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Japanese Approach of Pollutant Load Reduction to Achieve Environmental Water Quality Goals

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Contents

1. Water Pollution Control Institution

Water Pollution in Kitakyushu City in 1960's

Courtesy by Kawai, JSC(2018)

Serious water pollution in Kitakyushu City (1960s)

Water Pollution of Tokyo in 1970's

Courtesy by Kawai, JSC(2018)

Photos Credit : Environmental Bureau of the Tokyo Metropolitan Government

Setting EWQS and Pollution Session Diet

Basic Law for Environmental Pollution Control (1967)※

※Replaced by the Basic Environment Law in 1993

- Establishment of Environmental Water Quality Standard (EWQS)
  - EWQS for the protection of human health (Health Item)
  - EWQS for the conservation of the living environment (Living Environment Item)

Pollution Session of Diet (1970)

- Discussed intensively on pollution issues and developed the framework for environment/sanitation policies

Major achievements

- Water Pollution Control Law
- Amendment of Sewerage Law

Pollution Diet in 1970

Courtesy by Kawai, JSC(2018)

Enactment of Water Pollution Control System

Water Pollution Control Law (1970)

- Nationwide effluent regulations on factories or commercial facilities
- Water Quality Monitoring in Public Waters
- Domestic Wastewater Control
- Total Pollutant Load Control System in designated enclosed coastal seas (1979)

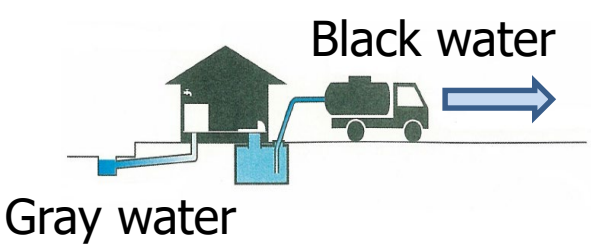
Sewerage Law (Amendment 1970)

- Sound development of urban areas
- Contribution to improvement of public health
- **Preservation of water quality in public water body(CBPSS)**

Typical Domestic Wastewater Systems

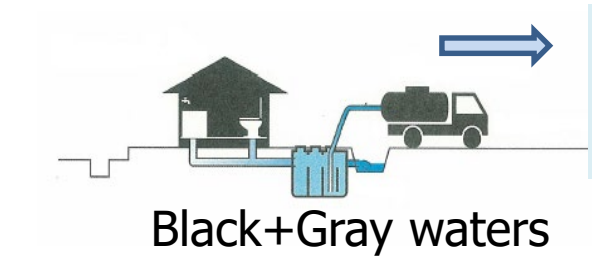
Courtesy by Kawai, JSC(2018)

Night Soil Collection and Treatment

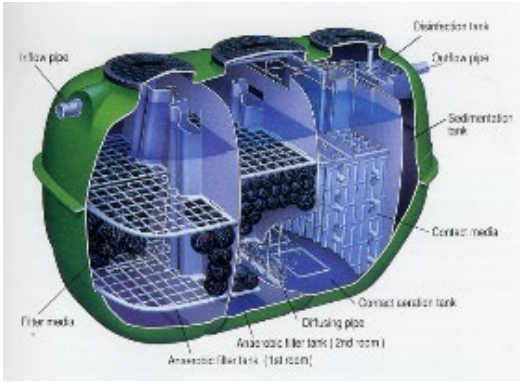


Night Soil Treatment Plant

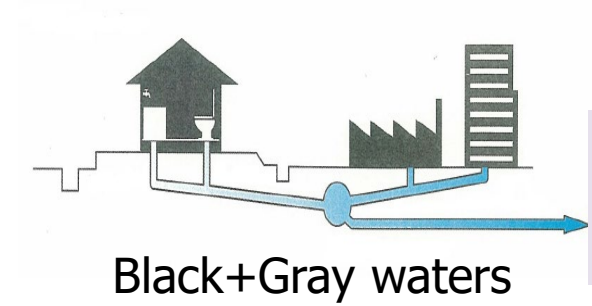
Johkasou System



Sludge Treatment Plant



Public Sewerage System

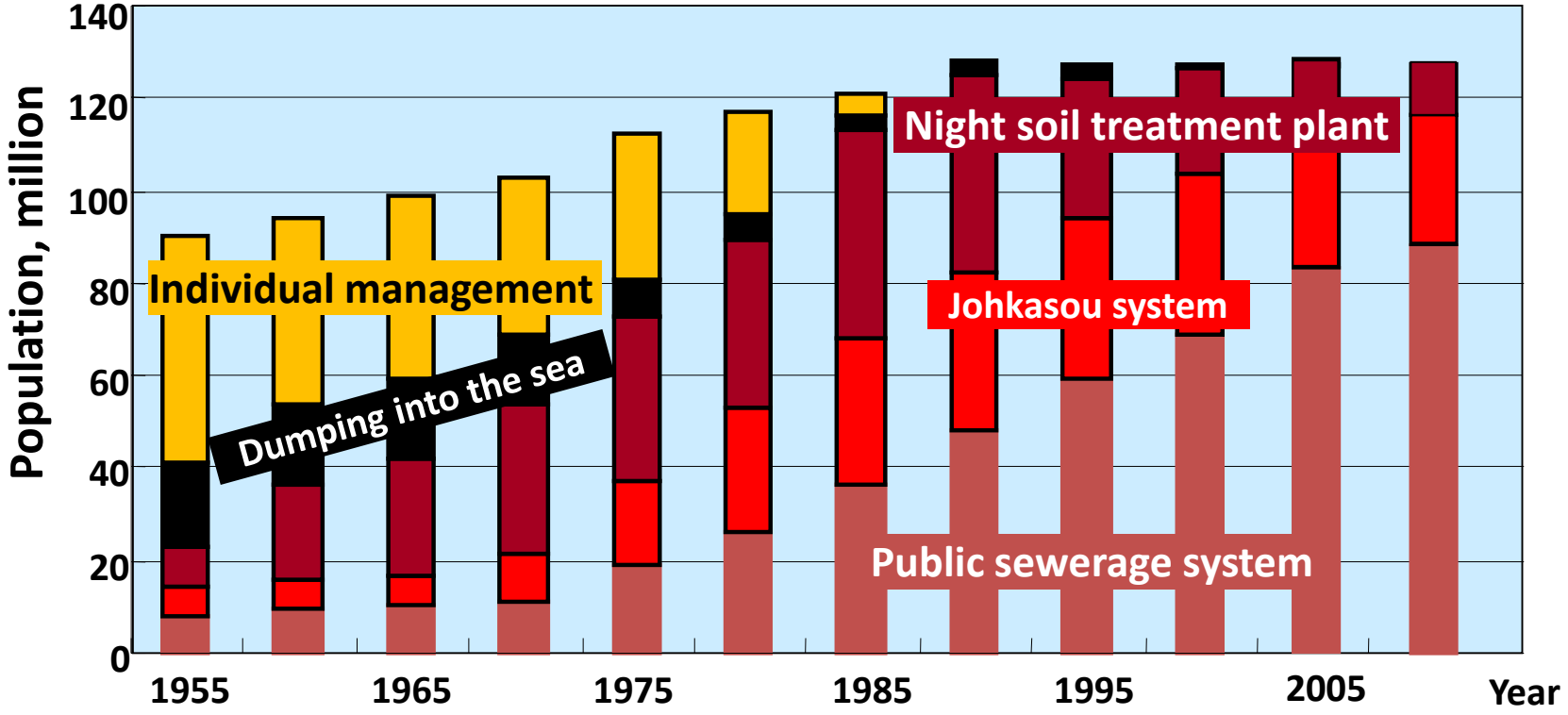


Sewage Treatment Plant

Population Trends for On-site and Off-site Domestic Wastewater Systems in Japan

Total population: 124,483,000
(End of fiscal year 2023)

- Public sewerage system: 101,280,000 (81.4%)
- Johkasou system: 11,770,000 (9.5%) Black＋Gray
- Community size Johkasou: 3,090,000 (2.5%)B＋G
- Gray wastewater Non-treatment : 8,339,000 (6.7%)



Development of domestic wastewater management in Japan (1955 - 2010)

Courtesy by Kawai, JSC(2018)

Water Pollution Control Law (national-minimum effluent quality)

Effluent must satisfy stricter quality standards than the following standards.

Typical Items	range
pH	5.8～8.6
Escherichia coli	～800CFU/mL※
Suspended Solid	～200mg/L（Daily av. 120）
BOD_5 (rivers) COD_{Mn} (lakes, seas)	～160mg/L（Daily av. 120） ～160mg/L（Daily av. 120）
T-N	～120mg/L（Daily av. 60）
T-P	～20mg/L（Daily av. 8）

※ Effective as of April 2025

and

15 other items relevant to living environment are also regulated besides 28 hazardous substances

More stringent regulation by Total Pollutant Load Control System and prefecture if necessary.

Sewerage Law (on Effluent Quality)

Effluent must satisfy stricter quality standards than the following standards.

Parameter	Range
pH	5.8～8.6
Escherichia coli	～800CFU/mL※
Suspended Solid	～40mg/L
BOD_5	～15mg/L
T-N	～20mg/L
T-P	～3mg/L

※ Effective as of April 2025

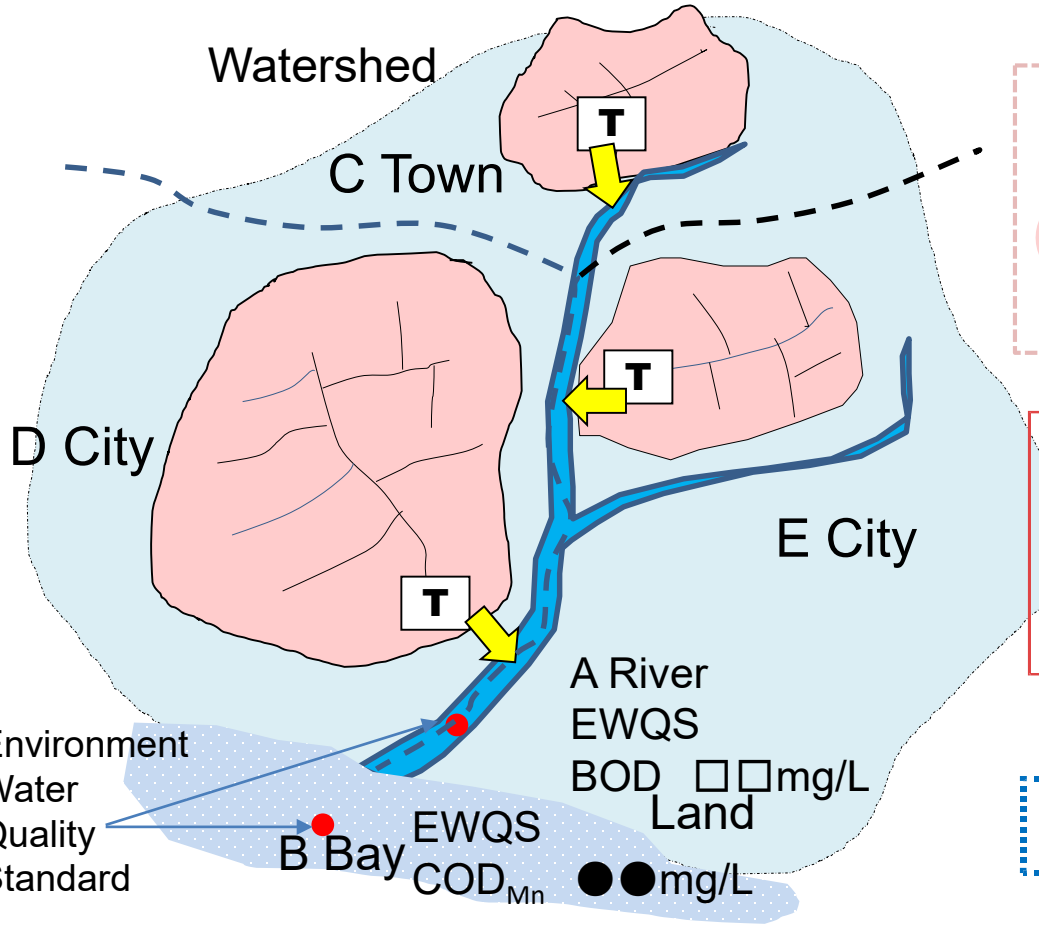
OR **Effluent quality standards has to follow STP discharge quality designated by Basin-wide Planning of Sewerage System (CBPSS) if completed.**

OR **Effluent quality standards of the Water Pollution Control Law.**

2. EWQS Achievement Plan by CBPSS

Outline of Comprehensive Basin-wide Planning of Sewerage Systems (CBPSS)

Pollutant reduction by sewerage systems on the watershed should be evaluated if **achieve environment water quality standards（EWQS)** of corresponding water bodies.



