Environmental Technology Verification Projects Related to Water Quality

ETV International Forum,
Water and Water Security Session
13 July 2005

Kenji KAMITA,
Ministry of the Environment, Japan

Outline

I. Organic Wastewater Treatment Technologies for Small-scale Establishments (Kitchens/Restaurants and Food Manufacturing Plants)

II. Treatment Technologies for Human Waste in Mountain District

III. Simplified Monitoring Technologies for Chemical Substances

IV. Wastewater Treatment Technologies for Nonmetallic Elements (e.g., boron)

V. Technologies for Improving Water Quality of Lakes/Reservoirs

I. Organic Wastewater Treatment Technologies for Small-scale Establishments (Kitchens/Restaurants and Food Manufacturing Plants)

~ Why are they needed? ~

(Need)

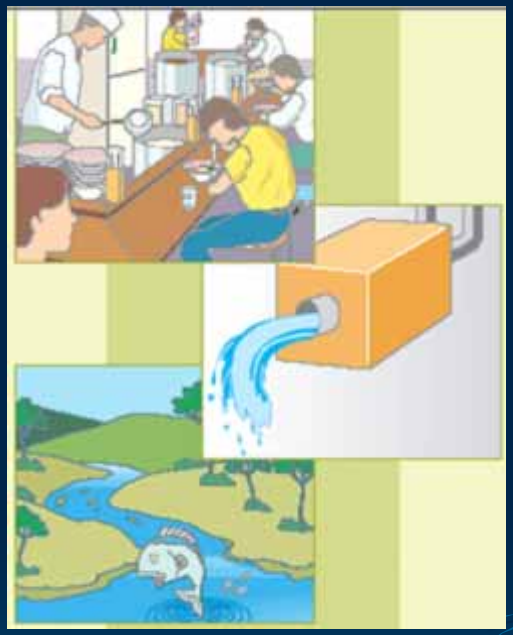
(1) Water quality has not been adequately improved:

BOD/COD concentrations have been improving, but in FY2003 achievement rate of Water Quality Standard were still at 87.4% (rivers), 55.2% (lakes/reservoirs), 76.2% (seawater). (Similar problem with T-N, T-P.)

(2) Many unregulated emissions sources:

Small establishments (effluent < 50 m^3/day) are not subject to effluent standards for organic pollutants. But number of these small-scale ones account for about 87% of all establishments.

→ To reduce the organic pollutant load, need to promote organic wastewater treatment technologies that are low-cost, compact, and low-maintenance.



An image from the cover of FY2003 report

I. Small-scale Organic Wastewater Treatment

~ Overview ~

Technologies to treat organic wastewater from the kitchens of small establishments (wastewater discharge up to 50 m^3/day).

Example: Technology (or equipment or plant) that properly treats, by biological or physicochemical means, the organic wastewater emitted from kitchens, restaurants, or food processing plants.

- Verification project began in FY2003
- FY2003: 3 Verification Organizations participated (Ishikawa Pref., Hiroshima Pref., Osaka Pref.), total of 8 technologies verified.
- FY2004: 5 Verification Organizations participated (Fukushima Pref., Saitama Pref., Hiroshima Pref., Osaka Pref., Kagawa Pref.), total of 10 technologies verified.
- FY2005: Now shifting to vender-pays stage (Phase 2) as two-year pilot period has ended.
- FY2003 verifications and reports have been completed.
- FY2004 verification testing have been completed, and reports are now being prepared.
- A number of Verification Organizations wish to continue.

I. Small-Scale Organic Wastewater Treatment

~ Outline of Verified Technologies (1) ~

Target technologies in FY2003 project

Verification Organization	Technology developers	Name of technologies
Ishikawa Pref.	Ams Corporation	Treatment equipment for oily wastewater, using oil-decomposing bacteria
	Gate, Ltd.	Treatment technologies for wastewater containing oil, using oil-decomposing microbial agents
Environmental Pollution Control Center, Osaka Pref.	Kondoh-FRP Co., Ltd.	Fixed-bed oil-decomposing bacteria adsorption type Contact aeration method
	Suiko Engineering, Co., Ltd.	Enzyme reaction/fruidized bed type Contact aeration method
	BioRangers, Inc.	Multi-microbe/tornado-type bio-reactor system
	River SS., Ltd.	Coagulation reaction/electrolytic flotation separation
Hiroshima Pref.	Aquamake, Co.,Ltd.	Restaurant/kitchen wastewater treatment equipment "Super Aqua"
	Kowa Emtech Limited	"Zero Combo" (oil-recovery equipment for kitchen wastewater treatment)

Note1: Names of Developers and Technologies may not be accurate.
2: FY2004 report is currently being prepared.

