Modified Watershed-Based Approach to Clean Water
- Amendment to Sewerage Law -

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Abstract: Sewerage Law was amended in 2005 and a modified approach was established by introducing the concept of transferable LRA (Load Reduction Assignment) for nitrogen and phosphorus in the basin of enclosed water bodies. Transferable LRA is somewhat similar to the transferable permit in WQT (Water Quality Trading) employed in the U.S.. The guideline issued by MLIT (Ministry of Land, Infrastructure and Transport) proposes how to determine the baseline LRA, laying an emphasis on the attainment of equity between local entities. Environmental equivalence between before and after the transfer of LRT is expected to be appropriately maintained by evaluating the impacts of every discharged load. "Phased program" of the transfer of LRA and a kind of "LRA Clearinghouse" would be required to explore the opportunities for the transfer of LRA. Draft guideline issued by MLIT proposes the cost allocation that is based on the proportionate relation between transferred LRA and its cost, taking the WQT into consideration. Modifications were made so that the subsidy might not affect the smooth and cost-effective load reduction through the transfer of LRA.

Keywords: watershed-based approach, Comprehensive Basin-wide Plan of Sewerage Systems, water quality trading, load reduction assignment, amendment to Sewerage Law

1. Introduction

Sewerage Law was amended in 2005 and a modified approach was established by introducing the concept of transferable LRA (Load Reduction Assignment) for nitrogen and phosphorus in the basins of enclosed water bodies in Japan. The modified watershed-based approach is supposed to play a role equivalent to WQT (Water Quality Trading) which has been applied to quite a few watersheds in the United States[1), where Environmental Protection Agency (EPA) issued Water Quality Trading Policy[2) and Water Quality Trading Assessment Handbook[3) in 2003 to facilitate the achievement of Total Maximum Daily Load through water quality trading. The aim of this paper is to describe the context of the establishment of this new approach as well as its institutional structures and administrative policies including its comparison with WQT.

2. Difficulties Relating to Advanced Treatment

The water quality has been improved gradually so far in rivers. But most of the enclosed water bodies such as bays and lakes are not getting cleaner in spite of the progress in the population served with sewage treatment (See Figure 1). It is no wonder that those enclosed stagnant water bodies, which are severely polluted through eutrophication, require the reduction in nitrogen or phosphorus inflow by means of advanced treatment of sewerage systems in those basins. In particular, advanced treatments in Tokyo Bay and Osaka Bay basins are considered to be most effective, because almost 90% of population is covered by sewerage and more than half of nitrogen and phosphorus inflows into those water areas through effluent from public WWTP(wastewater treatment plant)s. Therefore, it is no exaggeration to say that the averaged water qualities in Tokyo Bay and Osaka Bay are fundamentally controlled by the water quality of the effluent from public

WWTPs. However the rate of population covered with advanced treatment is very low, 3.6% for Tokyo Bay and 14.1% for Osaka Bay as of the end of fiscal 2003.

The requirements of advanced treatment i.e. effluent water quality that each WWTP is to meet are usually determined by CBPSS (Comprehensive Basin-wide Plan of Sewerage Systems). CBPSS was legislated in the Sewerage Law as early as 1970. Every prefecture is by law to formulate CBPSSs for ordinance-required water bodies to drive local entities concerned to advance their sewerage construction/improvement projects toward the achievement of EWQS (Environmental Water Quality Standard) in the targeted water bodies (See Figure 2). Although Sewerage construction/improvement programs shall be made and implemented "in accordance with" the relevant CBPSS, CBPSS could not function as strict command-and-control measures and it is often very difficult to guide local entities toward advanced treatment just as is required by CBPSS for the following reasons;

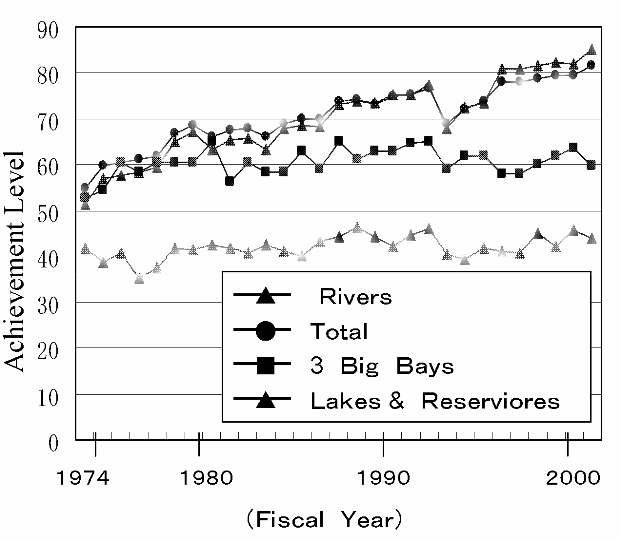
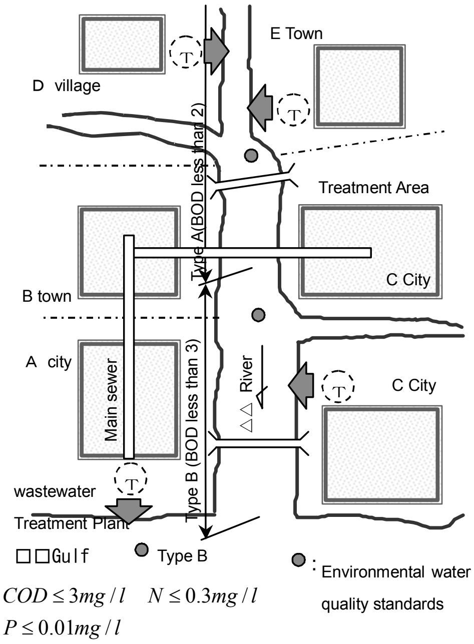


Figure 1: Achievement of Environmental Water Quality Standard

Notes :
1.BOD used for rivers, and COD used for lakes/reservoirs, and sea/coastal areas.
2.Achievement level (%)=(no. of water bodies achieving / no.of designated water bodies) × 100
Source : Ministry of Environment

(1) Sewerage Law postulates that CBPSS should be formulated taking cost-effectiveness into account. Basin-wide cost-effectiveness is theoretically guaranteed on the condition of the equalization of marginal reduction costs across all the WWTPs in the basin. However prefectures formulating CBPSS cannot determine the marginal reduction costs beforehand in reality.
(2) The expression "in accordance with" does not necessarily imply "coinciding with" juristically. Therefore it is not perceived as illegal for local entities to postpone, for some reasons, the initiation of advanced treatment that CBPSS requires. In other words, command-and-control method cannot be easily applied on the basis of CBPSS.
(3) Generally speaking, local entities tend to be unwilling to forward the program of advanced treatment in pursuit of downstream benefit alone. Meanwhile, there is often no sufficient reasonable persuasiveness other than downstream benefit to make local entities carry out programmed advanced treatment.

Taking heavily polluted lakes and bays into consideration, some kind of modified approach was obviously needed to promote the advanced treatment in Japan.



