WEPA Malaysia 2008.10.22

JAPANESE EXPERIENCES ON THE MANAGEMENT OF WATER ENVIRONMENT

---Environmental Water Quality Standards and Effluent Standards for Nitrogen and Phosphorus---

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JAPANESE EXPERIENCES ON THE MANAGEMENT OF WATER ENVIRONMENT

- **How did we defined our target on water environment?**
  - **environmental water quality standard**
- **How did we forced to satisfy with the effluent quality standards**
  - **Natinal Minimum and Provisional effluent standard**

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Environmental Water Quality

- **The Cleaner the Better?**
  - **w/o human impacts on the Environment**
- **Preferable conditions of aquatic environment for the designated water use**

Environmental Water Quality Standards

- **The Basic Law for Environment**
- **Preferable conditions of aquatic environment**
  - ***To protect human health***
  - ***To conserve living environment***

    All the properties closely related with:

    - **daily human life**
    - **the living environment for plants and animals closely related to human life**

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WATER QUALITY STANDARDS

- **administrative targets and criteria for promotion of comprehensive measures against water pollution**
- **standard conditions to be achieved and maintained in public water bodies**
- **water without pollution/ tolerable level of pollution**
  - **the standards for preventive measures for further pollution and oblige certain measures to keep the pollution within the standards**
- **water with considerable pollution**
  - **the targets in carrying out specific measures to restore polluted waters to the quality specified by the standards**

Environmental Water Quality Standards for Rivers

category	water use	standards				
		pH	BOD	SS	DO	CG
AA	Water supply class 1 ; conservation of natural environment, and uses listed in A-E	6.5-8.5	1	25	7.5	50
A	Water supply class 2 ; fishery, class l; bathing and uses listed in B-E	6.5-8.5	2	25	7.5	1,000
B	Water supply class 3 ; fishery, class 2, and uses listed in C -E	6.5-8.5	3	25	5	5,000
C	Fishery class 3 ; industrial water, class l, and uses listed in D -E	6.5-8.5	5	50	5	-
D	Industrial water class 2 ; agricultural water; and uses listed in E	6.0- 8.5	8	100	2	-
E	Industrial water class 3 ; conservation of living environment	6.0-8.5	10	*	2	-

no floating matters like garbage

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Water Quality Standards for Estuaries

category	water use	pH	COD_{Mn} (mg/l)	CG (/100ml)	NHE
A	fishery calss 1, bathing, conservation of natural environment and uses B-C	7.8-8.3	2.0	1,000	ND
B	fishery calss 2, industrial water and uses B-C	7.8-8.3	3.0	-	ND
C	conservation of environment	7.0-8.3	8.0	-	-

WATER QUALITY STANDARDS FOR ESTUARIES on N,P

category	uses of water	T-N (mg l^{-1})	T-P (mg l^{-1})
I	Conservation of natural environment and II, III, IV	0.2	0.02
II	Fisheries class 1, Marine recreation / bathing and III, IV	0.3	0.03
III	Fisheries class 2 and IV	0.6	0.05
IV	Fisheries class 3, Protection of benthic organisms, Industrial water supply	1.0	0.09

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Water Quality Standards for Lakes and Reservoirs: COD

(volume > 10 million m^3)

category	water use	pH	COD	SS	DO	CG*
AA	water supply class 1, fishery class 1, conservation of natural environment, and uses A-C	6.5-8.5	1	1	7.5	50
A	water supply class 2 and 3, fishery class 2, bathing, and uses B-C	6.5-8.5	3	5	7.5	1,000
B	fishery class 3, industrial water class 1, irrigation water, and use C	6.5-8.5	5	15	5.0	-
C	industrial water class 2, conservation of environment	6.0-8.5	8	**	2.0	-

**number of coliform groups (MPN/100 ml), **no floating matters*

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Water Quality Standards for Lakes and Reservoirs: T-N, T-P

Category	water use	Standards	
		T-N	T-P
I	Conservation of natural environment, and uses listed in II-V	0.1	0.005
II	Water supply classes -I, 2 and 3 (except for special types), fishery class 1, bathing; and uses listed in III-V	0.2	0.01
III	Water supply class-3 (special types), and uses listed in IV-V	0.4	0.03
IV	Fishery class 2, and uses listed in V	0.6	0.05
V	Fishery class 3, industrial water; agricultural water; conservation of living environment	1.0	0.1

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N/P Standards for Lakes Based on Expected Uses of Lake Waters

- Conservation of natural environment
- Drinking water supply: class 1, 2, 3
- Recreation/ bathing
- Fisheries: class 1, 2, 3
- Irrigation
- Industrial water supply
- Conservation of environment

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Drinking Water Supply

Troubles in drinking water purification plants?