I. Small-Scale Organic Wastewater Treatment

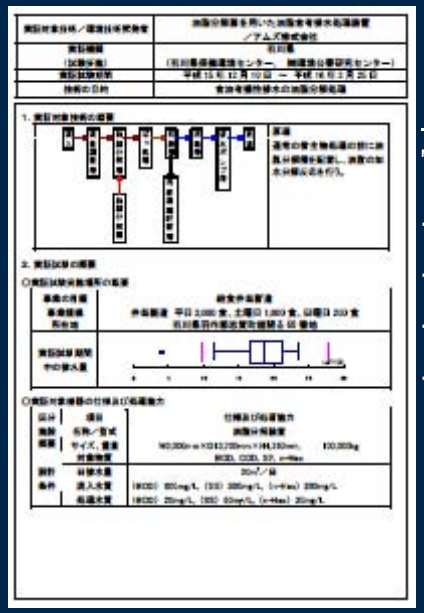
~ Outline of Verified Technologies (2) ~

Developer	Main Purpose of Technology	Pollutants Removed			
		BOD	COD	SS	n-Hex
Ams Corporation	Treatment of organic wastewater	X	X	X	X
Gate, Ltd.	Grease trap oil decomposition				X
Kondoh FRP Co., Ltd.	Treatments of organic wastewater	X		X	X
Suiko Engineering, Co., Ltd.	Treatments of organic wastewater	X		X	X
BioRangers, Inc.	Treatments of organic wastewater	X		X	X
River SS., Ltd.	Treatment of organic wastewater				X
Aquamake, Co.,Ltd.	Treatments of organic wastewater	X	X	X	X
Kowa Emtech Limited	Decomposition of grease trap oil, etc.				X

- For the each technology, the actual pollutant removal was confirmed to generally match the technology's stated specifications. (Although some technologies failed to achieve their stated specifications.)
- In some cases, the technology was confirmed to also remove some pollutants that were not being targeted (even T-N or T-P in some technologies).

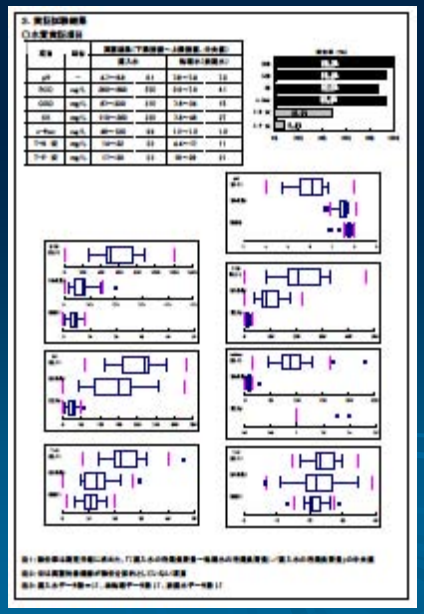
I. Small-Scale Organic Wastewater Treatment

Sample Verification Report (Summary Version)



1st page
Technology Outline
- Technology name
- Technology flowchart
- Location of test
- Technical specifications, etc.

3rd page
Verification results 2
- Environmental Impact (sludge generated, etc.)
- Resources used (electricity, chemicals, etc.)
- Maintenance features



2nd page
Verification results 1
- Pollutant removal performance

4th page
Applicant info.
- Product data
- Contact info., etc.

