

HYDRAULICS COMPUTATIONS FOR THE LOWER MEKONG RIVER BASIN TO STUDY FLOOD DRAINAGE FOR THE PLAIN OF REEDS IN VIET NAM

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ABSTRACT

Mathematical model was applied for flood computations for the Lower Mekong River Delta and the Plain of Reeds in Viet Nam. The model was calibrated and level data and inundation maps. The model was then applied to study flood drainage of the Plain of Reeds verified by using flood data in 2000 and 2001. Results of computations are compared with observed water when flood control structures installed on the Vam Co Tay River.

INTRODUCTION

Plain of Reeds is an important economic region of the Lower Mekong River Delta, it is considered as the main area in the project on flood planning for the Lower Mekong Delta. Flood and inundation is the difficulties for socio-economic development of the region. In recent years, high flood occurs more frequently and with high insensitive, occurring earlier with deep and long lasting inundation.

Together with flood control structures, infrastructure, embankment for resettlement development have made flood in the region more complicated and damage due to flood also increase. In this study, ISIS model (4, 5) is applied for flood computations to study flood drainage improvement for the Plain of Reeds.

ISIS MODEL

ISIS model is developed by Wallingford for flow routing in river system. The model is based on the full Saint - Venant equation for unsteady flow in open Canal. The Pressman - 4 point is used for discretization of the partial equations. The model can be applied for a complicated river system with many tributaries and hydraulic and flood control structures such as bridge, sluice, pump station and spillway.

ISIS model is currently used as hydraulic computation tool in the Water Utilization Program (WUP) of the Mekong River Commission (MRC) (4).

APPLICATION OF ISIS MODEL

Schematization

In the computation scheme of ISIS model for the Mekong Delta, high flow (flood season) and low flow (dry season) computational schemes are combined in only one scheme and the model can be run for the whole year [4]. The detailed computational scheme for the Mekong Delta includes more than 8.000 nodes and about 500 flood cells. This scheme is based on the scheme of the currently used model for the Mekong Delta, VRSAP model. Canal up to second order and main flood control structure are included in the scheme, especially the rubber dams, Tha La and Tra Su, controlling flood overflow across the Viet Nam - Cambodia border. The detailed scheme for the Plain of Reeds is shown in Fig. 1. The computational scheme for the whole Mekong Delta is shown in Fig. 2 and Fig. 3.

Data used in modeling

Canal cross-section data measured in 1999 to 2000 and hydrometric atlas of mainstream river Canal measured in 1999 are used in the model. Topographic data of the Tonle Sap area in Cambodia area based

on data measured by MRC in the WUP-JICA and WUP-FIN projects. Topographic data of flood cells are based on DEM of MRC derived from map scaled 1:25.000 and 1:10.000.