Fuigure 2 : Schematic Diagram of CBPSS

3. Preliminary Discussions

Economic, engineering and political studies as well as administrative experiences have revealed that traditional "command-and-control" measures are not enough to address the externality-related issues such as the promotion of advanced treatment for clean waters whose basin comprises many municipalities. Economic instruments are considered to be cost-effective alternatives, which should be applied solely or together with command-and-control method[4),5)]. As for the economic instruments for water pollution control, typical examples are

WQT in the US and effluent charge system which is very popular in European countries. Case study for Tokyo Bay and comparative studies focusing on these two methods from the viewpoint of applicability to sewerage works were conducted preliminarily[6),7)].

In the case study of WQT focusing on Tokyo Bay, constituents of pollutant were COD, total nitrogen and total phosphorus. By means of computer simulation, transferable permit of each constituent was separately traded among 75 WWTPs in the basin. The total cost abatement rate of water quality trading throughout the basin is estimated to be 31% as shown in Table 1.

Table 1 : Total Cost of Advanced Treatment (million yen/year)[6),7)]

Baseline Permit	After Trading	Cost Abatement Rate
65,916	45,792	31%

(simulated for WWTPs in Tokyo Bay basin)

Figure 3 is the schematic diagram of two types of economic instruments, i.e. effluent charge system and WQT. Herein, only the excess load reduction by advanced treatment beyond baseline load (initial permit) is transferable in WQT and let effluent charge system be combined with subsidy where the collected charges are distributed to WWTPs for their advanced treatment

By means of theoretical comparison between effluent charge system and WQT, the following conclusions are obtained[7)]:

(1) The mathematics for both the effluent charge system and WQT suggests an equivalent cost-effectiveness in meeting a predetermined target of load reduction. Effluent charge system equivalent to a WQT could be theoretically designed from the result of WQT.

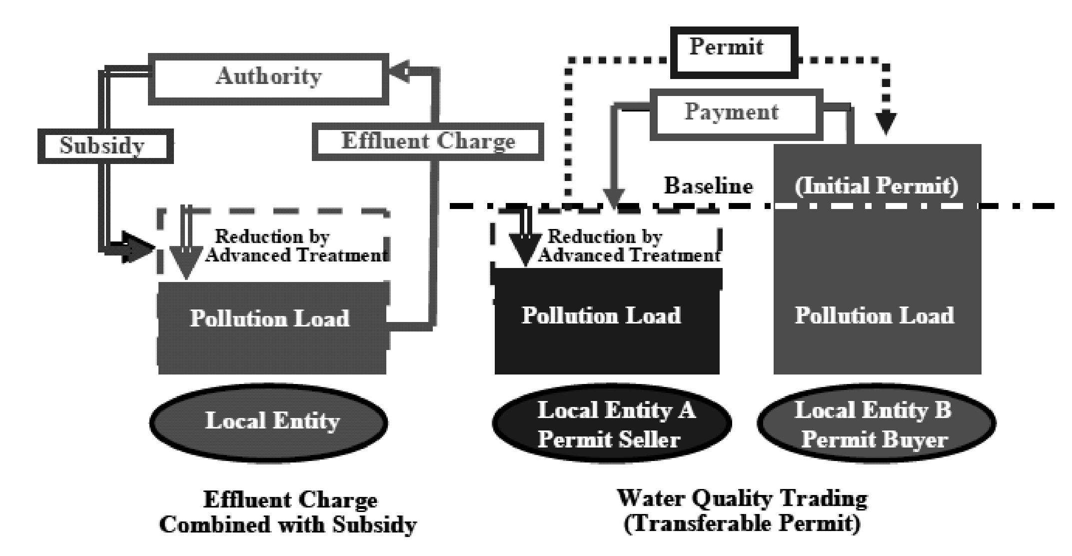


Figure 3 : Schematic Diagram of Two Types of Economic Instruments

(2) WQT could be easily designed on the basis of the total sum of permits which is the predetermined target of the policy, while effluent charge system cannot be designed directly from the target.

(3) Equality of unit net cost (= cost for advanced treatment - subsidy or revenue by selling permit + expenditure for buying permit) is assumed to be an indicator of the equity between WWTPs and the equality could be evaluated by the standard deviation of the unit net costs (net costs per unit volume of effluent). Smaller value of the standard deviation might well be perceived as stronger

equity. According to the comparison of the standard deviations of unit net cost, effluent charge system is estimated to be superior to WQT in terms of equity.

(4) Some local governments might have stronger motive for advanced treatment for their own benefits other than the clean water in targeted water areas. Local conditions like this are more likely to be reflected in the advanced treatment in effluent charge system than in WQT. In other words, effluent charge system is more favourable for local entities that want to forward advanced treatment for their own benefits than WQT.

In course of the energetic arguments for and against employing new economic incentives and scientific discussions about the design of the legislation, it was pointed out that effluent charge system has quite a bit advantage over WQT as shown above. However, the modified approach seems to have been favoured by policy makers mainly because of its plain structure that could be designed easily on the basis of predetermined target as well as of the general public resistance to charging/taxation.

4. Modified Approach

Sewerage Law was amended in 2005 and a modified approach was established by introducing the concept of LRA for nitrogen and phosphorus in the basin of enclosed water bodies. Transferable LRA is somewhat similar to transferable permit in WQT employed in the U.S.. While WQT is founded upon NPDES (National Pollution Discharge Elimination System), LRA is a concept in CBPSS and therefore only applied to the advanced treatment of WWTPs. It has become possible that local entities cooperate with each other in advanced treatment of nitrogen and phosphorus through transferring LRA in CBPSS. The outline of the amendment to Sewerage Law is as follows:

<u>A. Determination of the Baseline LRA</u>

<u>(1)</u> Prefecture shall determine the baseline LRA for nitrogen and/or phosphorus contained in the effluent of relevant WWTPs in the CBPSS which targets on enclosed water bodies where EWQS of nitrogen and/or phosphorus is set. Baseline LRA is the LRA initially assigned to WWTPs before initiating LRA transfer according to the procedures for cooperation between local entities.