- ***Water supply class 1*** **:**

  slow sand filtration

- ***Water supply class 2*** **:**

  conventional coagulation / rapid sand filtration

- ***Water supply class 3*** **:**

  advanced treatment with pretreatment

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Water supply class 2 : rapid sand filtration

Growth of phytoplankton

- **increase in coagulant doses**
- **decrease in filtration time**

- **N and P in raw waters ?**

  vs. problems in rapid sand filtration

  - **Little problems in rapid sand filtration if**

T-P ≦ 0.03 mg/l, T-N ≦ 0.4 mg/l

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N and P vs. troubles in rapid sand filtration

T-P ≦ 0.03 mg/l, T-N ≦ 0.4 mg/l?

plants	lakes	T-N (mg/l)	lakes	T-P (mg/l)
with troubles	L. Kasumigaura	1.21	L. Kasumigaura	0.10-0.24
	Tonden R.	0.76-1.57	L. Sagami	0.2*
	Hata R.	0.40-0.66	-	-
w/o troubles	-	-	Yamaguchi R.	0.03-0.07

*estimated from inorganic N and P concentrations

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Musty Odors

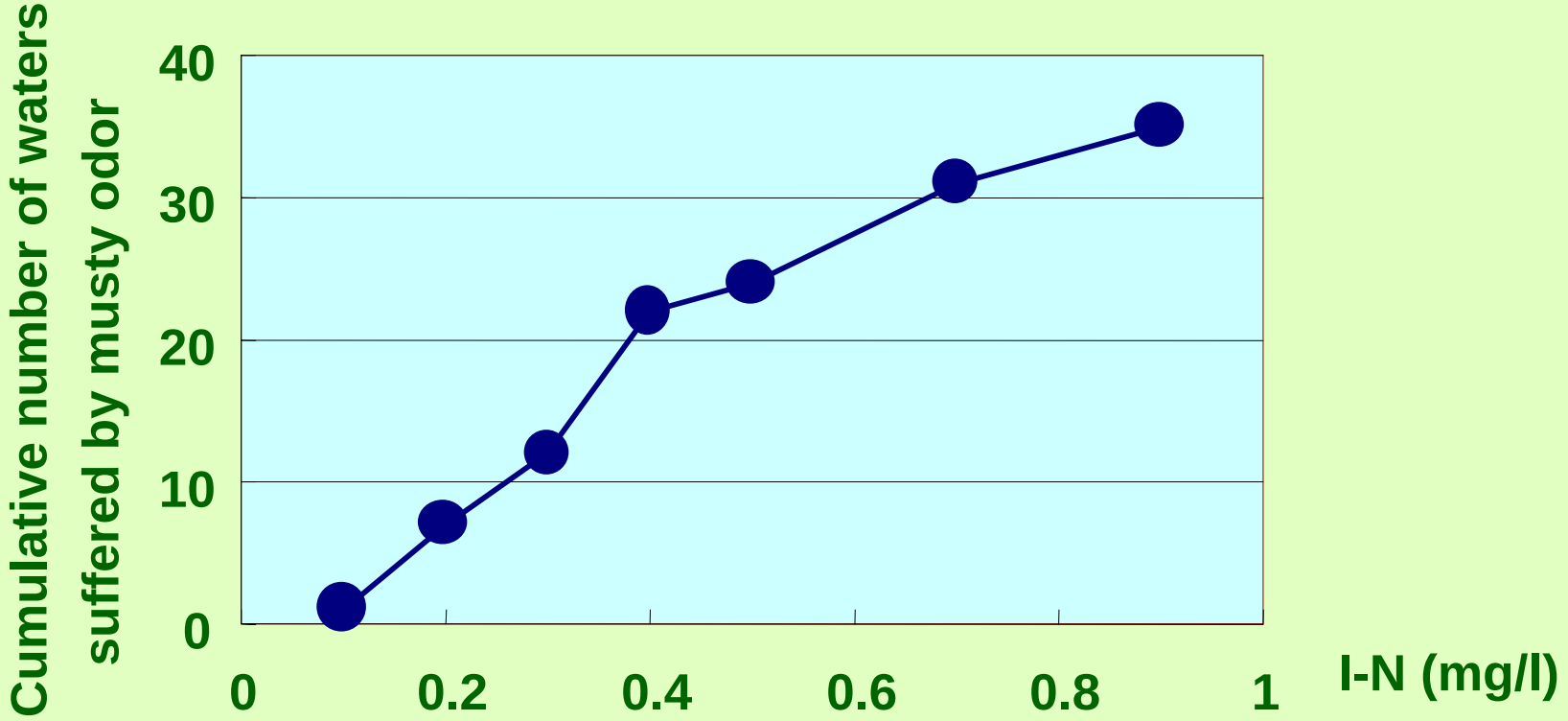
- by *actinomycetis*, cyanobacteria

Frequent musty odor by the report in Japan Water Works Association:

- **inorganic nitrogen ≧ 0.3 mg/l**
- **ortho-phosphate ≧ 0.006 mg/l**

≒ T-P 0.009 mg/l

Musty odor lakes vs. inorganic nitrogen



- **I-N ≧ 0.1 mg/l ≒ 0.15 mg T-N/l →→→ musty odor**
- **prevent musty odors : *T-P ≦ 0.01 mg/l, T-N ≦ 0.2 mg/l***

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Water supply class 2 : rapid sand filtration

- **filtration :**

  T-P ≦ 0.03 mg/l, T-N ≦ 0.4 mg/l

- **musty odors :**

  T-P ≦ 0.01 mg/l, T-N ≦ 0.2 mg/l?

↓

T-P ≦ 0.01 mg/l, T-N ≦ 0.2 mg/l

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NATIONAL MINIMUM EFFLUENT QUALITY STANDARDS

- **Regulate all the effluent discharges into public water bodies from the specified facilities (ca. 600 industries).**
- **Uniform and national minimum criteria for effluent quality**
- **Parameters**
  - **Human health : all facilities**
  - **Living environment : daily discharge > 50 m^3**