Pollutant Sources

Point Source	Nonpoint Source
Domestic, **Commercial**, **Industrial**, **Livestock** etc.	**Agriculture**, **Livestock**, Natural etc.

Domestic Wastewater Treatment Facilities
- Sewerage system
- Onsite system
- Johkasou
- Nightsoil collection

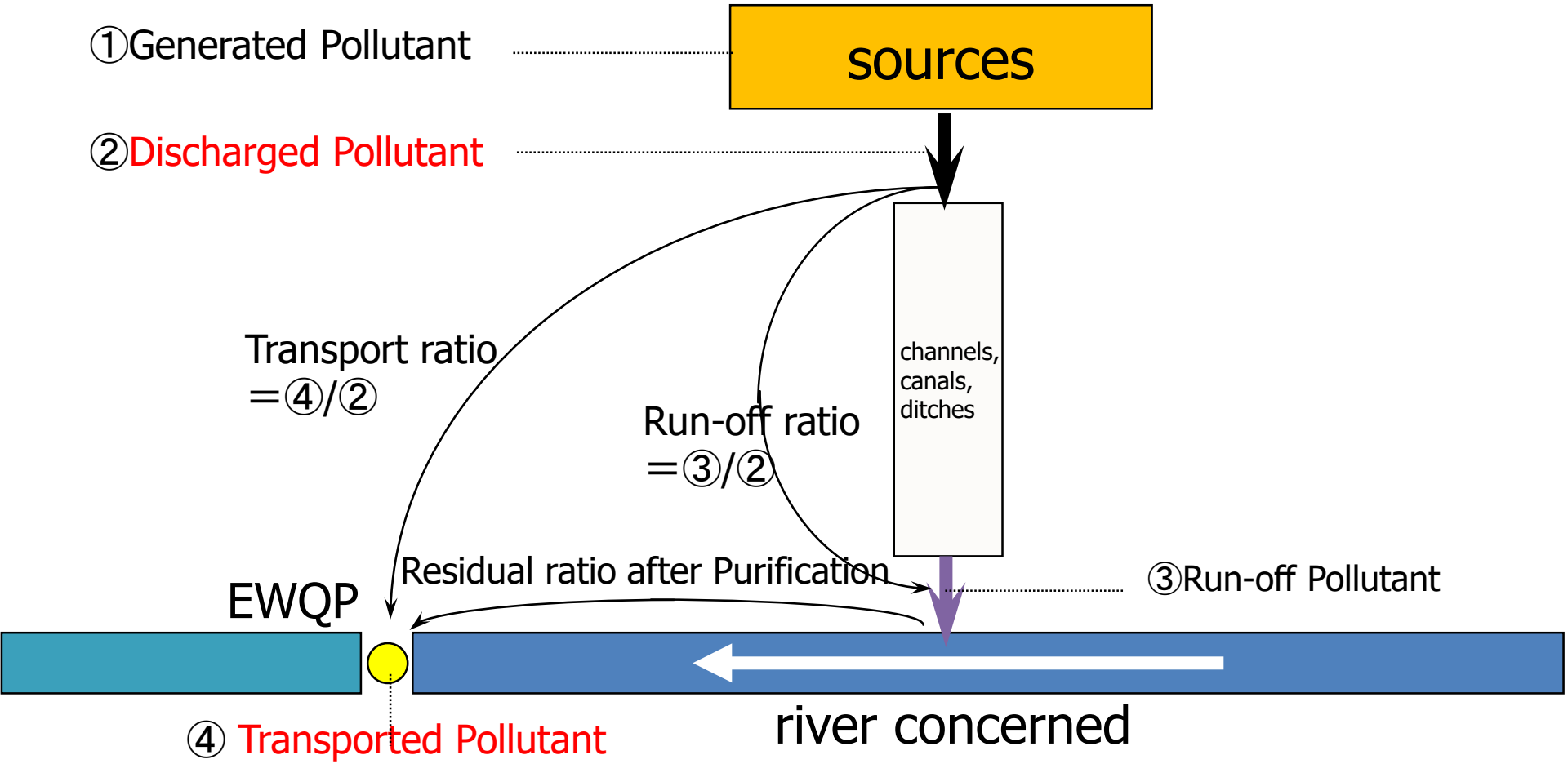
Wastewater Treatment Facilities

Effluent Regulation

Public Waters

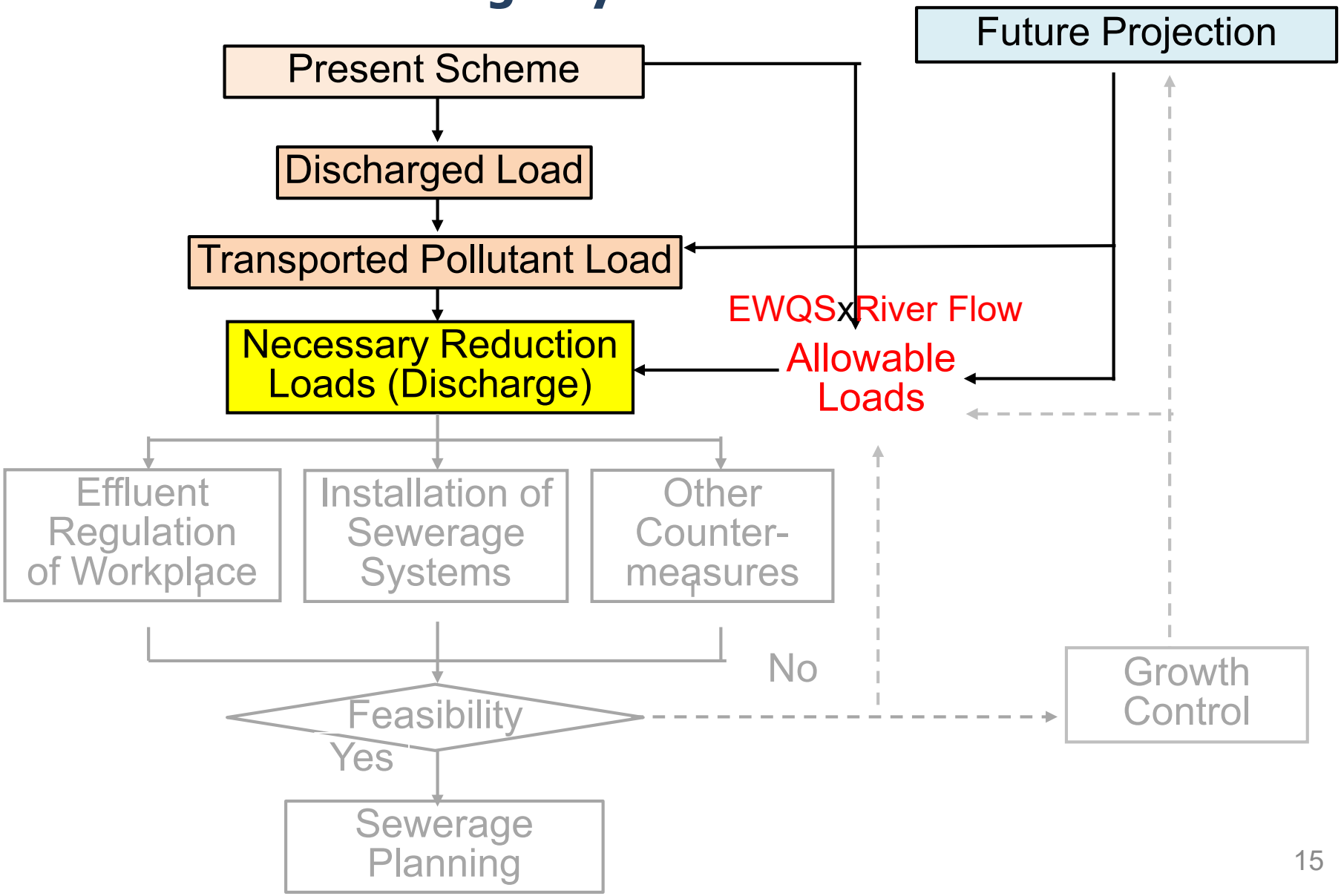
CBPSS designates treatment capacity of individual STPs