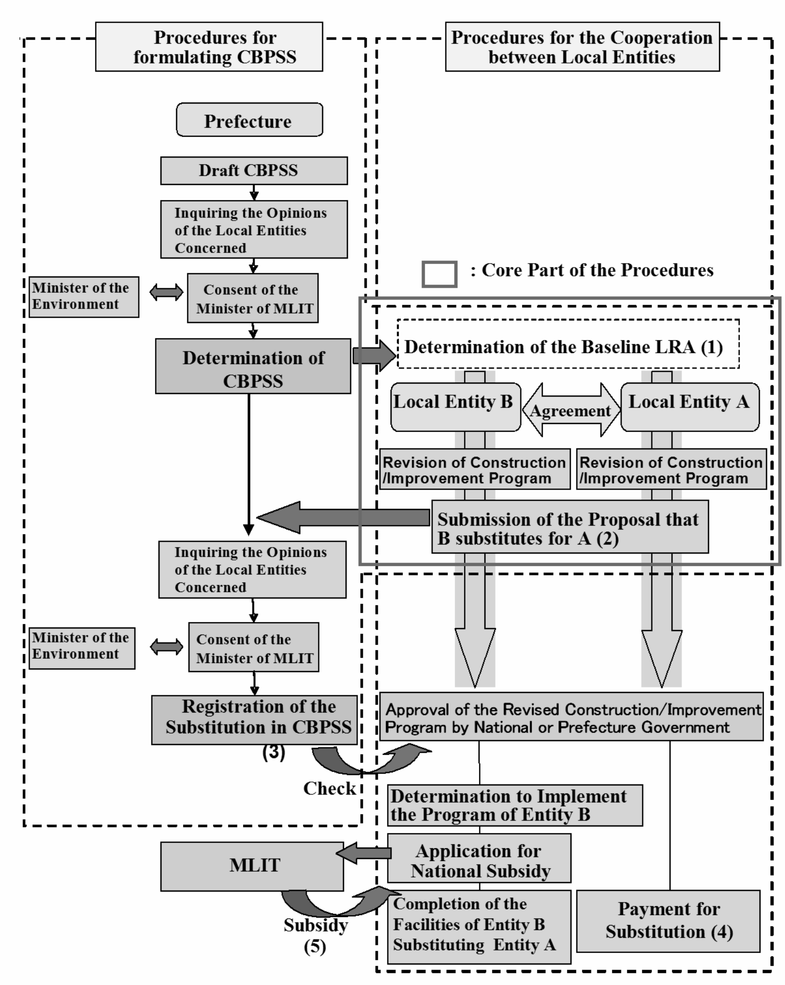


Figure 4 : Procedures for Cooperation between Local Entities Relating to Advanced Treatment of Nitrogen and Phosphorus

※ **(1)～(5) are correspondent to the underlined heads in this paper**.

B. Cooperation for Advanced Treatment between Local Entities

(2) Proposal of Substitution

Local entity can submit to the prefecture a proposal that it will substitutively fulfil the LRA assigned to the other entity's WWTP, after reaching the agreement with the local entity to be substituted for.

(3) Registration in CBPSS

The prefecture that has received the proposal of substitution can register the information of the substitution including the estimated cost and its sharing in the CBPSS.

(4) Payment for Substitution

The local entity that substitutively fulfils the LRA assigned for the other entity's WWTP can, as the legal effect of the registration in CBPSS, make the entity to be substituted for pay the cost for the substitution including the cost of construction, improvement, rehabilitation, repair, maintenance and control.

(5) Subsidy Rate

As to the construction or improvement of the facilities which is carried out for the purpose of the substitution, the subsidy rate for the WWTP whose LRA is substitutively fulfilled is applied. In the calculation of subsidy, the cost specified for the other WWTP is basically derived from the ratio of LRA transferred from the other WWTP to all the LRA to be fulfilled by the facilities (See chapter 8).

Legally, there is no concept of the permit for discharging pollutant, much less the concept of transferable permit in Japan. After juristic studies, the concepts of LRA and substituting for another local entity in terms of LRA were introduced to substantially establish the transferable permit for discharging pollutant, i.e. transferable LRA on the basis of CBPSS. Being substituted for by the other local entity on LRA is defined in Sewerage Law as a way to fulfil the duty of the baseline LRA registered in the CBPSS.

Transferable LRA is obviously supposed to play a role equivalent to transferable permit in WQT. Figure 5 shows the equivalence between the modified approach in Japan and WQT in the U.S..

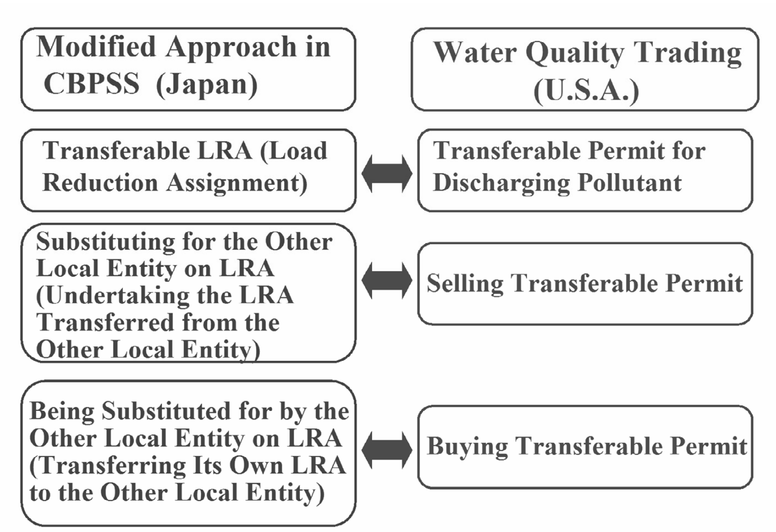


Figure 5 : Equivalence between Modified Approach and WQT

Modified approach with transferable LRA is expected to substantially abate aforementioned difficulties to guide local entities toward advanced treatment, because local entities, which can take the choice of substituting for the other local entities or being substituted for by the other local entities on LRA, will be able to conform to the CBPSS more easily as a whole.

Incidentally, enough attention has to be paid to the fact that "transferable LRA" is not juristically established concept, yet the term and the concept are used often in this paper for the sake of convenience. Figure 4 could be useful for the juristic interpretation.

5. Determination of Baseline LRA

Emphasis should be laid on the attainment of equity between local entities in successful determination of the baselines LRA. In other words, it is important that no entity has a feeling of unfair advantage toward the baseline LRA.

According to the guideline[8] issued by MLIT (Ministry of Land, Infrastructure and Transport), LRA is determined for every WWTP concerned as follows:

$$LRA(kg/day) = \frac{(C_r - C_t) \times Q_t}{1,000}$$

where

C_r : Water Quality of Reference (mg/L)

C_t : Average Water Quality Required in the Target Year (mg/L)

Q_t : Average Daily Flow Rate of the Effluent in the Target Year (m^3/day)

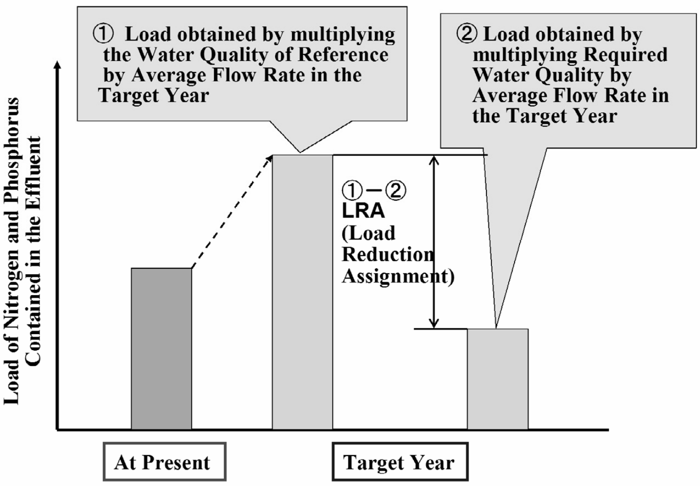


Figure 6 : Procedures to Determine Baseline LRA

Water quality of reference C_r is set by taking the present water quality requirement into account. Attention has to be paid to the relation : $C_r \geq C_t$, and therefore each LRA is non-negative.

Average water quality required in the target year C_t is determined so that the municipal wastewater treatment including the increase in the population served with public sewerage might make the relevant waters fulfil their EWQSs together with the other water quality control measures.