II. Treatment Technologies for Human Waste in Mountain District

~ Why are they needed? ~

(1) The Need for Toilets in Mountain Areas:

- The cold atmosphere and absence of electrical and water-supply infrastructure make it difficult to use conventional sanitation equipment in Japan's mountain areas, and thus the availability of proper toilet facilities is inadequate in these areas.
- The boom in recent decades of middle-aged hikers has increased the number of visitors to mountain areas, giving cause for concern about the impacts of human waste on the surrounding environment.

(2) Concerns about reliability of the technology:

- In recent years, there has been progress in the private sector with the development and commercialization of human waste treatment technologies that can be used in mountain areas.
- However, performance data on these technologies is limited to what the companies themselves have released. Hence, in the absence of clear standards, users such as local governments question whether or not the technologies have the proper treatment capabilities.

→ Thus, there is a need for objective information and verification regarding human-waste treatment technologies that can be used in mountain areas.

Toilets for Mountain Areas
(Cover of 1st Report)

II. Toilets in Mountain Areas

~ Overview ~

Technologies for the treatment of human waste from public toilets in areas such as mountain districts that lack adequate infrastructure (sewerage/drain pipes, electricity, etc.)

Example: Technology (equipment) that works without discharging water and can properly treat human waste, by biological, chemical, or physicochemical means, or some combination thereof

- Verification project began in FY2003
- FY2003: 1 Verification Organization (Toyama Pref.), total of 2 technologies verified.
- FY2004: 4 Verification Organizations (Nagano Pref., Shizuoka Pref., Kanagawa Pref., NPO “Yama no ECHO”), total of 4 technologies verified.
- FY2005: Now shifting to vender-pays stage (Phase 2) as two-year pilot period has ended.
- In many cases, verification testing cannot be completed in one year, due to the need for post-winter testing, etc. Of the projects that started the verification process over the past two years, reports have been completed for two technologies only.
- A number of Verification Organizations wish to continue.

II. Toilets in Mountain Areas

~ List of Technologies Verified ~

Starting Year	Verification Organization	Treatment Method	Technology Developer	Current Status
2003	Toyama Pref.	Soil treatment	Reinforce, Co., Ltd.	Report has been completed.
	Toyama Pref.	Composting treatment	Takahashi Boiler, Co., Ltd.	Testing is in process.*†
2004	Shizuoka Pref.	Biological treatment	Yamashirokizai, Co., Ltd.	Testing is in process.*
	Kanagawa Pref.	Soil treatment	Reinforce, Co., Ltd.	Report writing is in process.
	Nagano Pref.	Biological (aerobic) soil treatment	Daiichi Pollution Control Equipment, Co., Ltd.	Testing is in process.*
	NPO Yama no ECHO	Physico-chemical treatment process	Orient Ecology, Co., Ltd.	Report has been completed.

** The testing period will last more than one year, to allow comparison of performance over the winter season.*

† Actual testing began in FY2004, as access to the mountain was already closed at the time the project was selected in the winter of 2003.

Note: Names of Developers and Technologies may not be accurate.

II.Toilets in Mountain Areas

~ Summary of Verification Results ~

Views of equipment by Reinforce, Co., Ltd.
Location: Tateyama (elevation 2,700 m)

Views of equipment by Orient Ecology Co., Ltd.
Location: Nikko/Lake Chuzenji (elevation 1,270 m)

- Verification covered the following: Operating conditions, maintenance functions, in-door environment, impact on surrounding environment, treatment performance, etc.
- For both technologies for which verification has been completed, no troubles arose during the testing period, and both functioned well even at times of peak use frequency.
- For both toilets, 70% to 80% of respondents to a user survey on the indoor conditions during the testing period answered that “the odor and other inside conditions were acceptable.”

III. Simplified monitoring technologies for chemical substances

~ Why are they needed? ~

(1) Growing Need:

- As importance on risk communication relating to chemicals increased, there is a rising need to have a good grasp of the situation of chemical substances in the environment, for the public and other stakeholders.
- But because there are many kinds of chemicals and many are in the environment at low concentrations, conventional analytical methods are mostly complex, so there is a need to develop and apply simple analytical technologies.

(2) Current state of the technology and issues:

- Today there are many simple yet sensitive analytical technologies being placed on the market that could answer the analytical needs mentioned above.
- But these technologies often lack credibility, as little performance data is available based on actual sample testing, and there have not been enough comparisons with existing measurement methods.