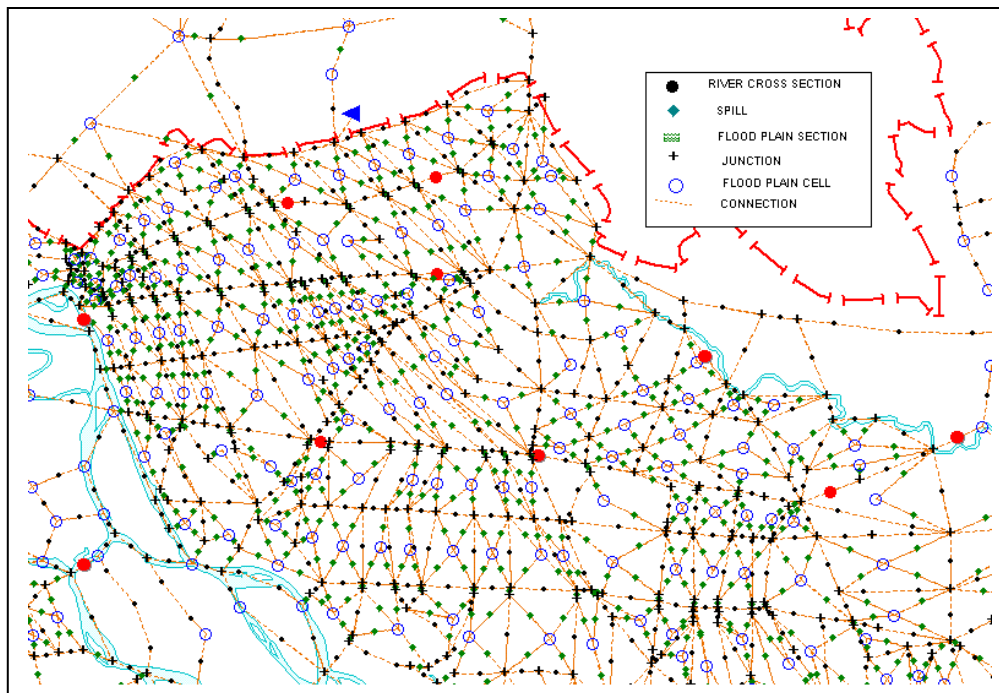


Fig. 1: Detailed Computational scheme of ISIS Model for the Plain of Reeds

Boundary Conditions

Totally, there are 44 water level downstream boundary conditions, and discharge upstream boundary conditions at Kratie basing on rating curve provided by MRC. Other inflows from tributaries i.e., to Tonle Sap Lake, Ta Keo, Kongpong, and Go Dau Ha on Vam Co Dong River, are computed from model.

Rainfall data from representative stations are used to compute rainfall in flood cells. There are 6 stations in Viet Nam territory: Ca Mau, Chau Doc, Can Tho, Moc Hoa, My Tho, and Rach Gia, and 3 stations in Cambodian territory: Kompong Cham, Phnom Penh, and Kompong Chhang.

Model Calibration and Verification

Hydrological data of flood season in 2000 and 2001 are used for model calibration and verification respectively. Water level data at 25 hydrological stations are used for comparison between computed and measured data. Moreover, water level data from flood investigation campaign in 2000 and 2001 are also used for comparison. Results of inundation including depth and extent are compared with satellite image and flood map derived from flood investigation data of 2000 and 2001.

Results of model calibration and verification are shown in Table 1. It is seen that the computed results are in good agreement with observed data both for water level and inundation map.

Inundation Maps in the Plain of Reeds in Flood Season of 2000 and 2001

Water level at computational node and flood cells are extracted from computed results to produce inundation map. Water depth at a time is result of water level subtracted by land elevation of the DEM. Basing on hydrographs in the river and in the flood plain, inundation maps are constructed for different time: 30 June, 15 July, 15 August, 15 September, 30 September, 15 October, 1 November, and 15 November.

Computed flood inundation maps are in good agreement with flood map of 2000 and 2001. Water surface in the Plain of Reeds area has a tendency of incline in the Northwest - Southeast direction, with a ridge lies between Phuoc Xuyen Canal and 79 Canal. The water ridge develops to the end of the flood season; this shows the mechanism of flood flow to the Plain of Reeds. At the early flood season, water is mainly over bank flow from Mekong River to the Plain of Reeds, especially in the location from Tan Chau to Cho Moi. After the period that overflow across the border has dominated, Phuoc Xuyen Canal and 79

Canal convey largest amount of water to the Vam Co River, resulting a water ridge from Thong Binh to Kien Binh hydrological station.