Concrete method to determine C_t for every WWTP is described as follows:

(a) Set a value for $\overline{C_t}$ common to all the WWTPs at higher level at first. Then decrease the value gradually until it fulfils all the EWQSs in the water areas in target year by means of computer simulation with appropriate boundary conditions e.g. the other countermeasures against pollution. $\overline{C_t}$ can be set in this way at nearly maximum value to fulfil the EWQSs.

(b) As for C_t for each WWTP, relevant local entity *i* determines the values of $C_{t,i,j}$ for its WWTP *j*, $(j = 1 \sim n_i)$ so that they may satisfy the equation:

$$\sum_{j=1}^{n_i} C_{t,i,j} \times Q_{t,i,j} \leq \overline{C_t} \times \sum_{j=1}^{n_i} Q_{t,i,j}$$

where the local entity *i* has n_i WWTPs.

But local entity *i* can take the other alternatives, if all the local entities concerned accept it.

(c) When some specific WWTPs dominate exclusively over the water quality at EWQS points in limited areas, then the average water qualities required in the target year for the WWTPs concerned could be determined separately from the rest on the condition that all the other local entities consent to it. In this case, $\overline{C_t}$ is calculated so that it may fulfil all the EWQSs except those of the water areas dominated by the specific WWTPs. The method to determine C_t for WWTPs except those specific ones is same as (b).

The manner mentioned above follows the precedent of basic idea in formulating CBPSS

6. Equivalence in Transfer of LRA

There must be environmental equivalence between before and after the transfer of LRA. In other wards, positive impact of the pollution load abatement in the WWTP undertaking the LRA of another WWTP must exceed or at least cancel the negative impact of the load increase in the WWTP transferring its LRA to the other WWTP.

The relation between the load in the effluent discharged from a point source and its load reaching the point of EWQS is described as:

$$L_r = \alpha \times \beta \times L_o$$

L_o : Pollution load that is discharged from a point source

L_r : Pollution load that is discharged from a point source and reaches the point of EWQS.

α : Runoff coefficient of the pollutant from the discharge point to the receiving point of stream

β : Runoff coefficient of the pollutant from the receiving point of stream to the point of EWQS

As is described in 3), a pound of phosphorus discharged into a river can “disappear” as it travels down a river through uptake by aquatic plants, settling out, and/or water diversion for agricultural or other users. The coefficient α is supposed to be 1.0 as to WWTPs, because most of the WWTPs discharge their effluents directly into rivers, seas and lakes.

There are quite a few data about β for nitrogen and phosphorus, but most of them are obtained in the fieldwork in dry weather. It is often observed that nitrogen and phosphorus loads in wet weather amount to so much as those in dry weather, while in dry weather the aquatic plants and the depositions/sediments on river beds, which have trapped and kept nitrogen and phosphorus in dry weather, are supposed to be washed out into the enclosed water bodies concerned. Therefore, the effect of deposit in the streams might be neglected from long-term point of view.

The impact of denitrification in riverbeds is generally estimated to be small enough, compared with the other factors. Concerning the diversion for agricultural use, paddy field use in particular, the impact seems to vary too greatly to be taken into account in the transfer of LRA.

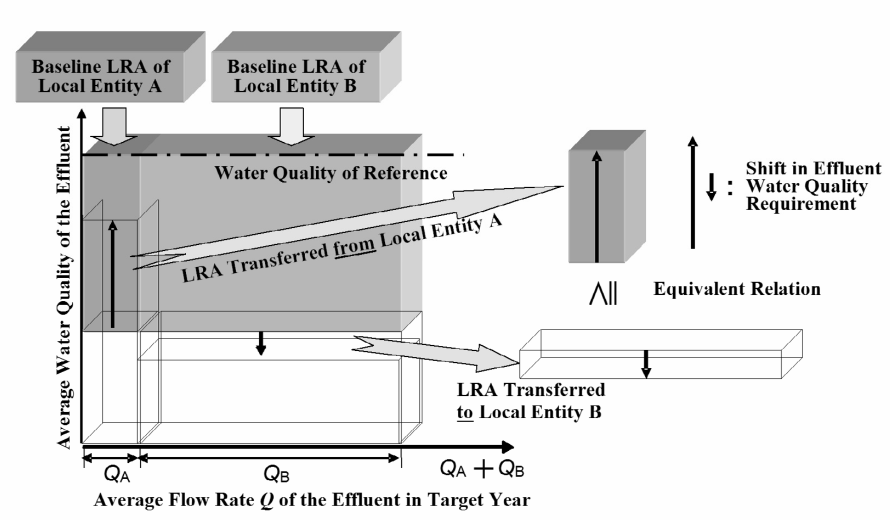


Figure 7 : Required Equivalence in Transfer of LRA

Thus, the runoff coefficient β of nitrogen or phosphorus from the receiving point of stream to the receiving point of the enclosed water body concerned (not to the point of EWQS) may be basically presupposed to be 1.0, except that some specific factors are recognized to give too big impacts to neglect.

Figure 7 is a schematic diagram showing the required equivalent relation between before and after the transfer of LRA. This relation can be written as :

$$Q_A \times (C_{1,A} - C_{0,A}) \leq Q_B \times (C_{0,B} - C_{1,B})$$

where

Q_A : Average Flow Rate of WWTP A Transferring Its Own LRA to WWTP B

Q_B : Average Flow Rate of WWTP B Undertaking the LRA Transferred from WWTP A

$C_{0,A}$, $C_{0,B}$: Effluent Water Quality Requirements of WWTPs A and B before the Transfer of LRA

$C_{1,A}$, $C_{1,B}$: Effluent Water Quality Requirements of WWTPs A and B after the Transfer of LRA

Hot Spot" is also a delicate issue in the modified approach just as in WQT. Some potential transfer of LRA that could result in a general water quality improvement in a broad area may also result in acute, localized impacts[3)].

Since all the proposals submitted by the local entities involved in transfers of LRA is legally checked by the prefecture, the formulator of CBPSS, before being approved as shown in Figure 4, the equivalence is expected to be appropriately maintained by evaluating the impacts of every discharged load and avoiding the transfer of LRA that creates "Hot Spot".

7. Flexible Transfer of LRA

In most cases, WWTPs cannot fulfil their own LRA shortly. The facilities of advanced treatment are constructed in conjunction with reconstruction or extension project of WWTP and those projects are carried out step by step in the long term. If only the WWTP already fulfilling its own LRA were allowed to undertake the LRA transferred from the other WWTP, then the transfer of LRA would not occur because of the shortage of undertakers of LRA.

In order to facilitate the transfer of LRA in a watershed, more flexible processes are proposed[9)] as shown in Figure 8. The WWTP can undertake the LRA transferred from the other WWTP by means of its facilities of advanced treatment, even if the WWTP fulfils only a part of its own LRA. It is recognized as being needed to register the "phased program" of the transfer of LRA in the legal construction/improvement program to promote the smooth and cost-effective load reduction in a watershed. Furthermore, a kind of "LRA Clearinghouse", where aligning the needs and offers to transfer LRA are conducted on the basis of the phased programs, would be required to explore the opportunities for the transfer of LRA between WWTPs.