Concept of Pollutant Transport from Sources to Receiving Waters in CBPSS

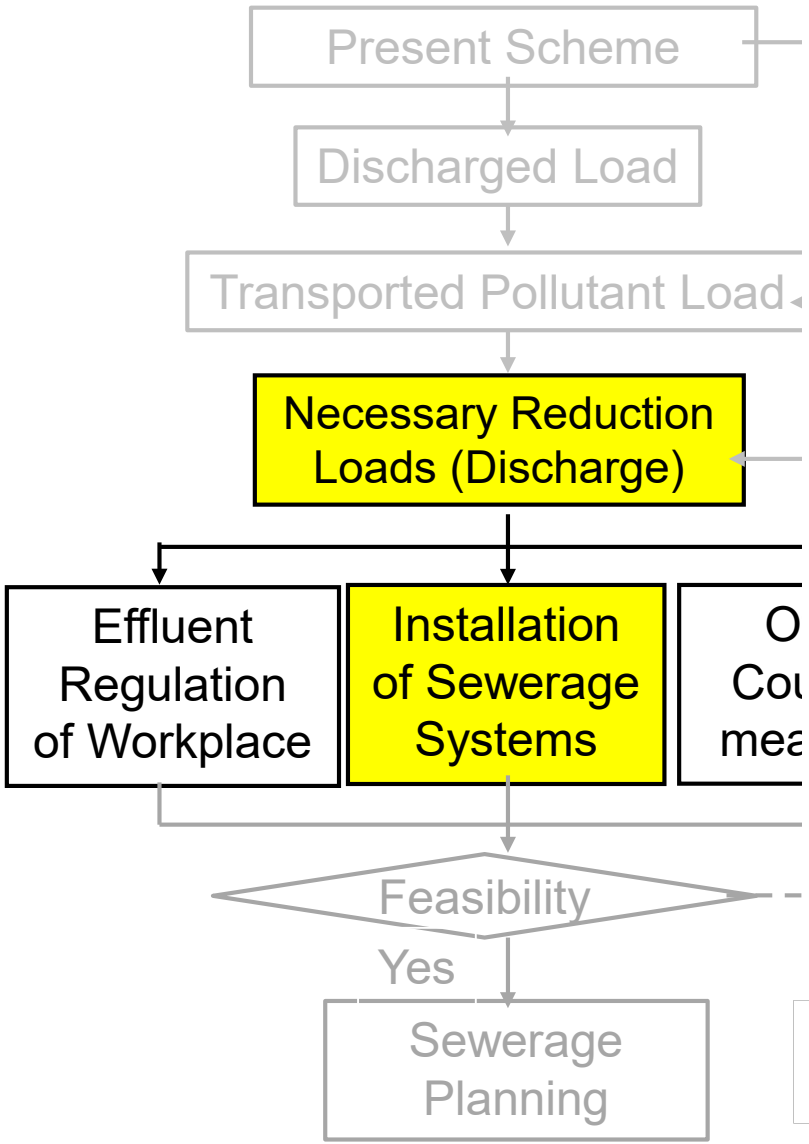


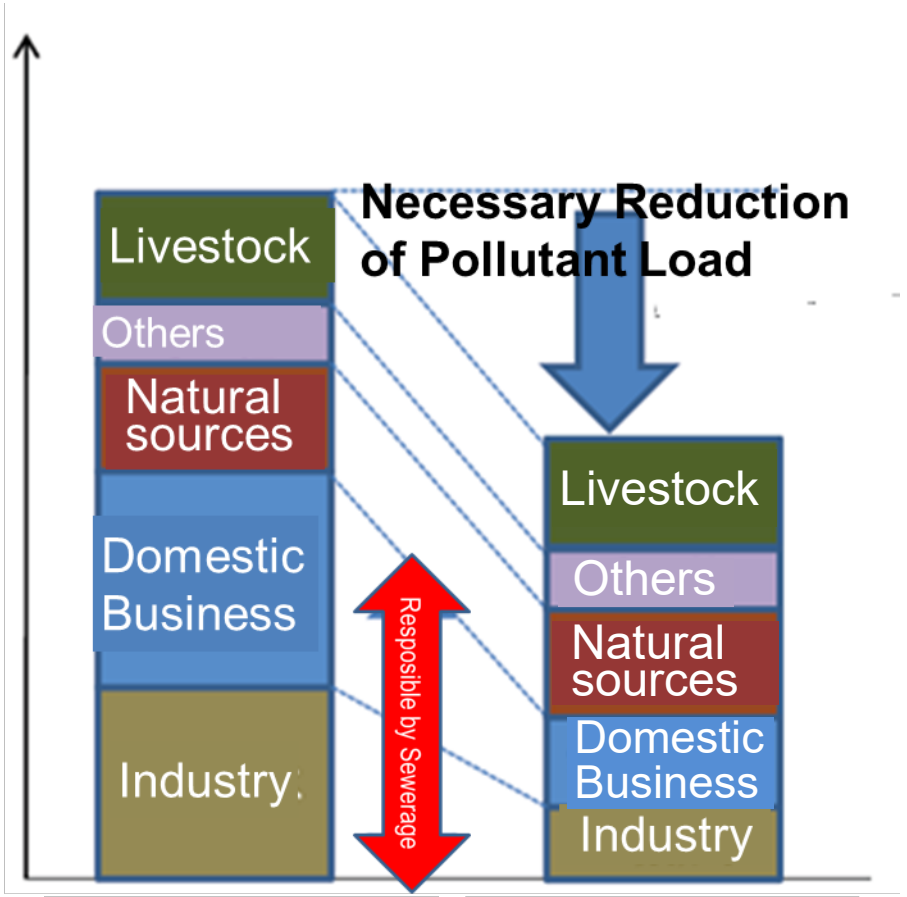
Discharged Ratio =Discharged Load/Generated Loads=②/①
Run-off Ratio= Run-off Load/Discharged Loads=③/②
Transported Ratio=Transported Loads/ Discharged Load=④/③

Allocation of Pollutant Load to Sewerage Systems in CBPSS



Allocation of Pollutant Load to Sewerage Systems in CBPSS





Pollutant Loads Discharged in Watershed

Pollutant Loads Allowable to observe EWQS

C_{EWQS} X QFlow Rate = Allowable Pollutant Load @ gaging location

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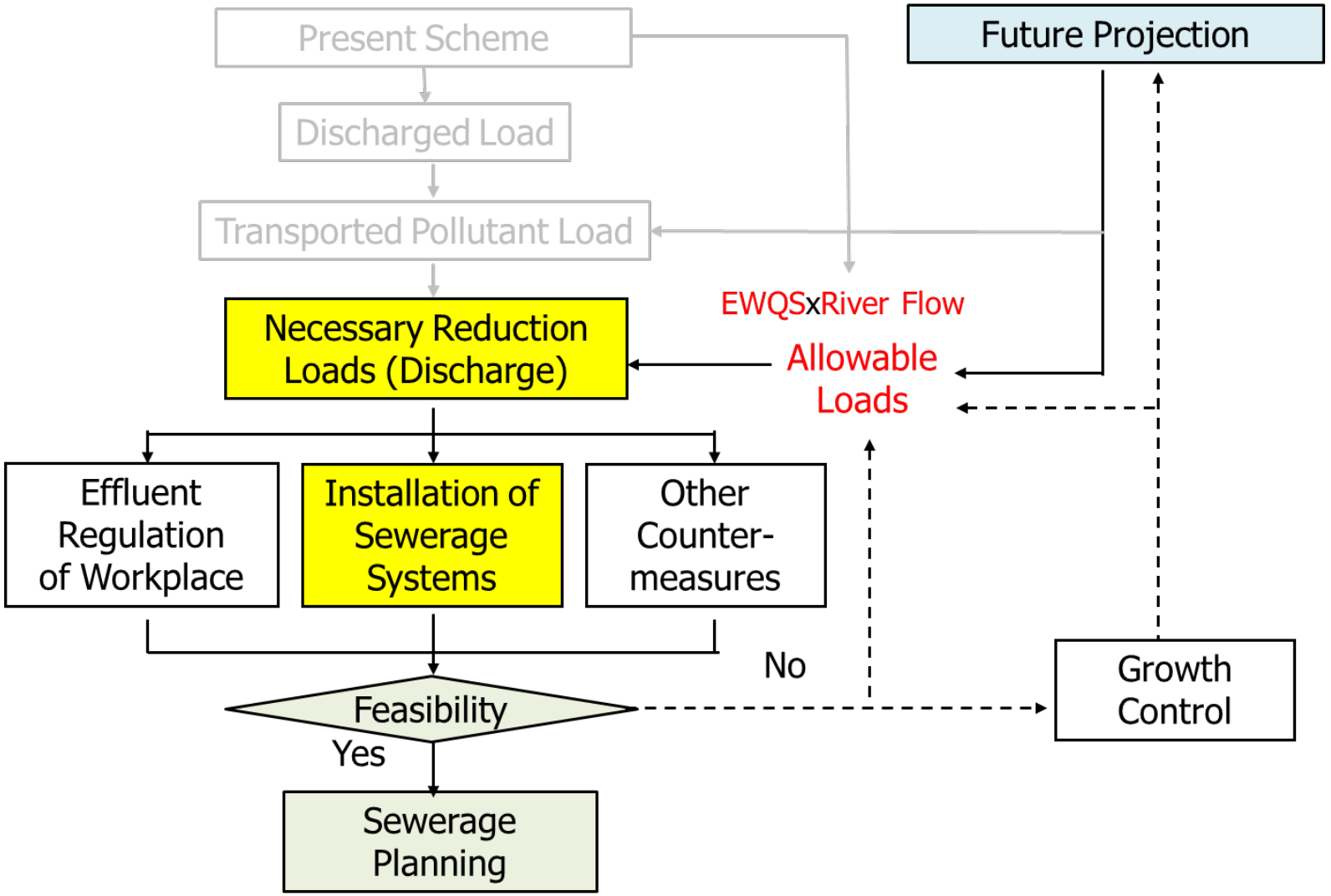
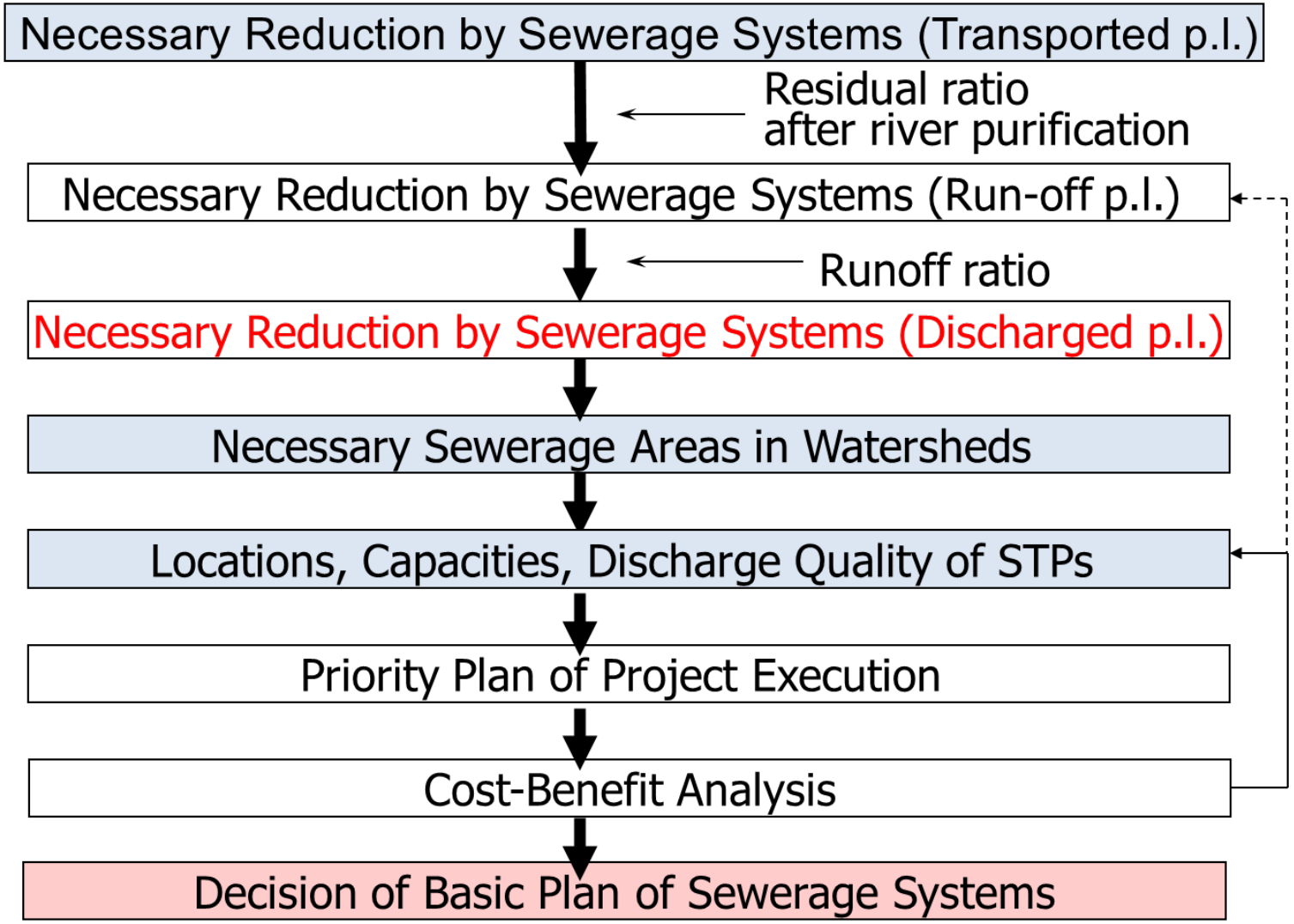
Allocation of Pollutant Load to Sewerage Systems in CBPSS

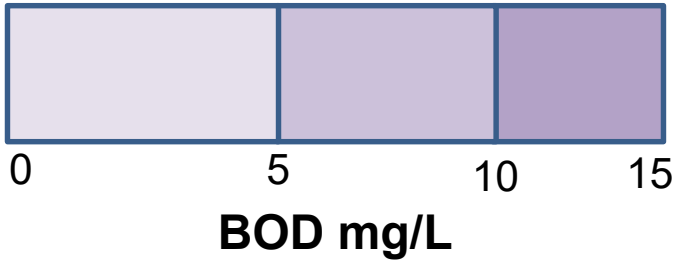


Decision of Sewerage Plan on Watersheds to Achieve EWQS

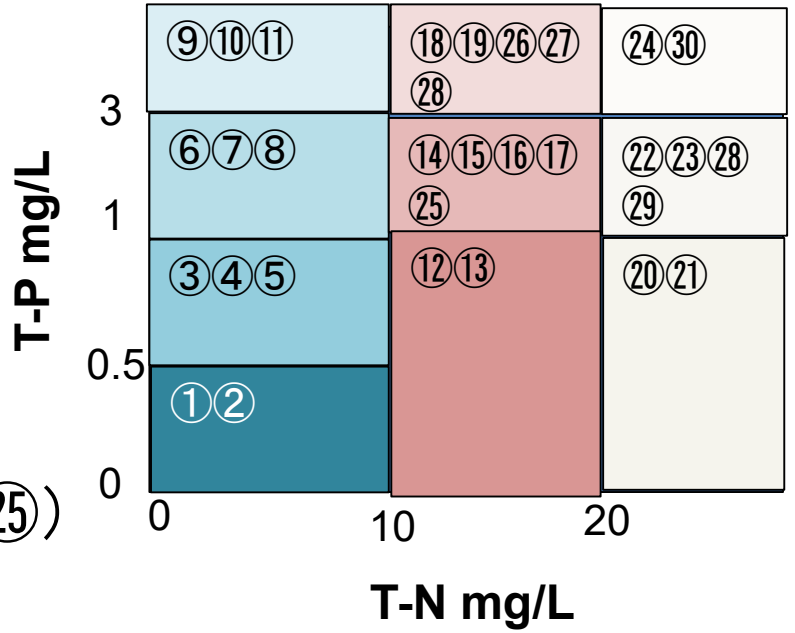


Selection of Conventional/Advanced Treatment of Structure Standard in Sewerage Law

- Filtration
- Charcoal Absorption
- Coagulation etc.