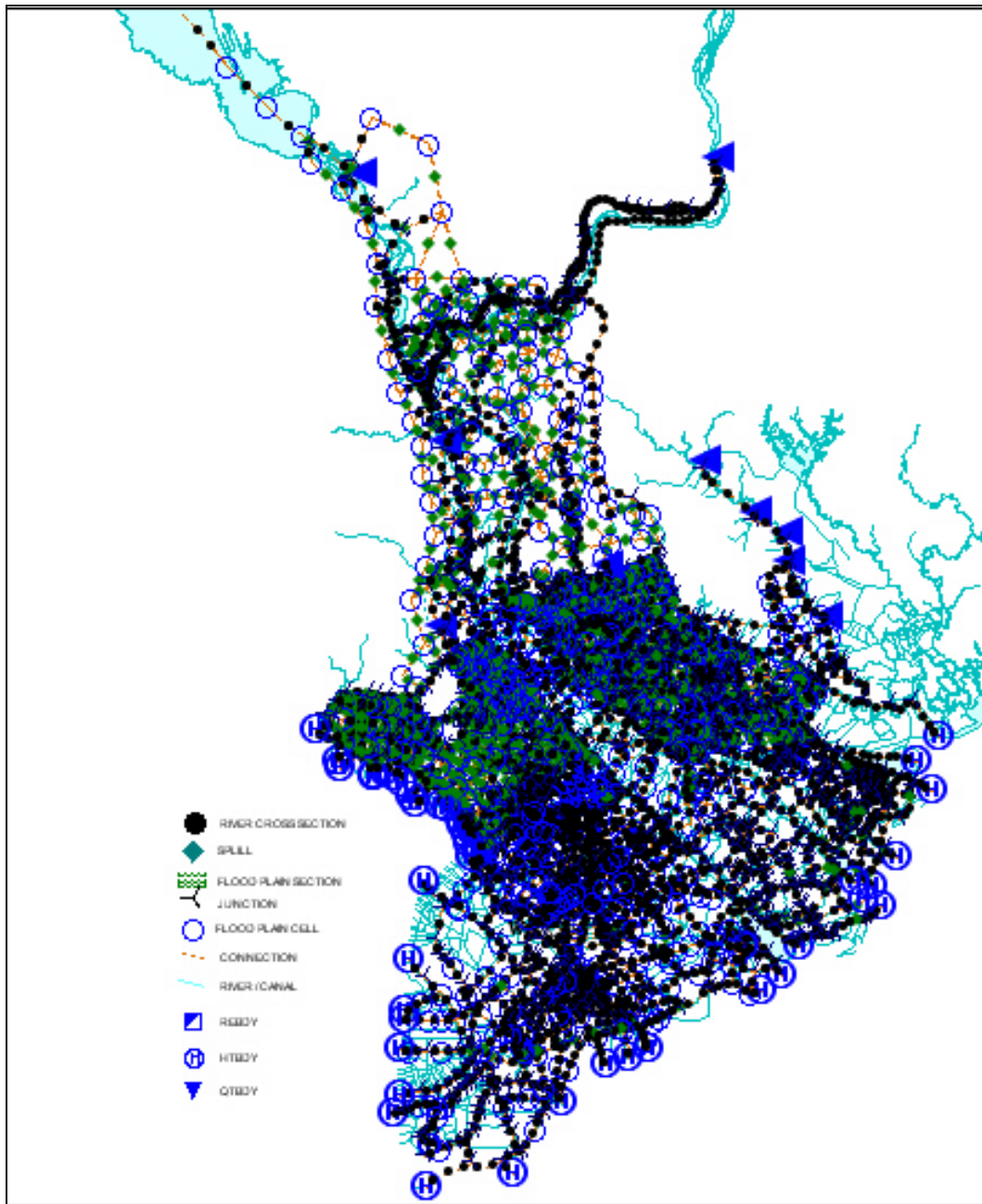


Fig. 2: Computational Scheme in ISIS Model for Mekong River Delta

As a result, in order to increase flood drainage for the Plain of Reeds, it is not only dredging to increase drainage for Vam Co River itself, but also enlarge the Phuoc Xuyen Canal and 79 Canal and their inlets at the border.

Floods in 2000 and 2001 have deepest and largest inundation area by the end of September to early November, corresponding to the time that water depth at Hung Thanh station, at the center of the Plain of Reeds, has the highest value. In analyzing flood inundation may of 30 September, it is found that, in the 2000's flood, most of the areas that have water depth more than 2 m are in Tam Nong, Tan Hong, and Tan Hung Districts. Districts of Thanh Binh, Cao Lanh, Thap Muoi; Tan Thanh, Moc Hoa, Vinh Hung are in the areas that have inundation depth of 1 - 2 m. In the 2001's flood, the values are 1.5 - 2.5 m and 0.5 - 1.5 m, respectively.