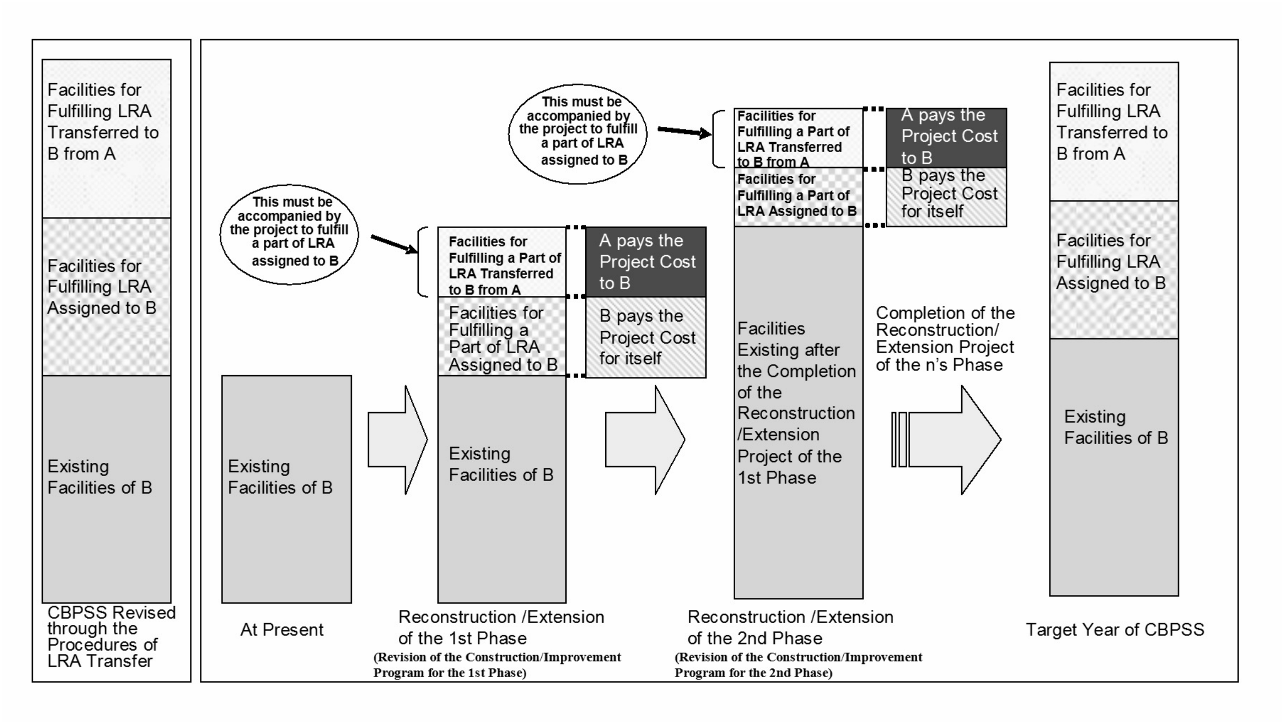


Figure 8 : Phased Program of the WWTP (B) Undertaking the LRA Transferred from Another WWTP(A)

8. Cost Allocation

As is described in chapter 4, the local entity that substitutively fulfils the LRA assigned for the other entity's WWTP can, as the legal effect of the registration in CBPSS, make the entity to be substituted for pay the cost for the substitution including the cost of construction, improvement, rehabilitation, repair, maintenance and control. Following the examples shown in Figure 7 and Figure 8, WWTP B (or local entity B) fulfils the LRA transferred from WWTP A (or local entity A) together with the baseline LRA assigned to B itself. In this case, how should A and B share the cost for the advanced treatment that is conducted by B? Draft guideline issued by MLIT proposes the following method (See Figure 9)[9]:

(a) Specify the facilities of B and the total project cost C_T for cooperative project of A and B relating to the advanced treatment of N(nitrogen) and/or P(phosphorus).

(b) Divide the specified facilities into 2 parts : part for the removal of N and the part for the removal of P. Then the project cost C_T is also divided into 2 parts : the costs C_N and C_P related to the facilities for the removal of N and P, respectively.

(c) Cost allocation for the cooperative project is written as:

The cost that A pays : $C_A = \dfrac{LRA_{N,A} \times C_N}{LRA_N} + \dfrac{LRA_{P,A} \times C_P}{LRA_P}$

The cost that B pays : $C_B = \dfrac{LRA_{N,B} \times C_N}{LRA_N} + \dfrac{LRA_{P,B} \times C_P}{LRA_P}$

where

LRA_N , RLA_P : LRA for N and P, respectively, fulfilled by B in this project

$LRA_{N,A}$, $LRA_{P,A}$: LRA for N and P, respectively, transferred from A and fulfilled by B in this project

$LRA_{N,B}$, $RLA_{P,B}$: Baseline LRA for N and P, respectively, fulfilled by B for itself in this project

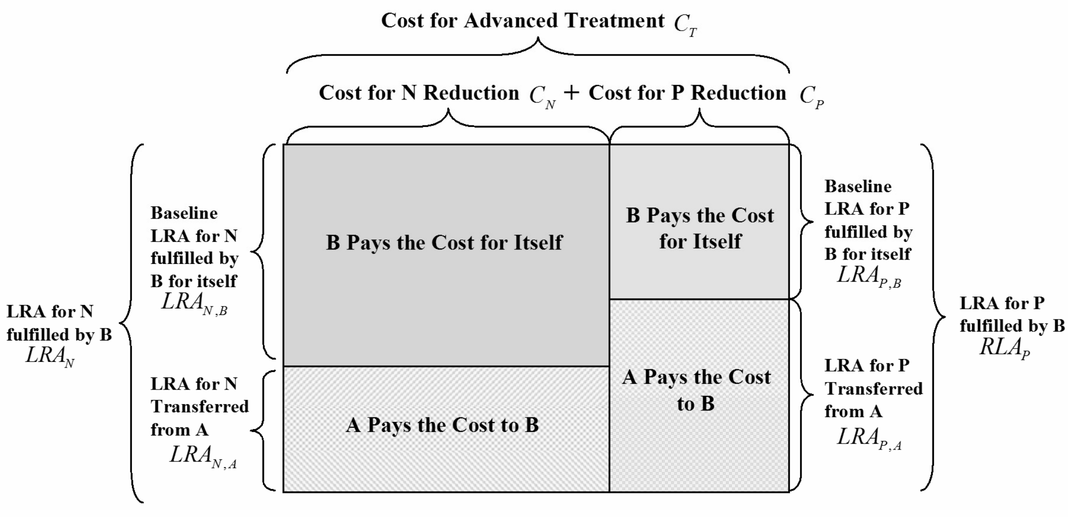


Figure 9 : Cost Allocation in the Cooperative Project with the Transfer of LRA from A to B

Those proportionate relations between LRA and its cost suggest that the prices of permits would be C_N / LRA_N for nitrogen and C_P / LRA_P for phosphorus, if the loads of nitrogen and phosphorus discharged from WWTPs were traded independently from each other.

In the cooperative projects with the transfer of LRA, the capacity of the advanced treatment of B can exceed sum total of LRA that should be fulfilled by B. The cost for that allowance could be allocated easily, according to the above-mentioned manner. In any way, the details of the cost allocations should be discussed enough among relevant local entities and it is desirable to make an agreement about the result before starting the legal procedures shown in Figure 4.