- Nitrogen Removal
  (⑨⑩⑪⑱⑲㉖㉗㉘)
- Phosphorus Removal
  (⑳㉑㉒㉓㉔㉘㉙㉚)
- Simultaneous Nitrogen-Phosphorus Removal etc.
  (①②③④⑤⑥⑦⑧⑫⑬⑭⑮⑯⑰㉕)

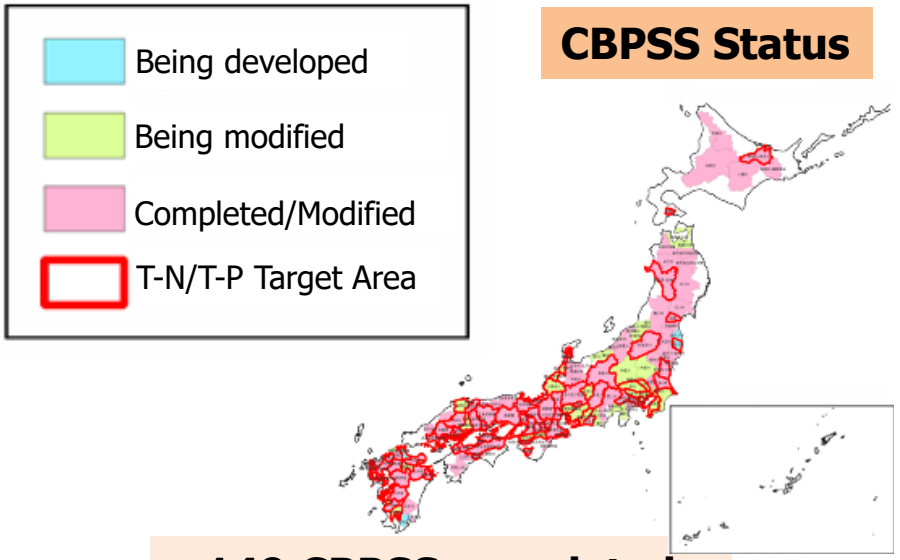


CBPSS Promote Sewerage Development and Advanced Treatment

Courtesy by MLIT(2025)

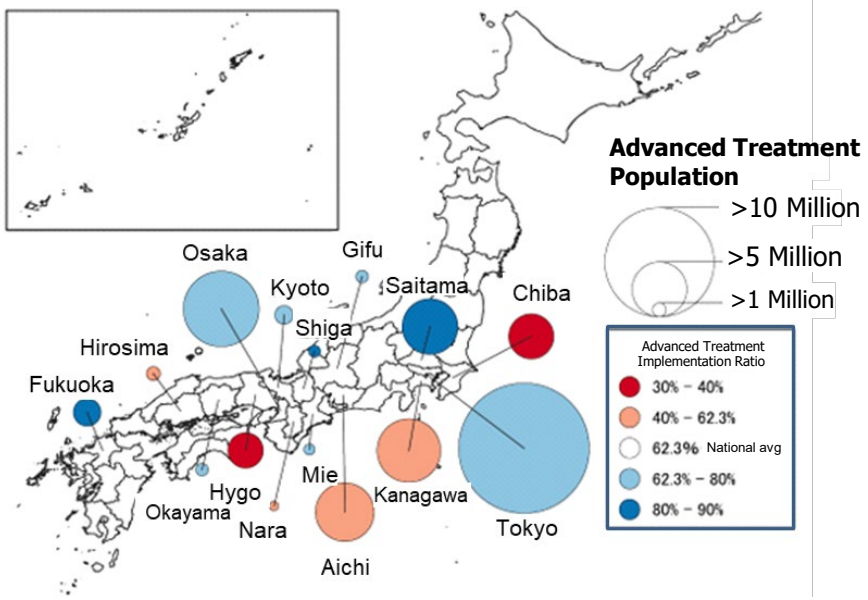
Courtesy by MLIT(2025)