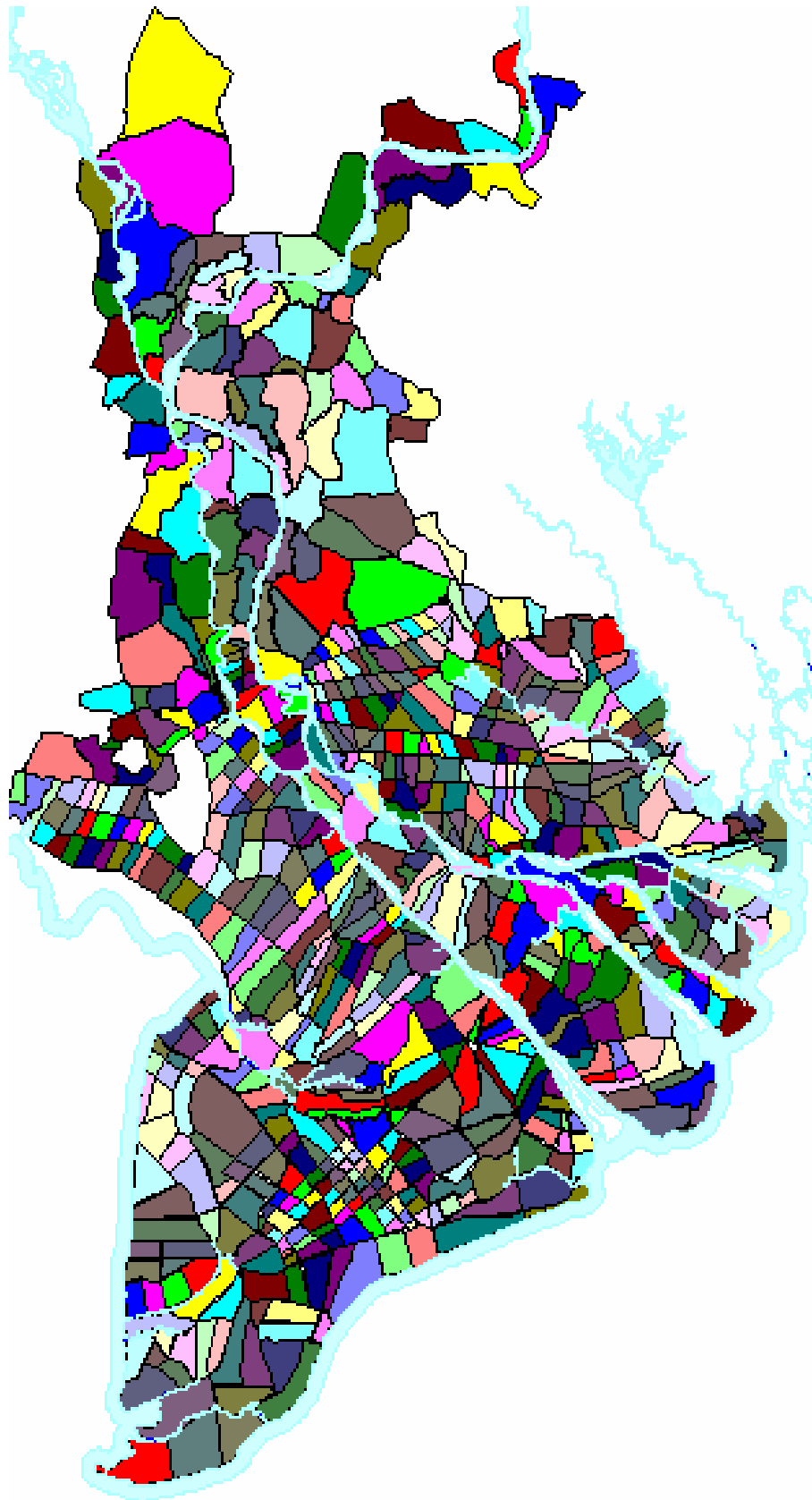


Fig. 3: Flood Cell in Numerical Scheme of ISIS Model for the Mekong Delta

Table 1: Results of Model Calibration and Verification

No	Station	Flood in 2000 (Model Calibration)			Flood in 2001 (Model Verification)		
		Nash Coeff	R	$ Z_{Crest} $ (m)	Nash Coeff	R	$ Z_{Crest} $ (m)
1	Ca Mau	0.54	0.93	0.05	0.43	0.87	0.05
2	Can Tho	0.68	0.94	0.00	0.53	0.90	0.09
3	Chau Doc	0.40	0.95	0.25	0.54	0.83	0.23
4	Dai Ngai	0.67	0.95	0.01	0.75	0.97	0.05
5	Hung Thanh	0.58	0.93	0.07	0.52	0.86	0.09
6	Kien Binh	0.67	0.97	0.15	0.8	0.93	0.05
7	Kongpong Cham	0.82	0.99	0.35	0.83	0.99	0.16
8	Long Xuyen	0.20	0.90	0.30	0.37	0.85	0.17
9	Moc Hoa	0.79	0.97	0.28	0.81	0.98	0.04
10	My Hoa	0.63	0.98	0.03	0.52	0.97	0.10
11	My Tho	0.78	0.98	0.01	0.68	0.99	0.03
12	My Thuan	0.60	0.93	0.07	0.67	0.94	0.01
13	Neakluong	0.40	0.97	0.35	0.50	0.96	0.17
14	Phnom Penh	0.54	0.91	0.21	0.54	0.96	0.01
15	Phung Hiep	0.44	0.93	0.12	0.73	0.97	0.06
16	Ph-uoc Long	0.10	0.81	0.06	0.30	0.70	0.06
17	Prek Dam	0.30	0.93	0.03	0.43	0.88	0.07
18	Tan An	0.79	0.98	0.09	0.72	0.95	0.02
19	Tan Hiep	0.53	0.93	0.02	0.64	0.93	0.10
20	Tan Chau	0.45	0.93	0.24	0.54	0.94	0.12
21	Tra Vinh	0.73	0.97	0.01	0.78	0.96	0.03
22	Tuyen Nhon	0.71	0.97	0.00	0.76	0.97	0.11
23	Vam Nao	0.45	0.95	0.23	0.53	0.93	0.03
24	Xuan To	0.12	0.90	0.36	0.46	0.90	0.16
25	Vi Thanh	0.10	0.75	0.20	0.30	0.80	0.19

Inundation duration map for 2000 and 2001's flood