→ Thus, there is a need for objective verifications of these simple analytical methods.

III. Simplified Monitoring of Chemicals

~ Outline of the Technologies ~

Technologies that can be implemented more easily than conventional methods, particularly to analyze chemical substances in the environment that are yet not covered by officially sanctioned methods.

Example: Simple analytical methods such as enzyme immunoassays or fluoroimmunoassays that use antigen-antibody reactions, for substances subject to Japan's PRTR Law, as well as suspected endocrine disrupting chemicals, etc.

- Verification project began in FY2004
- FY2004: 3 Verification Organizations (Yamaguchi Pref., Aichi Pref., Hyogo Pref.), total of 8 technologies verified (3 companies, 8 substances, 8 kits).
- FY2005: Invitation/selection of Verification Organizations is in progress.
- For FY2004 verifications, testing is completed, and reports have almost been completed.

III. Simplified monitoring for chemicals

~ List of Technologies ~

Verification Organization	Produce Name	Environmental Technology Developer	Target of Analysis
Aichi Pref.	Atrazine ELISA Kit (microplate method)	Japan EnviroChemicals, Ltd.	Atrazine
	High-sensitivity fenitrothion measurement kit	Horiba Biotechnology, Co., Ltd.	Fenitrothion
Hyogo Pref.	PCB ELISA System	EnBioTec Laboratories, Co., Ltd.	PCB
	Environmental pollutant diagnostic materials, ECOLOGIENA/anion surfactant (LAS) ELISA kit	Japan EnviroChemicals, Ltd.	Linear alkylbenzene sulfonate (LAS)
Yamaguchi Pref.	Environmental pollutant diagnostic materials, ECOLOGIENA/alkylphenol (AP) ELISA kit	Japan EnviroChemicals, Ltd.	Alkylphenol
	Isoxathion measurement kit	Horiba Biotechnology, Co., Ltd.	Isoxathion
	Malathion measurement kit	Horiba Biotechnology, Co., Ltd.	Malathion
	Isoprothiolane measurement kit	Horiba Biotechnology, Co., Ltd.	Isoprothiolane

Note 1: All are based on the ELISA (Enzyme-Linked Immunosorbent Assay) method.
Note 2: Target chemicals are, 5 agricultural chemicals, 2 surfactants and PCB.
Note 3: Names of Developers and Technologies may not be accurate.

III. Simplified monitoring of chemicals

~ Summary of Verification Results ~

Target of Analysis	Detectable Range (in parentheses: company data)	Detection Time (not counting preparation)	Remarks: Comparison with Conventional Methods
Atrazine	0.25-5.0 ug/L (0.05-5.0 ug/L)	About 5 hrs	GC/MS-SIM method: about 3 days
Fenitrothion	0.15-2.0 ug/L (0.15-2.0 ug/L)	About 5 hrs	GC/MS-SIM method: about 3 days
PCB	10-250 ug/L (6.5-250 ug/L)	About 2 hrs	GC/MS method: about 3 days
Linear Alkylbenzene Sulfonate (LAS)	50-1,000 ug/L (20-1,000 ug/L)	About 4-5 hrs	–
Alkylphenol	20-500 ug/L (5-500 ug/L)	About 3 hrs	GC/MS-SIM method: about 3 days
Isoxathion	1-20 ug/L (1-20 ug/L)	About 3 hrs	GC/MS-SIM method: about 3 days
Malathion	15-100 ug/L (15-250 ug/L)	About 3 hrs	GC/MS-SIM method: about 3 days
Isoprothiolane	6-100 ug/L (6-100 ug/L)	About 3 hrs	GC/MS-SIM method: about 3 days

Note 1: These findings illustrate the convenience of the new compared to conventional technologies.
Note 2: These results found that for some technologies, the measurable range was not broader than the company's stated product data.
Note 3: Verification of measurable range was based on Intra-day variability, Inter-day variability, Inter-annual variability, Inter-lot variability, and cross-reactions, etc.

