

Strategy on Wastewater Control in Japan for 21st Century

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Abstract: When we stepped into the 21st century, we noticed so many changes in various fields, such as meteorological change in global scale, soaring price of crude oil, frequent draughts and floods, overt heat-island phenomena in big city areas, falling birthrate and rapidly aging population. These changes are not temporary mutations, but are transformations based on a long-term trend that we cannot ignore for planning and re-visioning of the future state of the wastewater systems. Starting from these understanding of present state of circumstances, new concept for the role of wastewater system is formed as a national strategy to be key infrastructure for recycling society, namely “*The Road toward Recycling Society*.” This paper describes the new concept of *The Road toward Recycling Society* along with its implementing policy.

Keywords: Recycle, the 21st century, policy for wastewater system, improvement of systems

Introduction

When we have perspectives of the 21st century, we can predict great changes in Japan that will emerge in many fields. We must change our living systems preparing for the coming future. Our systems consist of many sub-systems. Wastewater system is one of them, but important one to keep our society in healthy and comfortable one. This means that we need to have a new concept adapting our society to future situations. For setting the new concept and policy both of the wastewater systems and the wastewater works, a special committee was convened

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and carried out intense discussions for about one year, and announced their conclusion in a report titled as *Wastewater System Vision 2100*. The subtitle of this report is “*From Wastewater System to The Road toward Recycling Society as 100-years strategy*”. This paper describes about this new strategy and new concept of *The Road toward Recycling Society*.

A new concept for wastewater system adapting to the 21st century

Among the various future changes, some of the serious ones that we will face in the latter part of the 21st century may be the climate changes that will be caused by greenhouse-gas effect and the shortage of natural resources such as fossil oil and natural gas. These changes will be caused as the consequence of our lifestyle in the late 20th century of mass production and thus mass waste-production. In these several years we already suffered from abnormal climate that caused terrific flooding, unusual hot summers and abnormally heavy snowfalls. Another precursor of the future problem is the historically high oil price of these days. When these difficulties become extreme situations, our lives itself will be threatened by the problems. In view of this, we must adapt our society to sustainable one for future prosperity.

Other problems that we will also face in relatively near future in Japan are social problems that will be caused by decrease of population. Although the diminution of the population was predicted and well recognized in relatively long ago, it was a great shock for Japan in last year that periodic census showed actual reduction of the population. This reduction is due to the small number of birth rate of these days that is less than the death rate. On the other hand the life expectancy in Japan is high number. Consequence of these conditions introduces aging society and structural changes in industrial fields and economic aspects. In the aging society government will have limited resources for affording new infrastructure than our generations, and thereby we need to prepare for the future in early stages.

Along with the changes in the future of the natural environment and society, we are also questioned about the direction of future society. In these respects, wastewater system also must change for the establishment of bright future. We need to have a clear image of wastewater systems as new functions and new roles in the 21st Century as a key infrastructure for better world, thinking out of conventional images of the systems. For these view points, the vision for 21st century of the systems should work to bring out three goals: beautiful environment,

safe community and vigorous society. To realize these three goals, how our wastewater systems contribute to new era becomes crucial point. Contemplating these conditions, the new concept as the 21st century of wastewater systems has been emerged as “*The Road toward Recycling Society*” for the new strategy of the central government.