Food inundation maps for different time are constructed for analysis to produce inundation duration map. Time period from 30 September to 15 November are considered, this is the time period of inundation of the Plain of Reeds. Inundation duration at a location is the total time of inundation of that location during the period of computation.

Areas that have long inundation duration over 4 months are in districts that have deepest inundation depth. They form a quadrangle with sides of Khang Chien Canal - Dong Tien Canal - Phuoc Xuyen Canal - Tan Thanh Canal - Lo Gach Canal. In the 2000 and 2001's floods areas that have long inundation durations lie in this quadrangle. For other areas in the Plain of Reeds, inundation durations are 75 to 90 days. Total area that has inundation duration more than 120 days in the Plain of Reeds in 2000's flood reaches a value of 700 km²; in 2001 is over 600 km². This shows the extent of the 2000's flood.

Areas that have deepest and longest inundation lie near to the Mekong River rather than the Vam Co River, extending from Hong Ngu Canal to Dong Tien Canal.

In order to solve the problem of inundation for the Plain of Reeds, flood control structures are found necessary at the inlet of Hong Ngu, An Binh, Dong Tien. It is important to enlarge and dredge drainage Canals, i.e., Khang Chien, Phu Thanh, Phu Hiep, Phu Duc, and Tan Cong Sinh to increase water drainage to Dong Tien - Duong Van Duong Canals.