  - **Local (prefecture) ordinance**

NATIONAL MINIMUM
EFFLUENT QUALITY STANDARDS

(mg l^{-1} or less)

parameters	standard values
pH	5.8–8.6
BOD, COD	160 (daily average = 120)
SS	200 (daily average = 150)
n-hexane extract	5.0 (mineral oil), 30 (animal fat and vegetable oil)
phenols	5.0
copper	3.0
zinc	5.0
dissolved Fe, Mn	10.0, 10.0
chromium	2.0
fluorine	15
number of C.G.	3,000 ml^{-1} (daily average)
nitrogen	120 (daily average = 60)
phosphorus	16 (daily average = 8)

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EFFLUENT STANDARD FOR N,P

- **National Minimum Standard**
  - **T-N: 120 mg/l (daily max.), 60 mg/l (daily ave.)**
  - **T-P: 16 mg/l (daily max.), 8 mg/l (daily ave.)**
  - **daily discharge > 50 m^3**
  - **closed waters with high possibility of eutrophication**

- **Provisional Standard ← best available technology**
  - **specified industries: N:55, P:39**
  - **national minimum in 5 years (1993-1998)**

PROVISIONAL STANDARD

- **Industries hard to comply with the national minimum standard**
  - **pig/cattle farm: N (700,350), P (100,50)**
  - **coke oven: N (170,130)**
  - **dairy products, tofu: P (30,15)**
- **Improvement in production process**
- **Imput-output analysis for N,P,C**

PROVISIONAL STANDARDS FOR FOOD INDUSTRIES

	code	T-N		T-P	
		max.	ave.	max.	ave.
meat processing	1211	140	70	140	70
dairy products	1212	-	-	30	15
other livestock products	1219	140	70	60	30
fish canning, bottling	1221	440	220	100	50
seaweed processing	1222	180	90	60	30
fish ham/sausage	1224	260	130	160	80
fish paste (boiled)	1225	460	230	320	160
frozen fish products	1226	360	180	140	70
frozen fish processing	1227	460	230	320	160
other fish products	1229	380	190	340	170
soy source and amino acds	1242	480	240	-	-
synthetic seasoning	1243	480	240	-	-
beet sugar refinary	1251	260	130	50	25
fresh cake	1272	-	-	60	30
veqetable oil	1281	-	-	100	50
animal oil	1282	180	90	100	50
grain starch	1292	-	-	30	10
potato starch production	1292	500	250	140	70
tufu/tofu derivatives	1295	-	-	30	15
bean jam	1296	-	-	60	30