CBPSS Status

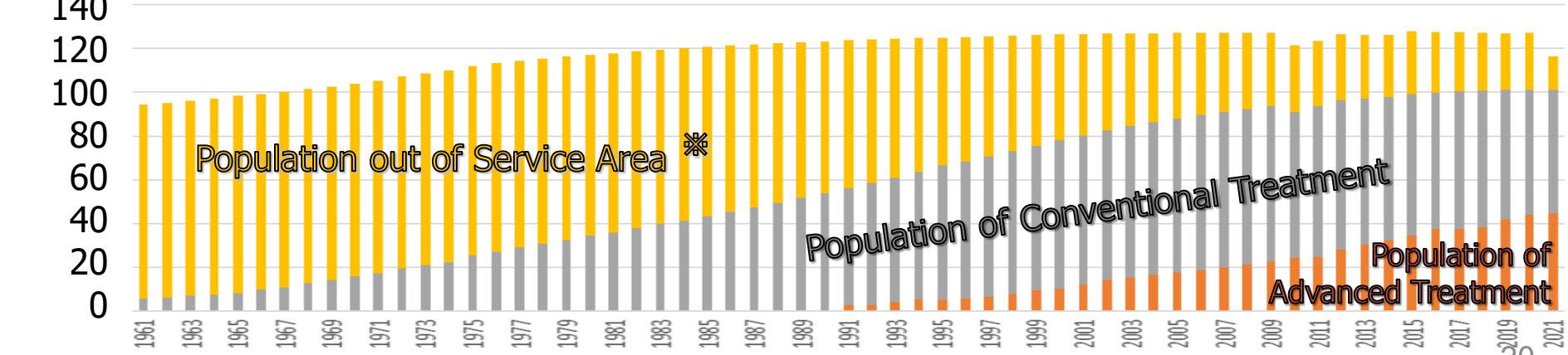


149 CBPSS completed

Advanced Treatment Status



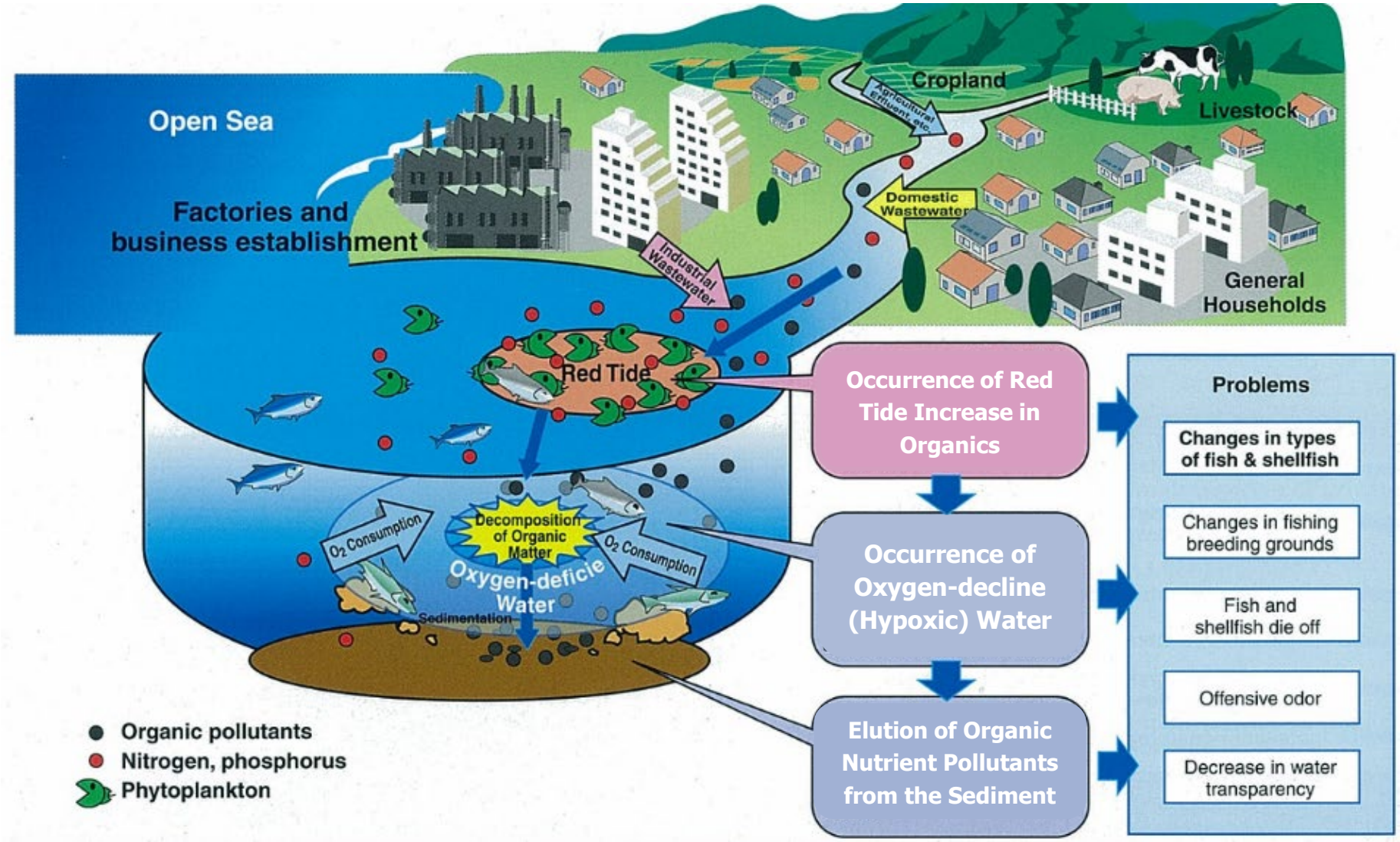
Population using Sewerage Systems



※This includes population using Johkasou users

3. Pollutant Reduction by Total Pollutant Load Control System

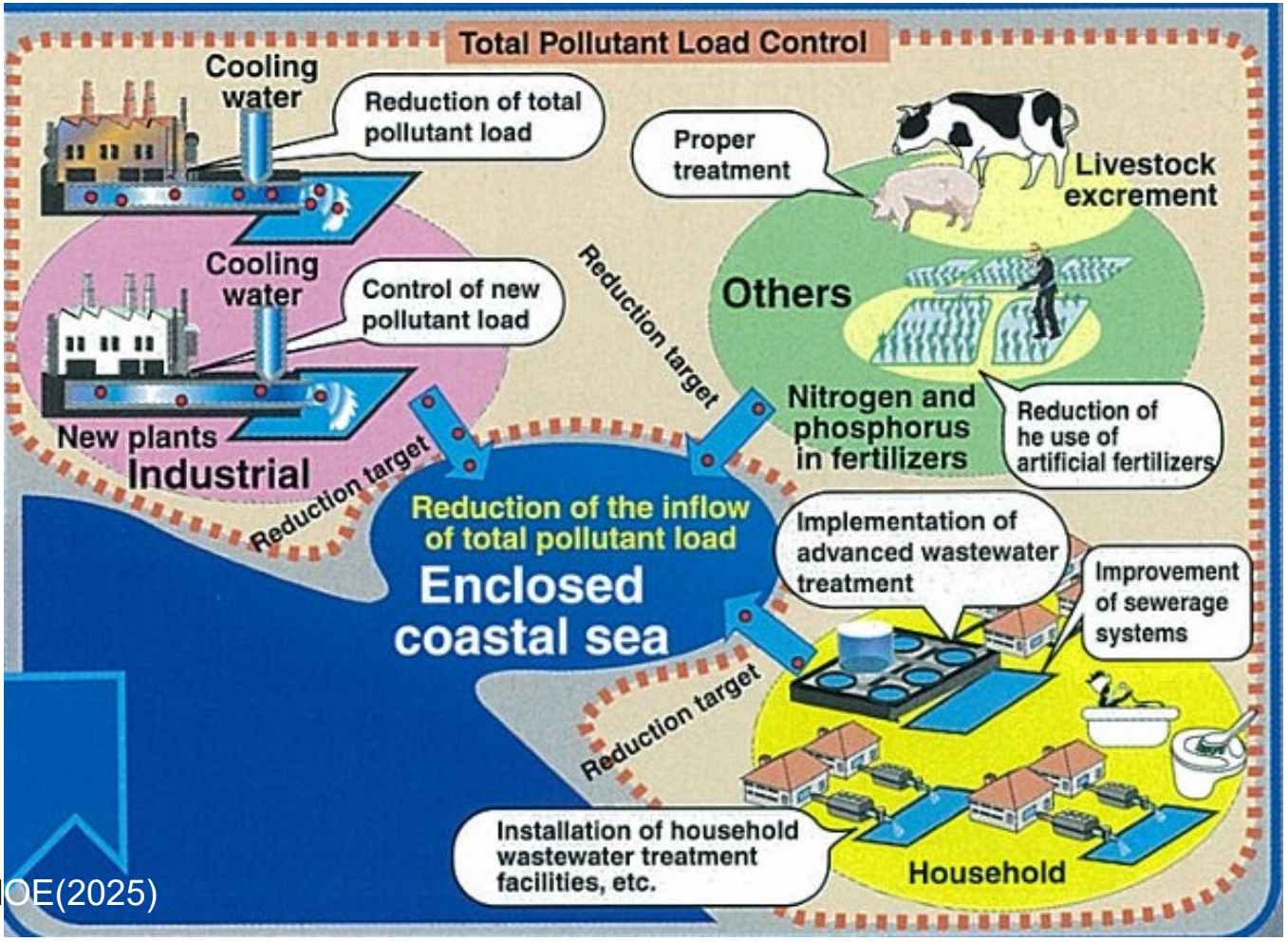
Organic & Nutrient Control Needed for Water Quality Management of Enclose Bays



Courtesy by MOE(2025)

Concept of Total Pollutant Load Control System

Effluent regulation alone could **not reduce efficient pollutant load in terms of COD, T-N, T-P for enclosed bays** with high population density and business activity.



Courtesy by MOE(2025)

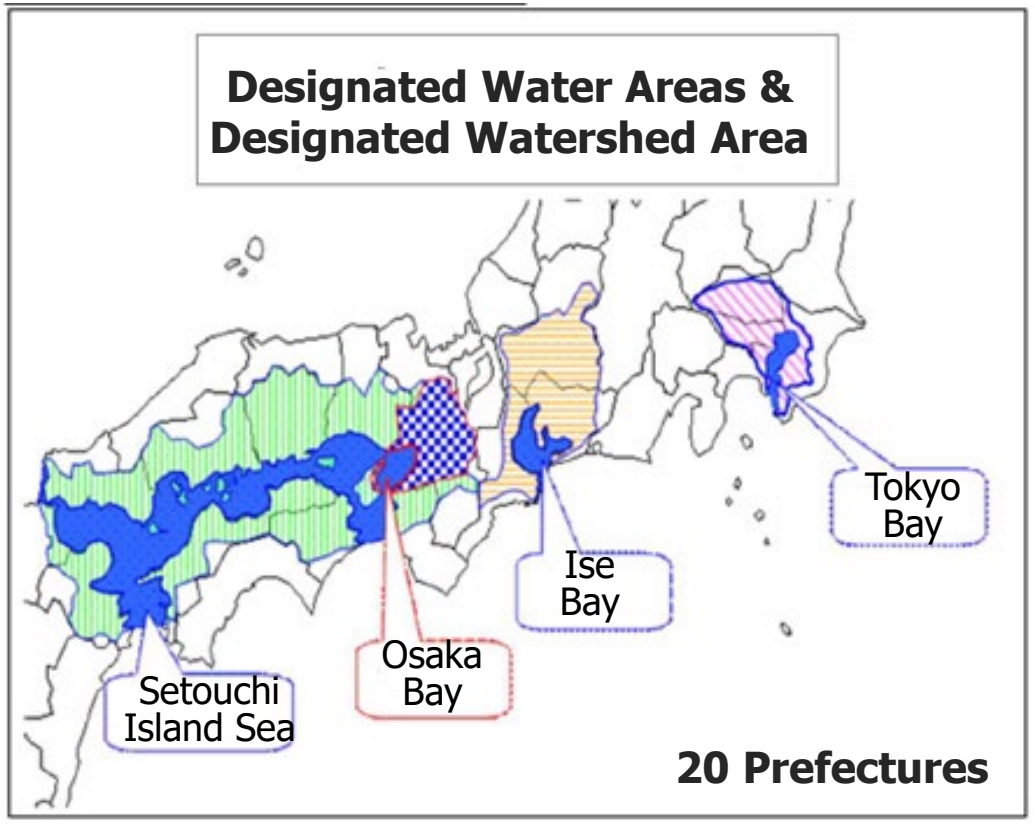
Total Pollutant Load Control System (TPLCS)

Reducing pollutant loads into the large enclosed sea and coastal areas, where effluent standards are insufficient for achieving and maintaining the Water Environmental Quality Standards.

Designated Particulars
- COD (1979～)
- T-N(2001～)
- T-P(2001～)

Every 5 years
- National Government indicates reduction amounts of pollutants

Prefectures set Standards for
- Controlling Total Emissions
- Designated Workplaces (Q≧50m3/day) in Designated Areas
- Allowable discharge daily load (L value)＝discharge concentration (C value) X discharge flow(Q value)



Courtesy by MOE(2025)

Total Pollutant Load Control System (TPLCS)

Basic Policy for Total Emission Reduction(Minister of MOE)

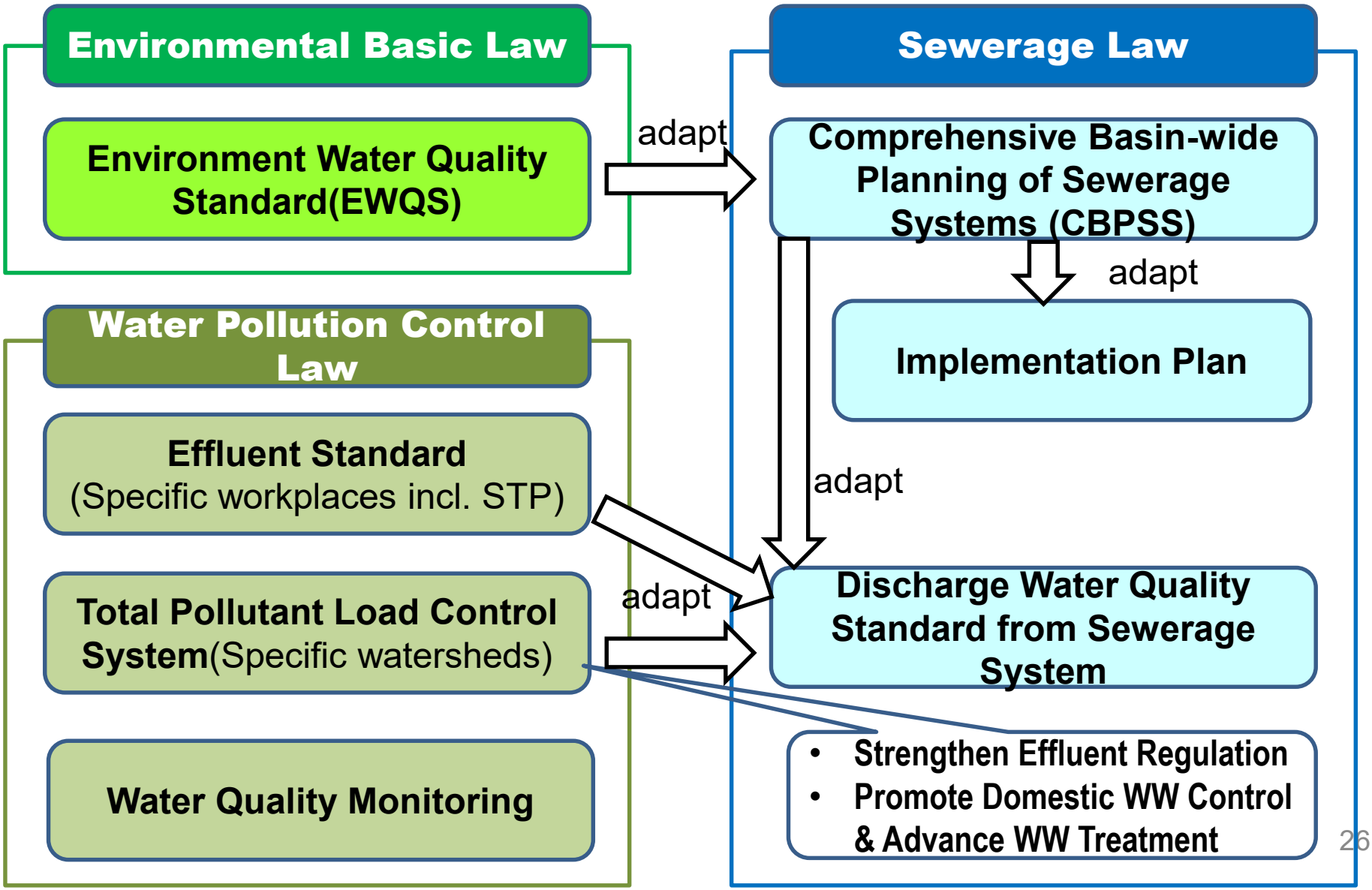
Target year, Reduction Amount, Basic policies

Plans for Reducing Total Emission Reduction(Prefecture Governor)

- Reduction Amounts of each sources(domestic, industrial, others)
- Countermeasures of reduction amounts
- Other necessary particulars