Computations to evaluate effectiveness of flood structure for 2000's flood

Results of computations for the 2000's flood indicate that flood drainage to the Vam Co River accounts for 30-40% of water from the Plain of Reeds. One of the possibilities is to increase flood drainage to Vam Co River. Tidal effect in the Vam Co River is quite strong; therefore, construction of tidal gate on Vam Co River was suggested by researchers. This structure can limit tidal effect, increase drainage capacity, and also enable navigation in the river.

a) Scenario:

- Tidal gate installed on Vam Co River: width $B = 250$ m, $Z_{\text{Bottom}} = -8$ m; operating condition: close at high tide, and open at low tide, time for gate operation is 30 minutes;
- Hydrological condition is that of 2000's flood.

The computational scheme is kept unchanged, only a gate is installed on Vam Co River.

b) Evaluation of flood drainage to Van Co River and flow regime in the Plain of Reeds under the effect of tidal gate

Effect on water level:

The gate has strong effect water level along Vam Co River and Northeastern area of the Plain of Reeds. In general, this effect is only seen clearly at Moc Hoa, Kien Binh, Tuyen Nhon and Tan An, Ben Luc stations. Water level in the Plain of Reed reduces about 0.05m on average. Meanwhile, changes in water level at Nguyen Van Tiep and Phuoc Xuyen are insignificant.

Effect on discharge:

Areas that have strong effect lies between Vam Co Tay River and Bo Bo, T1-T2, and Rach Ca Dua Canal, change in water level is from 0.25 to 0.35 m. Water level in the area south of Nguyen Van Tiep is almost unchanged due to strong effect from tide in the Mekong River.

Therefore, construction of tidal gate on Vam Co River has effect only to a small area, not significant to the Plain of Reeds. Combination with other measures such as increasing drainage to Mekong River, controlling water overflow across the border, is found necessary to improve drainage for the Plain of Reeds.

Tidal gate on Vam Co River has effect on water surface slope from the Plain of Reeds to Vam Co River, water flow is, therefore increases. However, only flows in Duong Van Duong and Nguyen Van Tiep Canal have notable changes, water volume to Vam Co River from 1 July to 30 November increases about 12 - 23%, next is Hong Ngu Canal 1.3%. Water from Mekong River to the Canal also increases. Water from Mekong River to Hong Ngu Canal increases 6.1%, to Nguyen Van Tiep Canal increases 6.4%, to Duong Van Duong increases 2.2%, to An Binh increases 1.6%.

CONCLUSIONS

Flood drainage to Vam Co River plays an important role in flood drainage for the Plain of Reeds, However, construction of a tidal gate on Vam Co River does not seem to have significant improvement of inundation in the Plain of Reeds. Combination of controlling water overflow across the border, enlargement and dredging of drainage Canal and Vam Co River, together with enlargement of drainage gate to Mekong River at Phong My - My Thuan is found more suitable.

Table 2: Change in Maximum Water Level and Flow due to Gate Operation

Node	Location	Z_{max}	W	
		(m)	(10^6 m^3)	%
554	Hung Thanh Station	-0.04	1	0.1
612	Kien Binh Station	-0.06	51	2.5
181	Moc Hoa Station	-0.07	121	1.2
186	Tuyen Nhon Station	-0.05	251	1.9
194	Tan An Station	-0.19	707	4.4
845	Ben Luc Station	-0.52	283	5.4
450	Hong Ngu Cannal to Vam Co Tay River	-0.06	44	1.3
434SD	Mekong River to Hong Ngu Cannal	-0.03	36	7.2
640	Duong Van Duong Cannal to Vam Co Tay River	-0.01	17	12.7
1352SD	Mekong River to Duong Van Duong Cannal	-0.03	33	1.9
690	Nguyen Van Tiep Cannal to Vam Co Tay River	-0.01	112	23.0
1347SD	Mekong River to Nguyen Van Tiep Cannal	0.05	99	6.4
1353SD	Mekong River to An Binh Cannal	-0.03	5	1.6

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