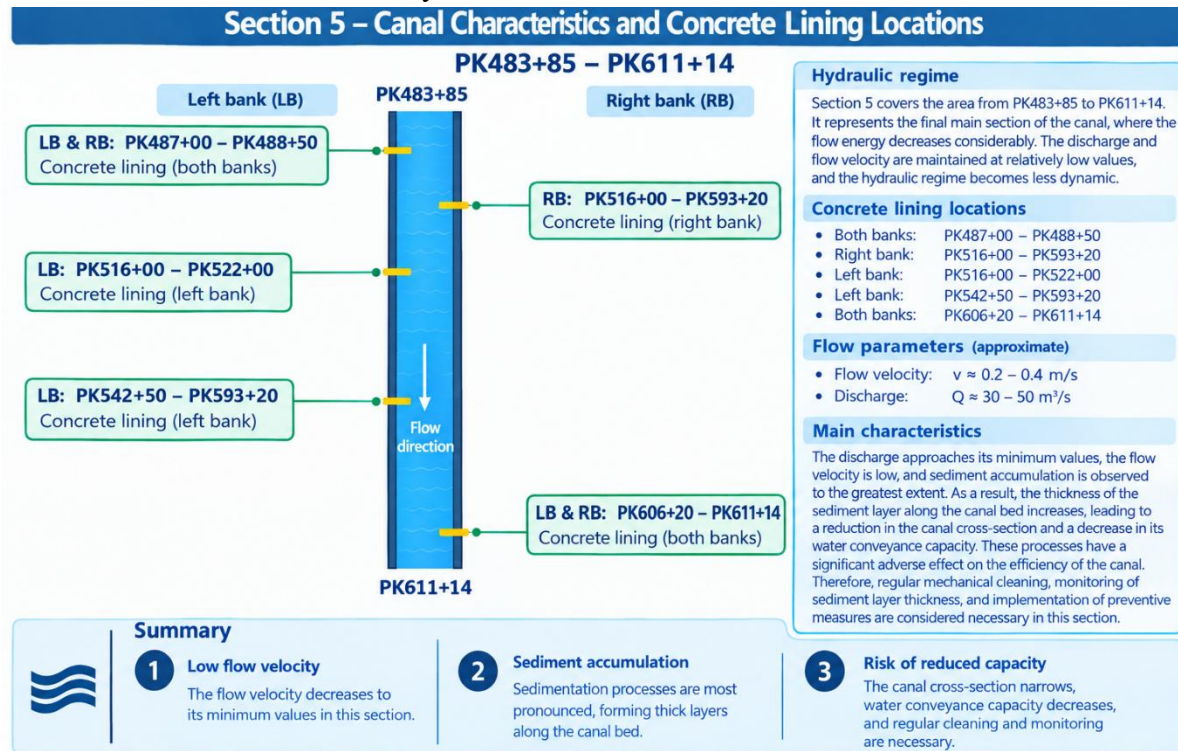


Figure 5. Tashkent Main Canal. Linear Scheme of Section 5

As a result of the analysis, it was determined that the hydraulic regime and operational conditions vary across different sections of the Tashkent Main Canal. The flow velocity is high in the initial section of the canal and gradually decreases toward the downstream sections. The decrease in flow velocity leads to increased sediment accumulation, particularly in Sections 3–5. This, in turn, results in a reduction in the canal cross-sectional area and a decrease in its water conveyance capacity. Therefore, studying the canal by individual sections makes it possible to accurately assess its technical condition, identify problem areas, and develop effective engineering measures to improve the canal's operational performance.

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