Construction projects for advanced treatment are usually funded by national government. The subsidy rate is 0.55 for public sewerage and 2/3 for regional sewerage. In the cooperative project with the transfer of LRA shown in Figure 9, the subsidy rate for WWTP A is applied to the construction cost of C_A, and subsidy rate for WWTP B is applied to that of C_B.

Local entities that conduct advanced treatment are privileged to get a national subsidy for wider range of collection networks. In the cooperative projects with the transfer of LRA, the local entities that transfer their LRA to the other local entities are also privileged in the same manner.

These kinds of modifications were made so that national subsidy system might not affect the smooth and cost-effective load reduction through the transfer of LRA.

9. Conclusion

(a) Sewerage Law was amended in 2005 and a modified approach was established by introducing the concept of LRA (Load Reduction Assignment) for nitrogen and phosphorus in the basin of enclosed water bodies.

(b) Though there is no legal concept of transferable LRA in Japan, the concepts of LRA and substituting for another local entity in terms of LRA were introduced to substantially establish the transferable LRA on the basis of CBPSS (Comprehensive Basin-wide Plan of Sewerage Systems).

(c) Transferable LRA is somewhat similar to transferable permit in WQT (Water Quality Trading) employed in the U.S.. While WQT is founded upon NPDES (National Pollution Discharge Elimination System), LRA is a concept in CBPSS and therefore only applied to the advanced treatment of WWTPs (Wastewater Treatment Plants).

(d) In preliminary discussions before the amendment to Sewerage Law, it was pointed out that effluent charge system has quite a bit advantage over WQT. However, the modified approach seems to have been favoured by policy makers mainly because of its plain structure that could be designed easily on the basis of predetermined target as well as of the general public resistance to charging/taxation.

(e) The guideline issued by MLIT (Ministry of Land, Infrastructure and Transport) proposes how to determine the baseline LRA, laying an emphasis on the attainment of equity between local entities.

(f) After the discussions on the relation between the load in the effluent discharged from each WWTP and its load reaching the point of EWQS, environmental equivalence is expected to be appropriately maintained by evaluating the impacts of the load discharged from every WWTP and avoiding the transfer of LRA that creates "Hot Spot".

(g) In order to facilitate the transfer of LRA in a watershed, "phased program" of the transfer of LRA and a kind of "LRA Clearinghouse" would be required to explore the opportunities for the transfer of LRA between WWTPs.

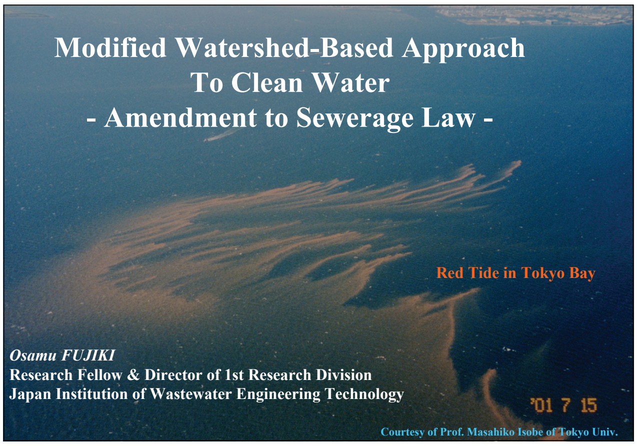
(h) Draft guideline issued by MLIT proposes the cost allocation based upon the proportionate relation between transferred LRA and its cost, taking the virtues of WQT into consideration.

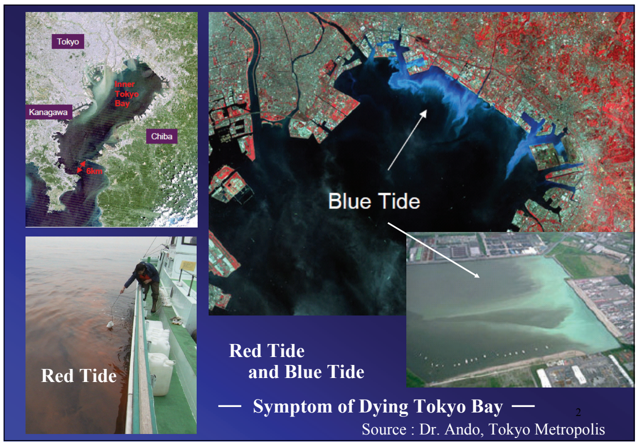
(i) As to the system of the national subsidy, modifications were made so that the subsidy might not affect the smooth and cost-effective load reduction through the transfer of LRA.

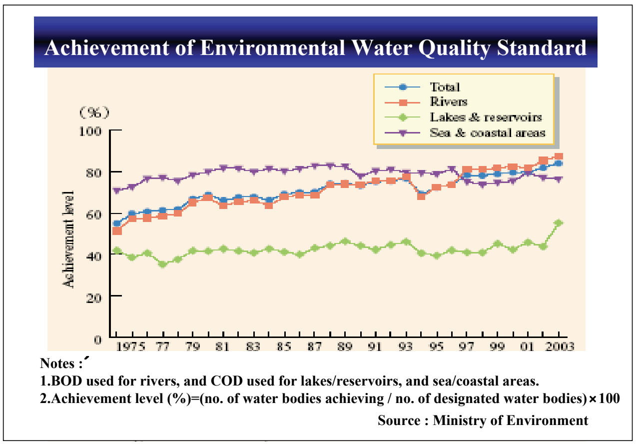
Now is progressing the formulating work of CBPSSs for the clean waters in the 3 big bays (Tokyo Bay, Osaka Bay and Ise Bay) and other enclosed water bodies. In that process, transfer of LRA is also discussed among local entities in parallel with the determination of baseline LRA.