IV. Wastewater treatment technologies for nonmetallic elements (e.g., boron)

~ Why Needed? ~

(1) Background:

- Because of evidence of the human health impacts of boron and fluorine, Japan introduced effluent standards in 2001 (across-the-board standards: 10 mg/l for boron, and 8 mg/l for fluorine, with the exception of seawater). But in 2001, provisional standards were established for some industries, as a concession for small-scale factories.
- In 2004, a study found that efforts to introduce treatment equipment were lagging, particularly in service industries, such as hotels and inns that use the water from hotsprings.

(2) Current state of the technology and issues:

- In recent years, space-saving, low-cost, technologies to treat boron and other substances have been developed, but facilities such as inns with hotsprings still lack knowledge and experience with introducing such technologies. Even though excellent technologies may be available that do not require the installation of expensive equipment, they are not spread.
- Thus, to promote and further develop these technologies it is important to verify the environmental-protection effectiveness of these technologies and obtain objective data about them.

IV. Wastewater Treatment for Boron, etc.

~ Outline of Technologies ~

Technologies for treatment of wastewater containing nonmetallic elements such as boron, applying to operating establishments such as hotels and inns where only organic pollutants in wastewater have been considered to date.

Example: Compact and low-cost technologies (equipment) for treating wastewater containing nonmetallic elements such as boron (for example, by the coagulation/sedimentation or ion-exchange methods), that may be retro-fitted into existing wastewater systems.

- Verification project began in FY2005. Initially, the target will be boron removal technologies.
- FY2005: 1 Verification Organization selected (Chiba Pref.) Currently in process of inviting/selecting technologies for verification.

V. Technologies for Improving Water Quality of Lakes/Reservoirs

－Why are they needed?－

(1) Background:

- Lakes and reservoirs are enclosed water bodies, and once organic pollutants accumulate in them it is difficult to return them to a clean state. Only 40-50% of lakes/reservoirs in Japan meet environmental water quality standards for COD. Also, pollution from nutrients such as phosphorus cause frequent occurrences of algae blooms of phytoplankton (water bloom).
- Despite steps taken by the Ministry of the Environment, such as strengthening effluent standards, to enhance efforts to reduce pollutant loads flowing into these water bodies, water quality has failed to improve.

(2) Current state of the technology and issues:

- In recent years, many technologies have been developed to directly improve water quality in lakes and reservoirs. It is important to promote the development and application of these technologies, along with strategies to reduce pollutant load inflows.

V. Improving Water of Lakes and Reservoirs

~ Outline of Technologies ~

Technologies for directly removing pollutants that have accumulated in water, benthic mud, etc., or for preventing internal production of pollutants within enclosed lakes and reservoirs, where it is difficult to improve the water quality merely by reducing pollutant load inflows.

Note: Mainly equipment that can be used on-site, and excluding technologies that require large-scale work such as dredging.

Examples: Technologies for improving the water quality of lakes and reservoirs, for example, by filtration, adsorption, or sedimentation, or by suppressing massive growth of phytoplankton (algae blooms).