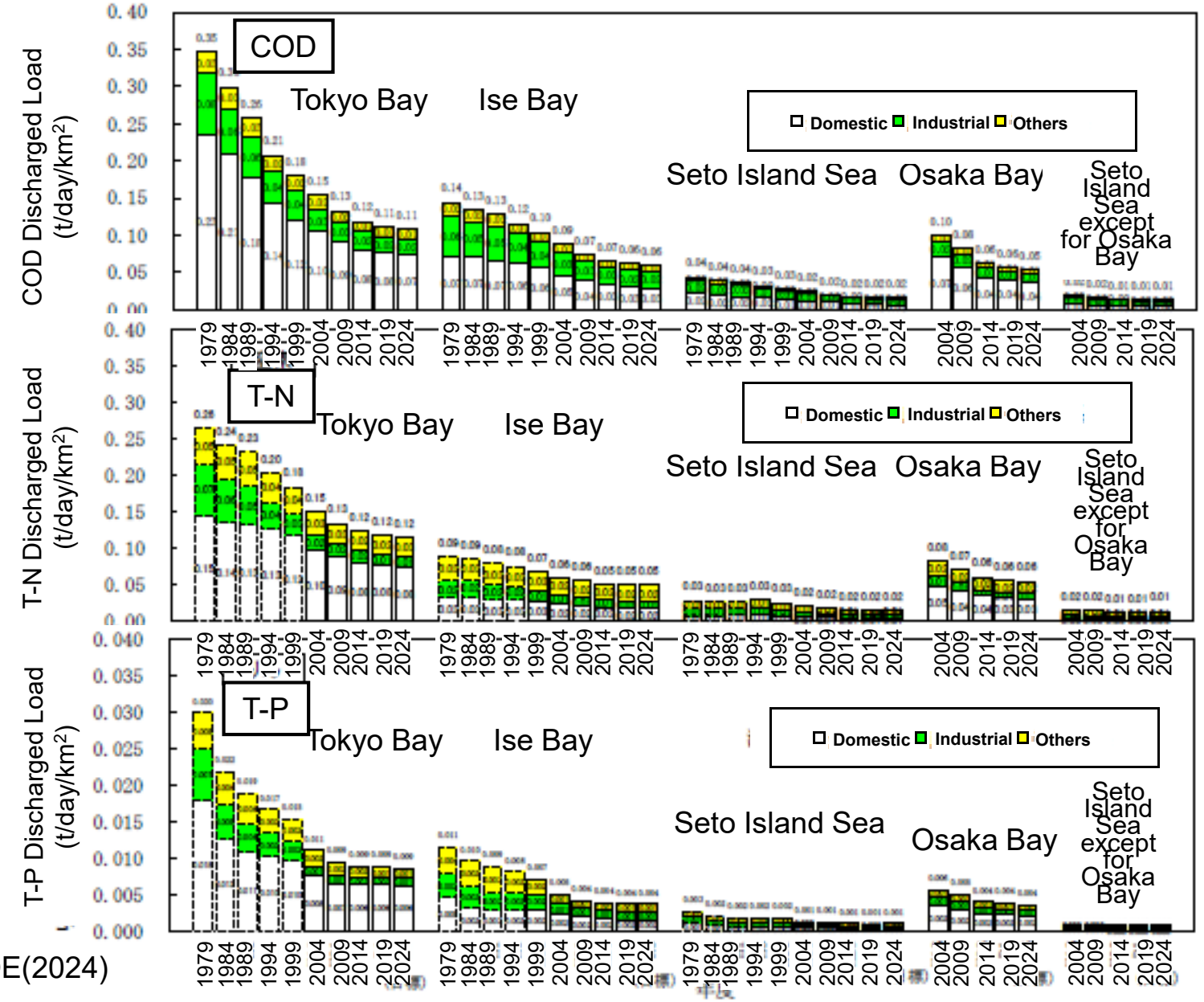
Standards for Controlling Total Emissions	**Guidance of reduction etc.**	**Project Implementation**
• Regulation of Pollutant Load from Specified Workplaces≧50m^3/day • Prefectures set C value to each type of industries	• Countermeasures of Effluents Discharged from Smaller Workplaces • Countermeasures of Unregulated Workplaces including Agriculture etc.	• Development of Sewerage, Johkaso etc • Introduction of advance treatment

Collaboration of Water Pollution Control Law and Sewerage Law



Success in Pollutant Reduction by Total Pollutant Load Control System

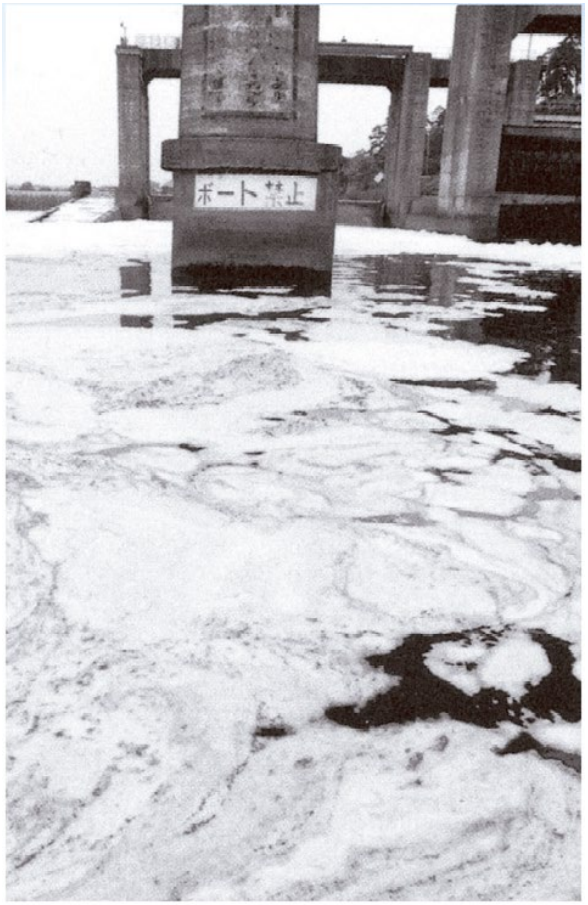
Trend of Pollutant Load Per Unit Watershed Area of Designated Water Area



Courtesy by MOE(2024)

4. Emerging Challenges After Success in Pollutant Load Reduction

Improvement of Water Quality in Tama River



Past view of Tama River (1970s)

Present-day view of Tama River

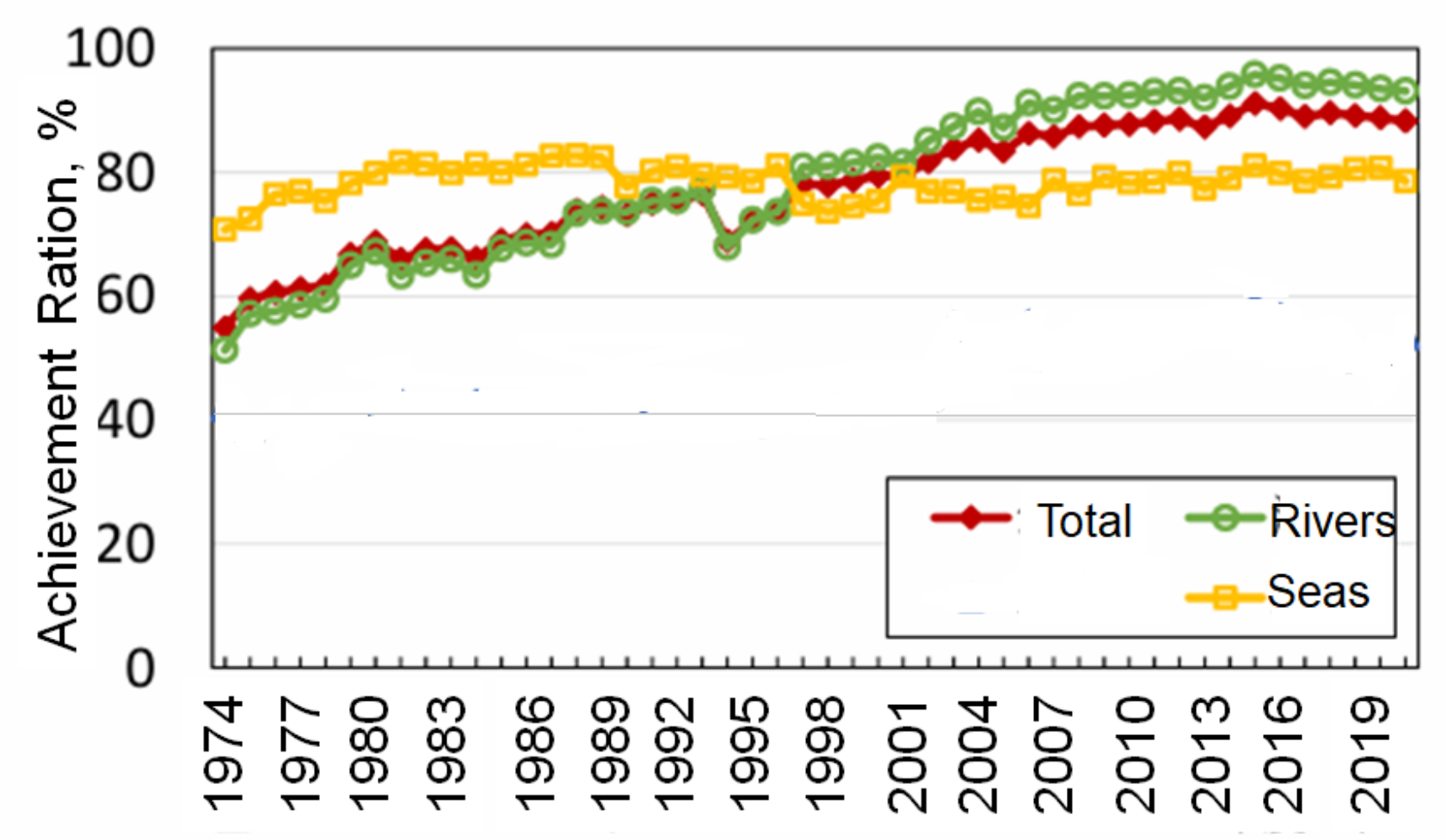
Ayu (Sweetfish) jumping upstream in Tama River

Courtesy by Kawai, JSC(2018)

Improvement of Water Quality of Kitakyushu City

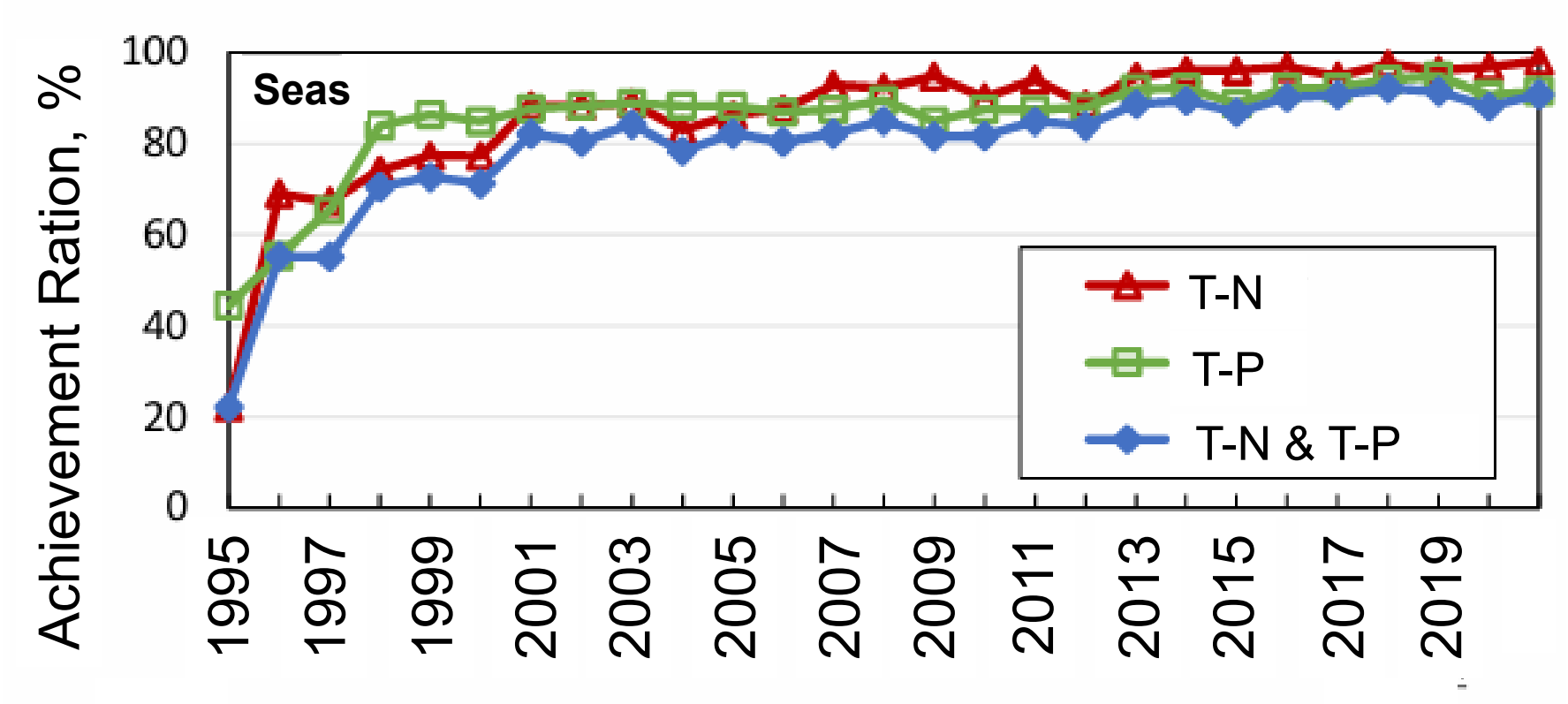
Courtesy by Kawai, JSC(2018)