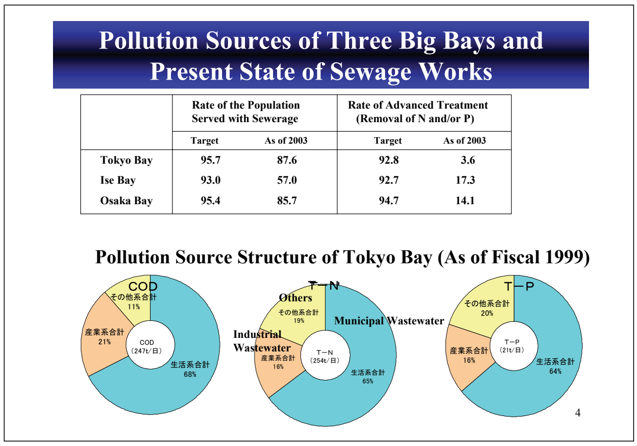
References

1) Mark S. Kieser and “Andrew” Feng Fang : *Economic and Environmental Benefits of Water Quality Trading – An Overview of U.S. Trading Program* -, "Proceedings of the Workshop on Urban Renaissance and Watershed Management, organized by the Ministry of Land, Infrastructure and Transport and Shiga Prefecture, 3, February 2004, Otsu "
2) US-EPA : Water Quality Trading Policy, January 2003
3) US-EPA : Water Quality Trading Assessment Handbook : EPA Region 10’s Guide to Analyzing Your Watershed, July 2003
4) T. H .Tietenberg : *Emission Trading, an exercise in reforming pollution policy*, Resources for the Future, Inc., 1985
5) William J. Baumol and Wallace E. Oates : *The theory of environmental policy, second edition*, Cambridge University Press, 1988
6) Yoshida, T. and Fujiki, O. : *Investigations on Economic Efficiency and Cost Sharing for Watershed Management in Japan*, "Proceedings of the 3rd U.S.-Japan Governmental Conference on Drinking Water Quality Management and Wastewater Control, July 12-15, 2004, Hawaii, U.S."
7) Fujiki, O.: *Economic Instruments for Basin-wide Efficient Pollution Load Reduction - Comparison between Effluent Charges and Water Quality Trading* -, "Proceedings of the 10th Japanese-German Workshop of Wastewater and Sludge Treatment Technologies, October 9-10, Munich, Germany"
8) Sewerage and Wastewater Management Department, MLIT : Guideline to Determine the Baseline Load Reduction Assignment of Nitrogen and Phosphorus for Each Wastewater Treatment Plant, June 2006
9) Sewerage and Wastewater Management Department, MLIT : Draft Guideline and Its Commentary on the Cooperation between Local Entities Relating to Advanced Treatment – For Addressing the Load Reduction Assignment – , 2006

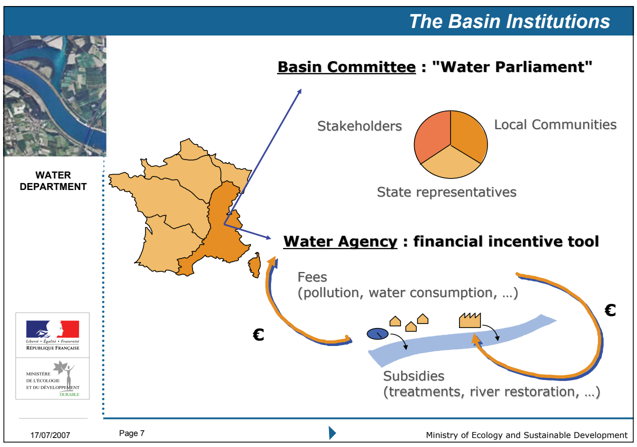


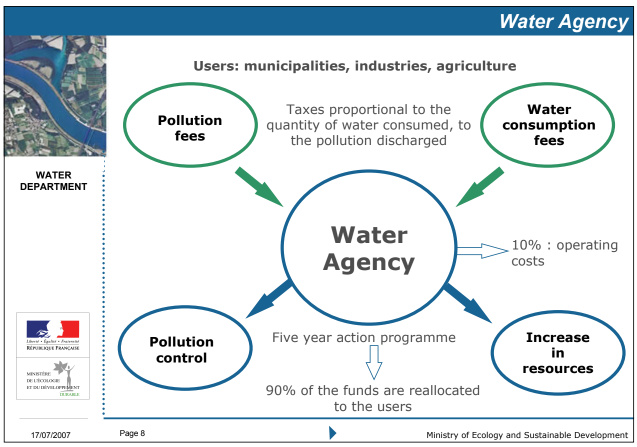




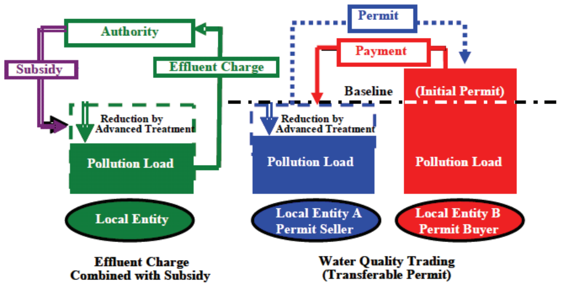


	Rate of the Population Served with Sewerage		Rate of Advanced Treatment (Removal of N and/or P)	
	Target	As of 2003	Target	As of 2003
Tokyo Bay	95.7	87.6	92.8	3.6
Ise Bay	93.0	57.0	92.7	17.3
Osaka Bay	95.4	85.7	94.7	14.1





Schematic Diagram of the Two Types of Economic Instruments



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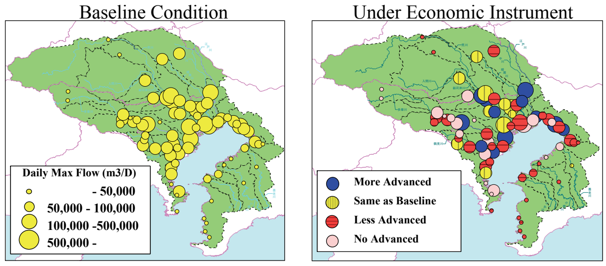
Shift in Advanced Treatment Level
- Result of Computer Simulation for Tokyo Bay -



Total Cost of Advanced Treatment (million yen/year)

Baseline Permit	Under Economic Instrument	Cost Abatement Rate
65,916	45,792	31%

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1. Equivalency in cost-effectiveness

- The mathematics for both effluent charge system and water quality trading suggests an equivalent cost-effectiveness in meeting a predetermined target.

Marginal cost for advanced treatment is equalized for every WWTP in both approaches.

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2. System Designing

Water quality trading could be easily designed on the basis of the total sum of permits which is the predetermined target of the policy, while effluent charge system cannot be designed directly from the target.

Water Quality Trading

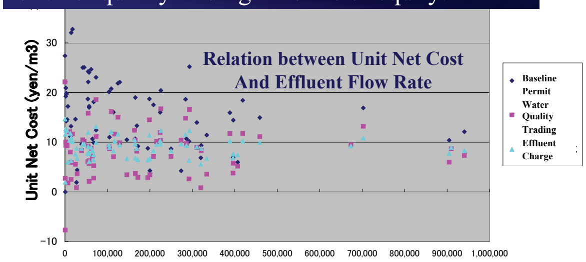
Target of the Policy → Allowable Load (Total Sum of Permits) → Baseline Load

Target of the Policy → **Effluent Charge Rate cannot determined easily**

Effluent Charge System

2. Equity

Effluent charge system is estimated to be superior to water quality trading in terms of equity.



Effluent Flow Rate (m³/D)

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3. Public Acceptance / Resistance

The Biggest problem related to effluent charge system is general public resistance to charging/taxation.

Equivalence between Modified Approach and Water Quality Trading

Modified Approach in CBPSS (Japan)		Water Quality Trading (U.S.A.)
Transferable LRA (Load Reduction Assignment)	⟷	Transferable Permit for Discharging Pollutant
Substituting for the Other Local Entity on LRA (Undertaking the LRA Transferred from the Other Local Entity)	⟷	Selling Transferable Permit
Being Substituted for by the Other Local Entity on LRA (Transferring Its Own LRA to the Other Local Entity)	⟷	Buying Transferable Permit

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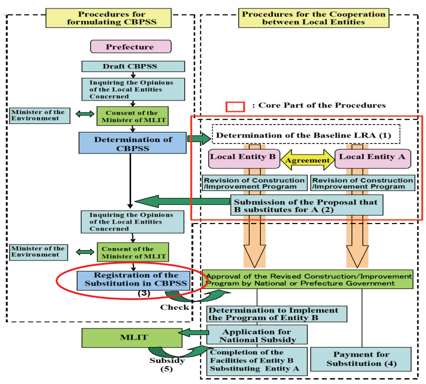
Procedures for Cooperation between Local Entities Relating to Advanced Treatment of Nitrogen and Phosphorus



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Modified Approach

- A. Determination of the Baseline LRA
- Prefecture shall determine the baseline LRA (Load Reduction Assignment) for nitrogen or phosphorus contained in the effluent of relevant WWTPs in the CBPSS which targets on enclosed water bodies where EWQS (Environmental Water Quality Standard) of nitrogen or phosphorus is set.
- B. Cooperation for Advanced Treatment between Local Entities
- B-1 Proposal of Substitution
- Local entity can submit to the prefecture a proposal that it will substitutively fulfil the LRA assigned to the other entity's WWTP, after reaching the agreement with the local entity to be substituted for on this issue.