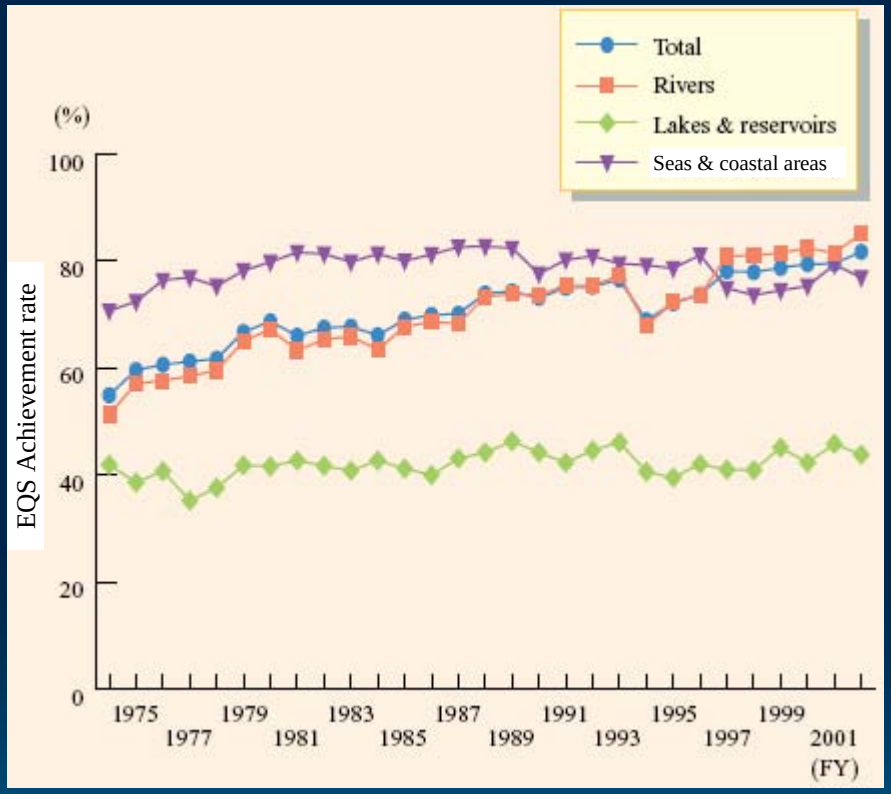
- Verification project began in FY2005.
- FY2005: 5 Verification Organizations were selected (Saitama Pref., Osaka Pref., Hiroshima Pref., Kagawa Pref., Ehime Pref.) Currently in process of inviting/selecting technologies for verification.

Thank you!

J-ETV Website (English)
http://etv-j.eic.or.jp/en/index.html

http://etv-j.eic.or.jp/index.html
(Japanese)

Appendix: Water Quality Status in Japan
Organic Pollutants (BOD and COD)



BOD and COD, 1974-2002

** COD for lakes & reservoirs, BOD for others*

EQS: Environmental Quality Standard

Appendix: Outline of Testing Criteria (Verification Items)(1)

I. Small-Scale Organic Wastewater Treatment

Category	Aspect Being Verified	Main Items Being Verified	
Verification of water quality	・Wastewater treatment capacity of the equipment ・Stability of operation	pH (hydrogen ion concentrations), BOD (biological oxygen demand), COD (chemical oxygen demand), SS (suspended solids), n-HEX (n‐Hexane extracts), coliform bacteria, T-N (total nitrogen), T-P (total phosphorus)	
Verification of operations and maintenance	・Performance in terms of operations and maintenance (qualitative, quantitative) ・Costs associated with operations and maintenance	Environmental impacts	Amount of sludge generated, amount of waste generated, noise/odor, qualitative assessments (e.g., ease of treating pollutants, waste, odor, etc.)
		Resources used	Consumption electricity, etc.; types and amounts of chemicals for wastewater treatment; other consumables
		Operations and maintenance performance	Time required for making observations and for start-up and stopping equipment operation; personnel numbers and skills required for equipment operation and maintenance; equipment reliability; methods to resume operations after trouble; assessment of operating/ maintenance manuals

Appendix: Outline of Testing Criteria (Verification Items)(2)

II. Toilets in Mountain Areas

Category	Aspect Being Verified	Main Items Being Verified	
Verification of operating conditions/situation	Preconditions/assumptions for proper operation	Users	Number of toilet users
		Water	Amounts of initial water required, refills, consumption
		Electricity	Normal electrical consumption, peak consumption, etc.
		Fuel	Type and amount of fuel consumed, etc.
		Materials	Type, amount, cost of materials consumed, etc.
		Temperature	Air temperature at installation site
		Weather conditions	Weather conditions at installation site
Verification of maintenance	Routine and special maintenance requirements	Tasks, required number of persons, time, and ease/difficulty of the following: routine maintenance; special maintenance; tasks at season start/end; removal/treatment/disposal of "products"; handling of trouble.	
		Reliability	Readability, understandability, accuracy, etc.
Verification of room conditions	Comfort inside toilet booth	Allowable range for temperature, humidity, comfort, operation	
Verification of surrounding conditions	Impact on local environment	Changes to site	Equipment footprint; landscaping, tree-clearing, soil relocation, etc.
		Surrounding soil	Nitrate nitrogen, chloride ions
Verification of treatment performance	Waste treatment performance of equipment	pH (hydrogen ion concentrations), BOD (biological oxygen demand), TOC (total organic carbon), SS (suspended solids), TS (residue on evaporation), IL "VS" (ignition loss), coliform bacteria, Cl- (chloride ions), EC (electric conductivity)	