Achievement Ratio of EWQS relevant to Organic Matters



Courtesy by MLIT (2024)

Achievement Ratio of EWQS Relevant to Nutrients in Seas



Courtesy by MLIT (2024)

Establishment of New EWQS

Background

Courtesy by MOE (2016)

- Indicator of **Coliform groups** that are not derived from feces, making them unsuitable for accurately detecting fecal contamination and **inappropriate as a hygiene indicator**.
- The existing COD, T-N, T-P have been established as indicators of eutrophication, but **hypoxic waters remain in enclosed bays**.

New Indicators

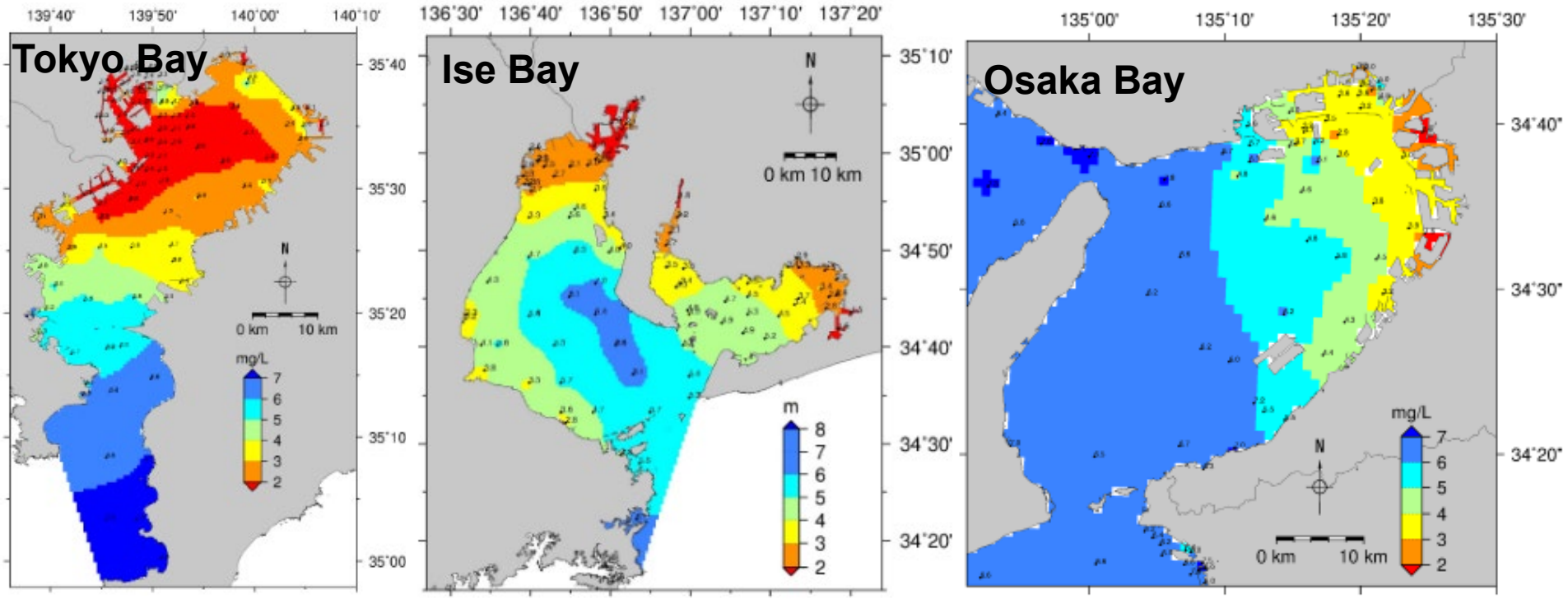
- **Change** coliform groups **to** ***E. coli*** **as for** fecal indicator of **EWQS** because of the establishment of its measurement (20CFU/100mL to 1000CFU/100mL) in 2022.
- Indicator of **bottom-layer dissolved oxygen concentrations** that can directly assess the impact on the habitat of fish and selfish is added to **EWQS** (2mg/L to 4mg/L) in 2016.

Emerging Issues of New EWQS

National Compliance Ratio of EWQS in terms of *E. coli* in FY 2022

1,991 stations among 3,368 monitoring station of *E. coli* measurement in rivers comply with EWQS, whose compliance ratio, 59% is equivalent to those of BOD in 1980s. Therefore, strengthening *E. coli* discharge regulation might be necessary.

Distribution of Bottom Layer DO Concentration in Enclosed Bays



Average of yearly minimum values during 2019 to 2021

Courtesy by MOE (2025)

Decrease in Nutrients Causes "Bountiful Sea" Activities by Fishery Sectors

Normal Seaweed

Bleaching Seaweed

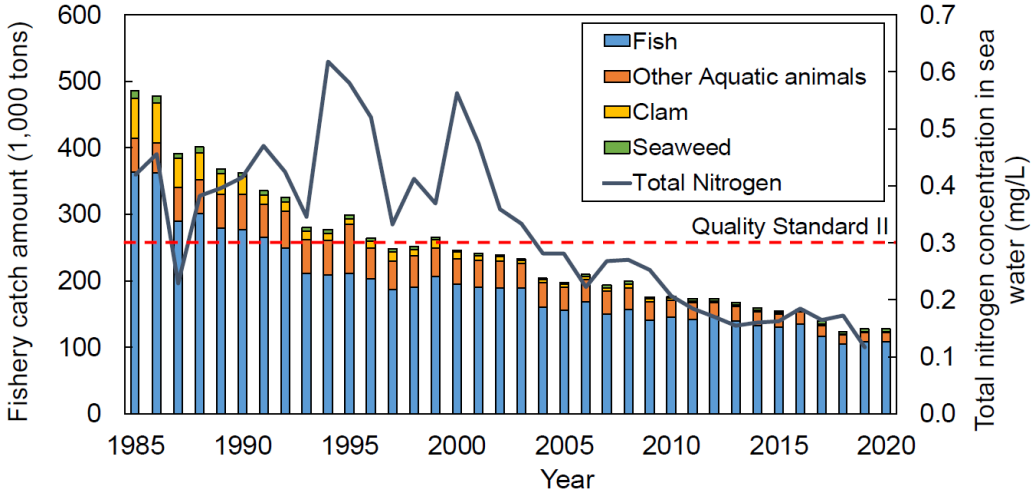
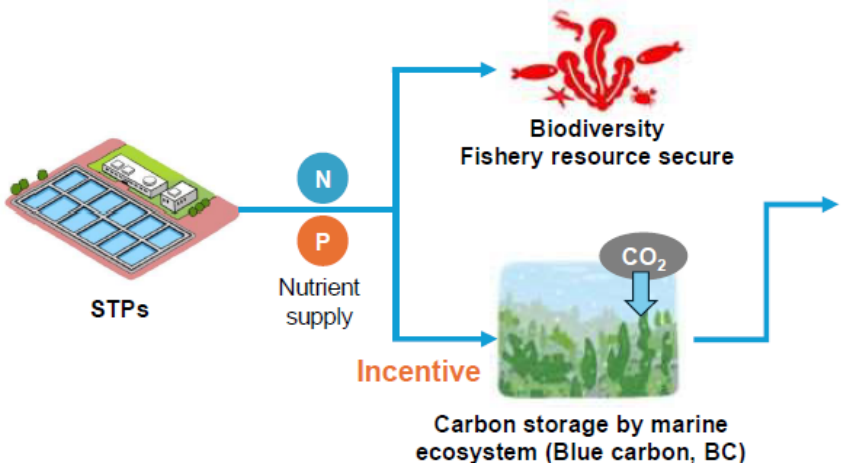
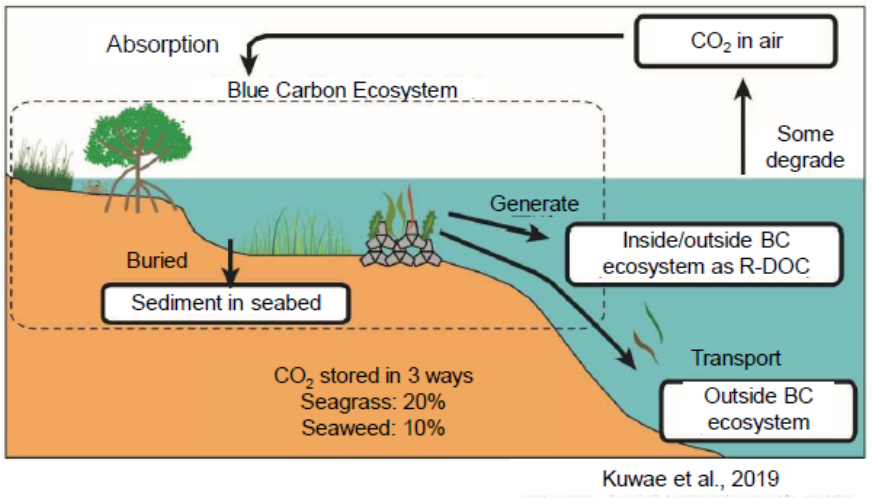


Figure 1 - The total nitrogen concentration in Harima-nada from 1985 to 2020. (Figure was made basing on the data from the Ministry of the Environment, Japan)