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- B-2 Registration in CBPSS
- The prefecture that has received the proposal of substitution can register the information of the substitution including the estimated cost and its sharing in the CBPSS.
- B-3 Payment for Substitution
- The local entity that substitutively fulfills the LRA assigned for the other entity's WWTP can, as the legal effect of the registration in CBPSS, make the entity to be substituted for pay the cost for the substitution including the cost of construction, improvement, rehabilitation, repair, maintenance and control.

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Concrete Methodology for the Modified Approach

- 1. How to determine baseline LRA for every
- WWTP concerned.
- ⇒ Guideline issued by MLIT

- 2. How to transfer LRA from a WWTP to
- another WWTP
- 3. How to allocate the cost between local entities.
- ⇒ Graft guideline issued by MLIT

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Determination of Baseline LRA

- According to the guideline issued by MLIT, Baseline LRA is determined for every WWTP concerned as follows:
- Baseline $LRA(kg/day) = \dfrac{(C_r - C_t) \times Q_t}{1{,}000}$
- where
- C_r : Water Quality of Reference (mg/L) set by taking the present water quality requirement into account.
- C_t : Average Water Quality Required in the Target Year (mg/L)
- Q_t : Average Daily Flow Rate of the Effluent in the Target Year (m3/day)

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C_t is determined so that the municipal wastewater treatment might make the targeted public waters fulfil their EWQSs.

- (a) Set a value for $\overline{C}_t$ common to all the WWTPs at higher level at first. Then decrease the value gradually until it fulfils all the EWQSs in the water areas in target year by means of computer simulation with appropriate boundary conditions e.g. the other countermeasures against pollution. $\overline{C}_t$ can be set in this way at nearly maximum value to fulfil the EWQSs.
- (b) As for for each WWTP, relevant local entity i determines the values of for its WWTP j, so that they may satisfy the equation:

$$\sum_{j=1}^{n_i} C_{t,i,j} \times Q_{t,i,j} \le \overline{C}_t \times \sum_{j=1}^{n_i} Q_{t,i,j}$$

- where the local entity i has WWTPs.

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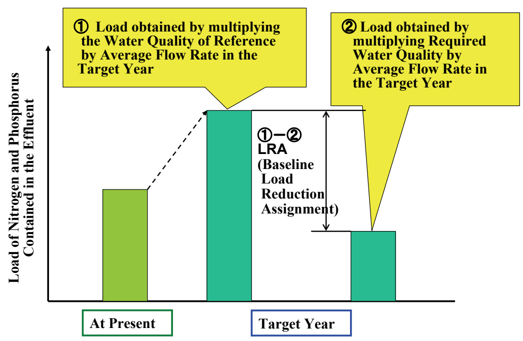
Procedures to Determine Baseline LRA



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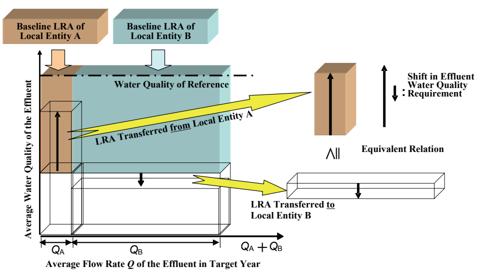
Equivalence in Transfer of LRA



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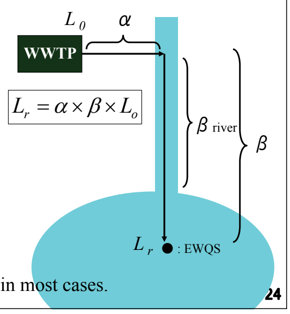
How should we evaluate the decrease in the load in the river basin?

The coefficient α is supposed to be 1.0, because most of the WWTPs discharge their effluents directly into rivers, seas and lakes.

There are quite a few data for β, but most of them are obtained in the fieldwork in dry weather. The aquatic plants and the river beds trap and keep nitrogen and phosphorus in dry weather. But most of the deposited nitrogen and phosphorus are supposed to be washed out into the enclosed water bodies in wet weather.

⇒ β_{river} may be presupposed to be 1.0 in most cases.



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In order to facilitate the transfer of LRA

Flexible processes are proposed as shown in Figure 8. The WWTP can undertake the LRA transferred from the other WWTP, even if the WWTP fulfils only a part of its own LRA.

"Phased program" of the transfer of LRA and a kind of Clearinghouse would be required to explore the opportunities for the transfer of LRA between WWTPs.

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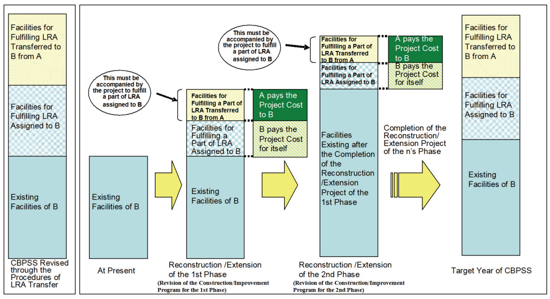
Phased Program of the WWTP (B) Undertaking the LRA Transferred from Another WWTP(A)



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Cost Allocation in the Cooperative Project With the Transfer of LRA from A to B

(a) Specify the facilities of B and the total project cost C_T for cooperative project of A and B relating to the advanced treatment of N(nitrogen) and/or P(phosphorus).

(b) Divide the specified facilities into 2 parts : part for the removal of N and the part for the removal of P. Then the project cost C_T is also divided into 2 parts : the costs C_N and C_P related to the facilities for the removal of N and P, respectively.

(c) Cost allocation for the cooperative project is shown as:

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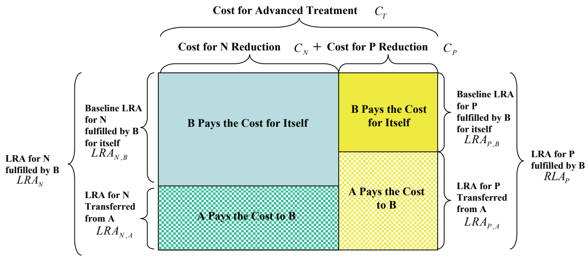
Cost Allocation in the Cooperative Project With the Transfer of LRA from A to B



This proportionate relation between LRA and its cost is recommended so that the result of the modified approach may be nearly equalized to the result of WQT.

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Formulating work of CBPSSs for the clean waters in the 3 big bays (Tokyo Bay, Osaka Bay and Ise Bay) and other enclosed water bodies are now progressing.

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