Appendix: Outline of Testing Criteria (Verification Items) (3)

III. Simplified Monitoring of Chemical Substances

Category	Aspect Being Verified	Main Items Being Verified
Basic performance	- Basic performance of the product - Reliability of product design	Measurable range, minimum detection limit and amount, Intra-day variability, Inter-day variability, Inter-annual variability, Inter-lot variability, and cross-reactions.
Performance in actual use	- Performance of the product in actual use - Adaptability to environmental specimens	Recovery characteristics, measurement accuracy, etc.

IV. Wastewater Treatment for Boron, etc.

Category	Aspect Being Verified	Main Items Being Verified	
Verification of water quality	- Wastewater treatment capacity of the equipment - Stability of operation	Boron concentrations in treatment water, boron removal rate Reference items: rate of boron regeneration, concentrations of nonmetallic elements other than boron (fluorine, arsenic); water plantation criteria for other than nonmetallic elements (pH, BOD, COD, etc.)	
Verification items for environmental burden	- Other environmental burdens, and cost of proper treatment	Amount of sludge generated, type and amount of waste generated, noise/odor, qualitative assessments (e.g., ease of treating pollutants, waste, odor, etc.)	
Verification of operations and maintenance	- Performance in terms of operations and maintenance (qualitative, quantitative) - Costs associated with operations and maintenance	Resources used	Electrical consumption; types and amounts of chemicals for wastewater treatment; other consumables
		Operations and maintenance performance	Time required for making observations and for start-up and stopping equipment operation; Personnel numbers and skills required for equipment operation and maintenance; equipment reliability; recovery methods after occurrence of operational trouble; assessment of operating/maintenance manuals

Appendix: Outline of Testing Criteria (Verification Items)(4)

V. Improving Water Quality of Lakes/Reservoirs

Category	Aspect Being Verified	Main Items Being Verified	
Verification items for water quality environment	- Criteria for environmental quality standards of water bodies - Criteria that indicate water quality even though no quality standards are set	pH (hydrogen ion concentrations), DO (dissolved oxygen), COD_{MN} (chemical oxygen demand), SS (suspended solids), T-P (total phosphorus), coliform bacteria, T-N (total nitrogen), NO3-N (nitrate), NO2-N (nitrite)	
Verification items for impacts on bottom sediment	- Items that indicate conditions and changes in bottom sediment of water body	Observations	Color and odor of bottom sediment
		Improvement of aerobic conditions	oxygen reduction potential
		Items relating to interstitial water	Decided based on consistency with water impact verification items
		Items relating to solid constituents	E.g., T-C (total carbon), T-N (total nitrogen), T-P (total phosphorus)
Verification items for biological impacts	- Impacts on living organisms Note: Where chemicals or microbial agents are used, the findings of separate biological impacts must also be reported	Phytoplankton	Chlorophyll a, number of individuals and populations for each type
		Zooplankton	Number of individuals and populations for each type
		Fish	Number of individuals for each species of benthic organisms (bivalves, insects, etc.) Impacts on nektons (fish, etc.)
Verification items for env.l burden	- Other environmental burdens, and cost of proper treatment	Amount of sludge generated, type and amount of waste generated, noise/odor, qualitative assessments (e.g., ease of treating pollutants, waste, odor, etc.)	
Verification of maintenance	- Performance in terms of maintenance (qualitative, quantitative) - Costs associated with maintenance	Resources used	Consumption of electricity, etc.; types and amounts of chemicals for wastewater treatment; types and amounts of microbial agents; other consumables
		Operation and maintenance performance	Time required start-up and stopping equipment operation; personnel numbers and skills required for equipment operation and maintenance; equipment durability; equipment reliability; recovery methods after occurrence of operational trouble; assessment of maintenance manual