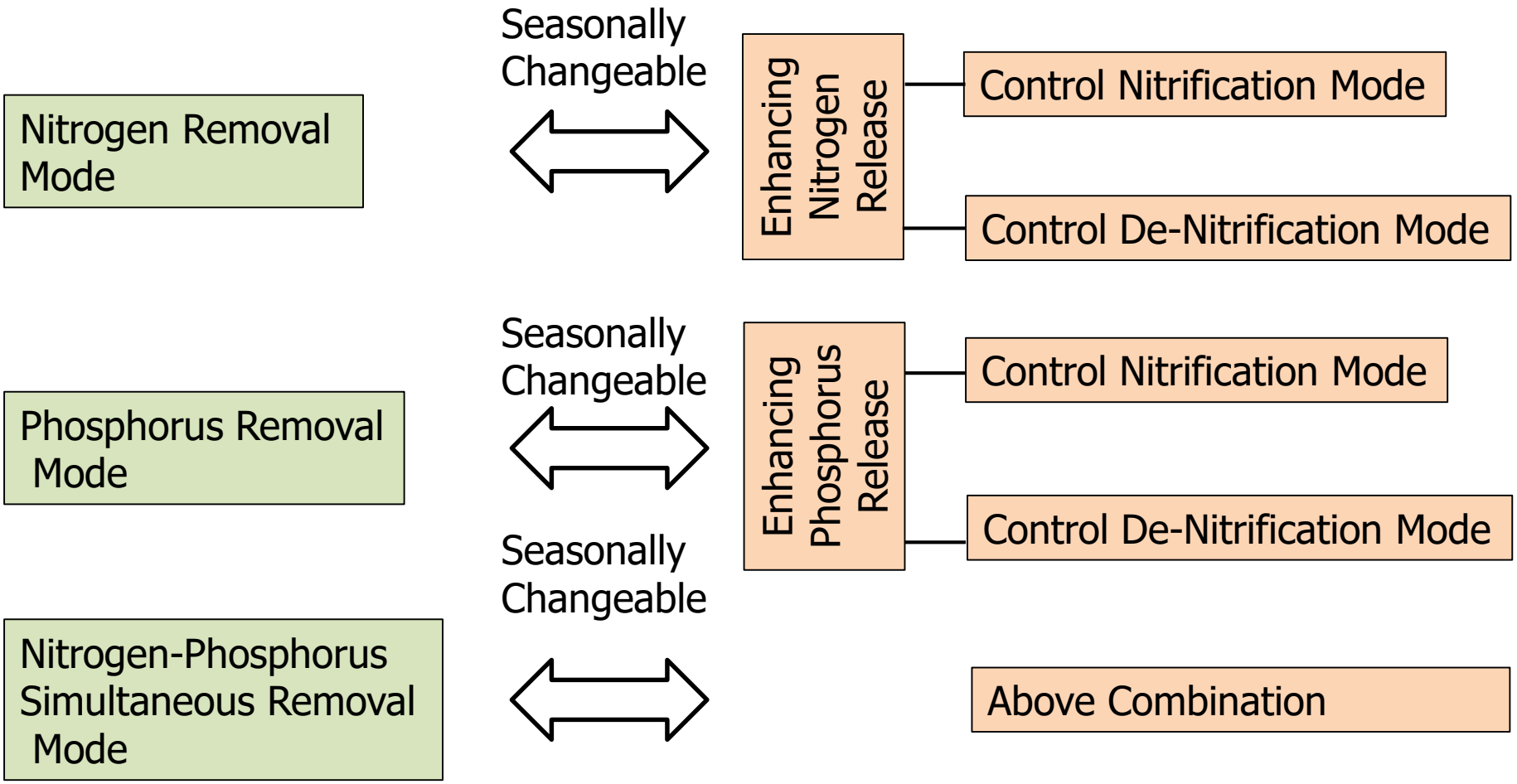
- Nutrients from STPs are expected to **enhance levels and "blue carbon" in enclosed bays**.





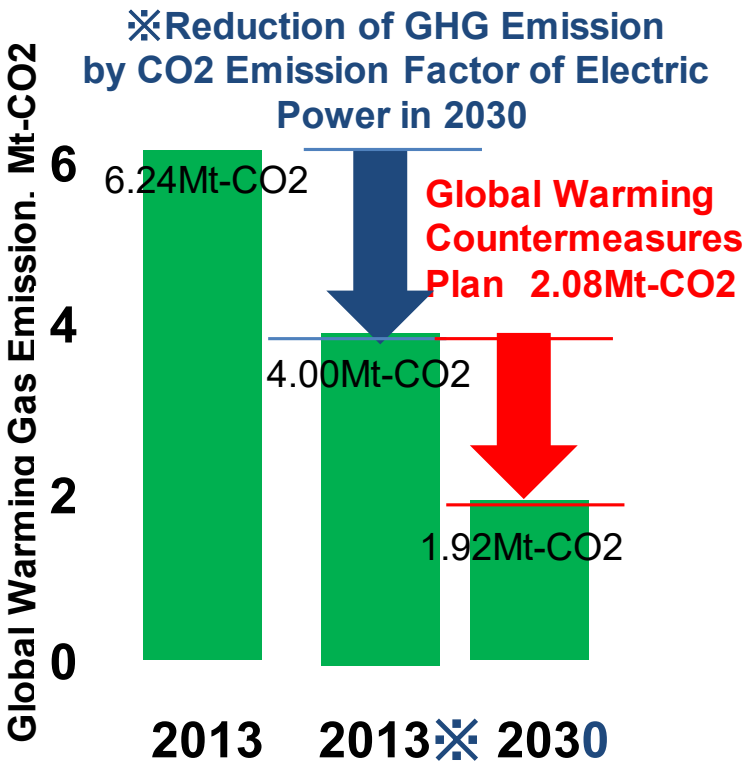
Chen, Takahashi, Tanaka(2024)

Seasonally Changeable Nutrient Reduction & Enhancement Operation of STPs



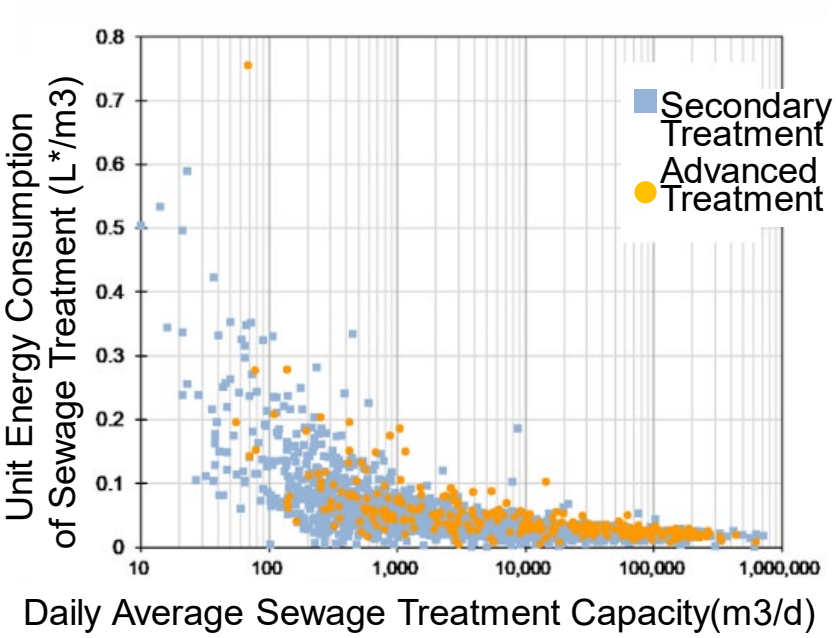
Increasing Energy Saving Needs in Sewerage Systems

National Reduction Goal of GHG Emission in Japanese Sewage Works



Courtesy by MLIT (2024)

Relationship of Scale of Sewage Treatment Plant and Unit Energy Consumption

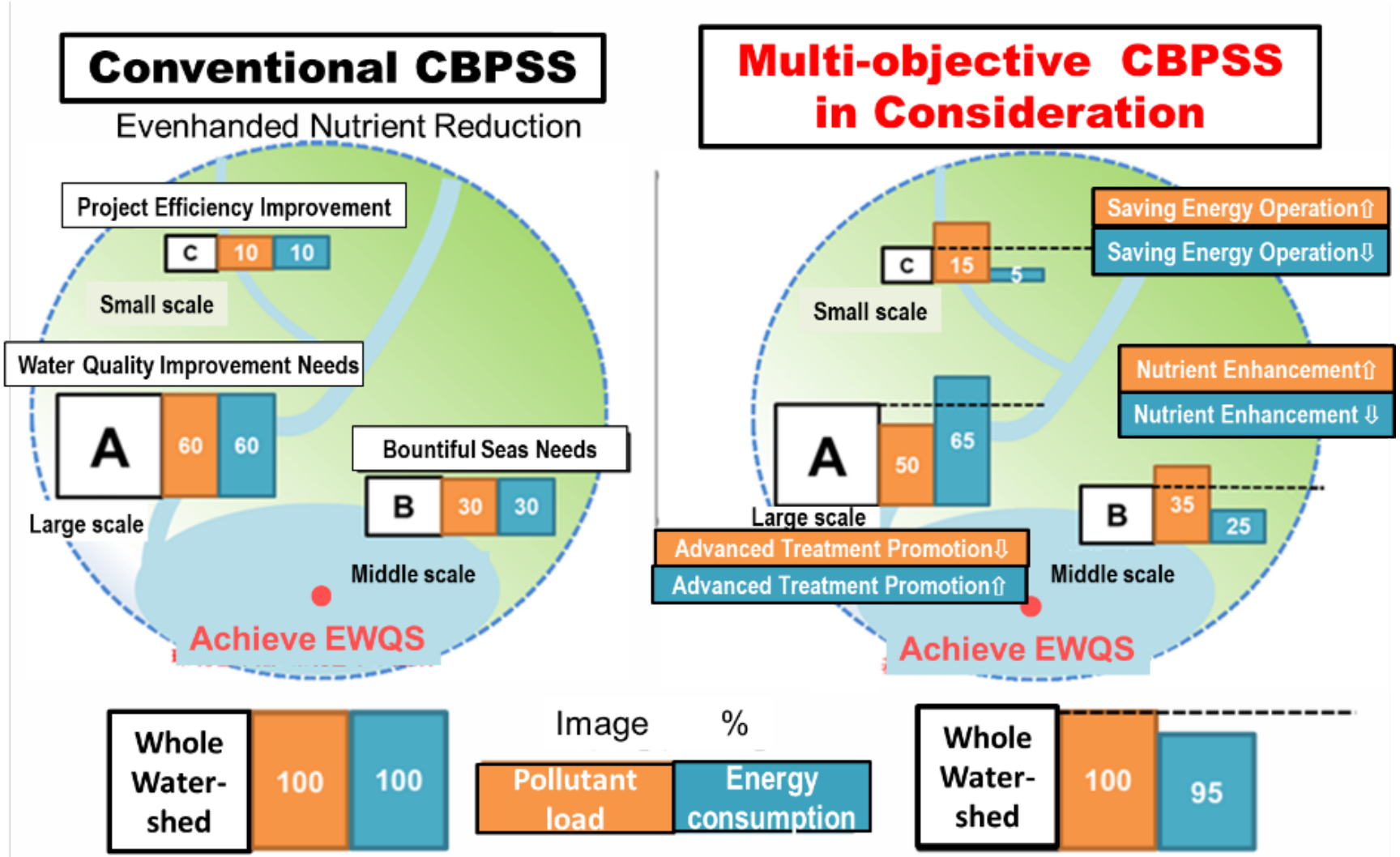


*1 Oil KL=4.28 kWh

Courtesy by MLIT (2024)

STP size significantly affects energy efficiency in treatment processes

Effective Pollutant Reduction Allocation for Water Quality Improvement & Energy Saving



Courtesy by MLIT (2024)

5. Conclusion

Watershed Approaches Successful in Pollution Reduction of BOD, Nutrients

- **Great success in BOD reduction** in most of rivers control by domestic source reduction due to **sewerage systems planned by CBPSS and other point source reduction** by effluent regulations .
- **Great success in nutrient reduction** in major enclosed bays **due to CBPSS and TPLCS** that promote sewerage installation and introduction of advanced treatment.
- **Outcomes of CBPSS to achieve EWQS are restricted to sewerage systems** but reduction of other sectors is out of business. TPLCS projects near future but is not subject to achievement of EWQS.

Future Challenges

- **Pollution of *E. coli* in rivers and deep layer DO** in enclosed bays might have **to be considered in CBPSS**.
- Simultaneous solution of hypoxia and bountiful sea is challenge and **adaptive nutrient management by proactive operation of STP** might contribute to a solution.
- Because energy saving and GHG emission reduction in water sectors etc. are big challenges, **multi-objective water quality management on watersheds should be discussed**.

Thank you for your listening!

All the viewpoints of this presentation reflect personal opinions but not Japanese Ministry of Environment or Ministry of Land, Infrastructure, Transport and Tourism.

The author acknowledges both the ministries for providing many documents regarding to this presentation.

Comments and questions are welcome!
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