REVISION OF THE PROVISIONAL STANDARDS

- **PROVISIONAL STANDARDS:**
  - **1993.10-1998.9**
- **REVISION Ⅰ : 1998.10-2003.9**
  - **N: 50 INDUSTRIES → 4 INDUSTRIES**

    2,851 plants → 115 plants
  - **P: 34 INDUSTRIES → 3 INDUSTRIES**

    2,512 plants → 117 plants
- **REVISION Ⅱ : 2003.10-2008.9**

Revised Standards: P

- **Alumite Processing : 1,000 (530)→ 50 (25)**

  Only for chemical polishing processes by phosphoric acid

- **Feedlot : 100 (50) →50 (40)**
- **Phosphorus and Compounds :**

  640 (280) →90 (40)

Revised Standards : N

- Natural Gas : 200 (180) → 170 (150)
- Feedlot : 270 (350) → 260 (200)
- Inorganic Chemical Industries
  - Silver Oxide : 560 (370) →350 (300)
  - Yttrium Oxide : 35,000 (12,000) → 3,500 (1,200)
  - Vanadium & Molybdenum Compounds : 26,000 (17,000) → 8,000 (6,000)

2nd REVISION (2003.10-2008.9) and 3rd (2008.10-2013.9) OF THE PROVISIONAL STANDARDS

- N: 6 INDUSTRIES
  - Natural Gas : 200 (180) → 170 (150) → 160 (150) → 160 (150)
  - Feedlot : 270 (350) → 260 (200) → 190 (150) →190 (150)
  - Silver Oxide : 560 (370) →350 (300) →240 (210) →remove
  - Cobalt Oxide: → 1100(880) → 900(750) →550(300)
  - Lead Chromate Paint : → 1,500(1,000) → 1,300 (950) →remove
  - Vanadium & Molybdenum Compounds :
    26,000 (17,000) → 8,000 (6,000) → 6,000 (5,000) →5,000(3850)
- P: 2 INDUSTRIES
  - Feedlot : 100 (50) →50 (40) →30 (24) →30 (24)
  - Phosphorus and Compounds : 640 (280) →90 (40) →40 (10) →40 (10)

MORE STRINGENT STANDARDS

- **Local (prefecture) ordinance**
  - **if the national standards are not enough to satisfy with the environmental water quality standards for a specific water body**

- **All the prefecture governments have put local standards in force**

Effluent Guideline for N and P in Tokyo Bay

		daily discharge (m^3)	new		operating			
			N	P	N		P	
					(1)	(2)	(1)	(2)
industries	food	50-400	15	1.5	15	20	3.0	4.0
		>400	10	1.0	10	15	2.0	3.0
	chemical	50-400	10	1.0	10	20	1.0	2.0
		>400	8	0.5	10	15	1.0	2.0
	steel	50-400	10	1.0	10	15	1.0	3.0
		>400	8	0.5	8	10	0.5	2.0
	metal	50-400	15	1.0	20	25	2.0	3.0
		>400	10	0.5	10	15	0.5	1.0
	others	50-400	10	1.0	10	25	1.0	3.0
		>400	8	0.5	10	20	1.0	2.0
others	livestock	50-400	40	5.0	40	50	5.0	8.0
		>400	30	3.0	30	50	3.0	8.0
	P.O.W.T.P	>50	10	0.5	15	20	1.0	2.0
	night soil T.P.	>50	10	1.0	20	45	2.0	3.0
	Jokaso	>50	20	3.0	20	30	4.0	5.0
	others	>50	20	3.0	20	25	3.0	5.0

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PARADIGM SHIFT ON WASTE/WASTEWATER TREATMENT

- **Production/life style**

  → **maximum efficiency**

- **Waste/wastewater treatment**

  → **maximum efficiency**

Production/life style+ Waste/wastewater treatment

→ **maximum efficiency**

Avoid waste/wastewater treatment as possible as you can!

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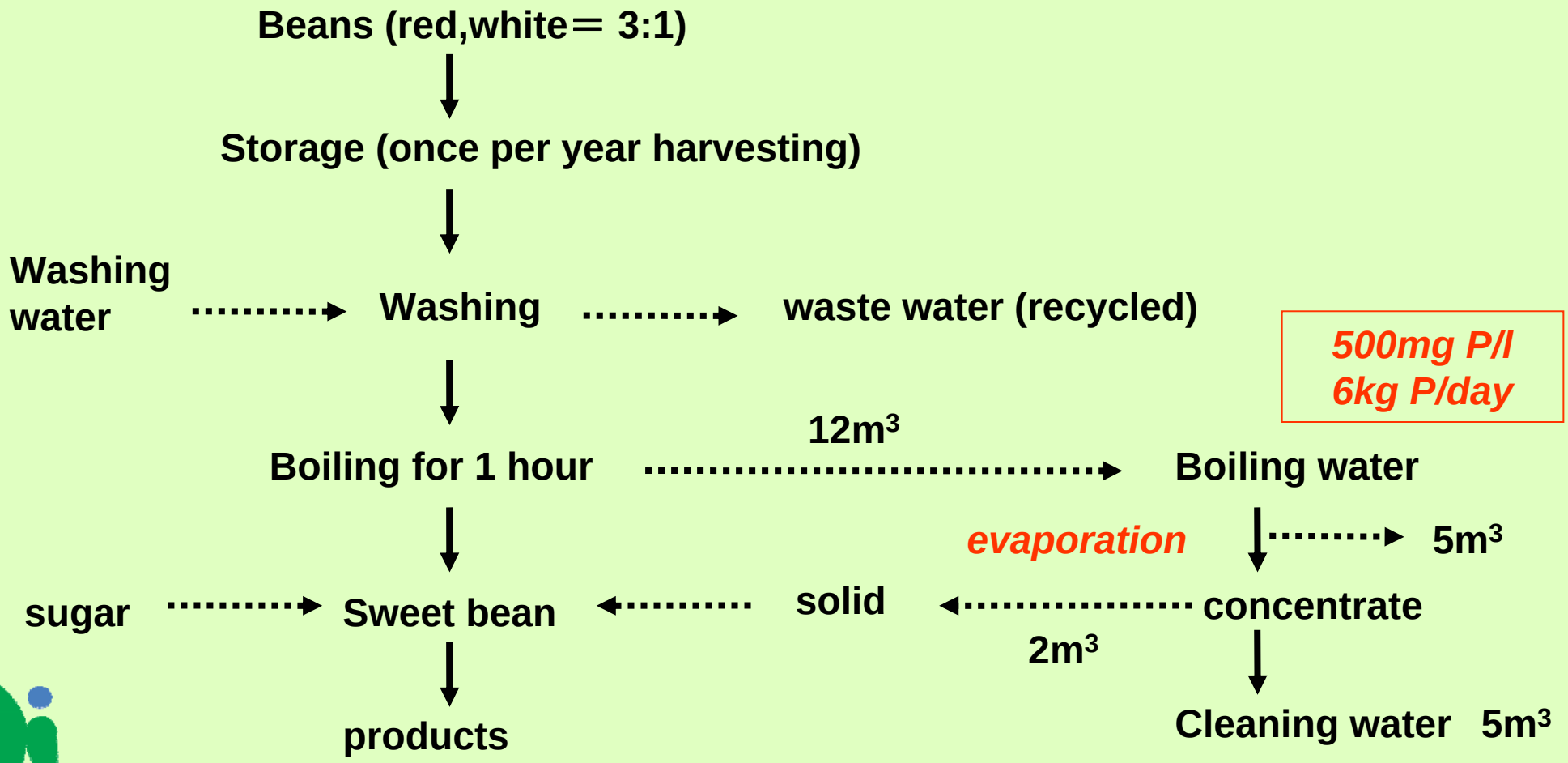
RECYCLING OF BIOLING WATER TO REDUCE P-LOADING



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SUMMARY OF LECTURE

① *Environmental water quality standards*

- *All the standards were developed based on limited scientific understandings and information to secure water use*

② *Effluent water quality standards*

- *The standards are proposed to satisfy with the environmental water quality standards but never ignored the state of the (best) available technology*

③ *Reduction of wastewater loading*

- *Green Engineering: The better production technology to reduce wastewater loadings rather than wastewater treatment*

Time for Q & A

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