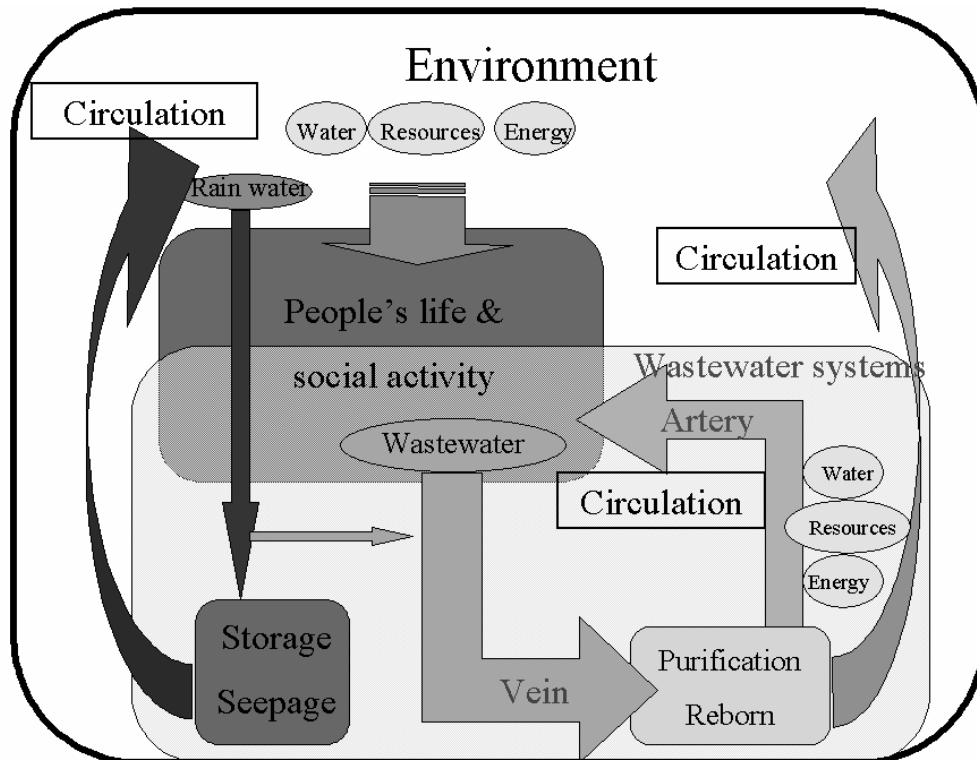


Figure 1. Schematic image of wastewater system's role in the 21st century society
Wastewater system is a key infrastructure to sustain limited resource society.

Besides above-mentioned future problems, we have already some problems straggling to solve in our working fields. Some of them are categorized in water problems and others are facility management. One of the examples of water problem is the quick run-off of storm water and dried up in the dry seasons in waterways. These cause frequent flooding and less amenity environments. These phenomena are caused partly because of the reduction of impermeable area in our communities. Another water problem is instability of water resources, such as big cities cannot secure their water resources within their water basins. These are not sustainable situations in terms of water resources. A typical example of facility managing problem is increasing aging facilities. These cause not only high demand of rehabilitation works and thereby high requirement of budget, but also increment of road corruptions caused by corroded sewers. The new policy is also

accounting these present problems into them.

What is *The Road toward Recycling Society*?

The term of *The Road toward Recycling Society* implies not only the venous system but also the arterial system including heart, which works as key organs for circulation of necessary materials and waste transportations of humans; in another word *The Road toward Recycling Society* suggest that the wastewater systems become key facilities for hydrologic circulations and resource cycles. This concept aims to change the 20th-century-type wastewater systems for new ones, and also seeks for new functions and images of the systems for 21st century. More specifically from the viewpoint of the healthy circulation of resources, discussion in the committee about the systems extended to basic question about what is wastewater system and what kind of substances we should collect with the systems and should not collect or how to recover and reuse from the collected substances, and how to create healthy recycling systems in our society. Based on these rethinking works, following three key sub-concepts were presented to achieve the main image or metaphor of *The Road toward Recycling Society*:

- *Creation of New Water Passage,*
- *Creation of New Resource Passage* and
- *Revitalization of the Systems.*

The first sub-concept, *Creation of new water Passage*, intends to create new water-networks and passages for exploiting manifold function of water from wastewater work filed. The second sub-concept, *Creation of new resource Passage*, plans on active working to recover resources, such as bio-solid or nutrients, and followed to supply recovered resources. This sub-concept also includes exploiting land site of wastewater work to create new energy, ---solar power, wind turbine, and micro-hydro-power generation--- to depart from dependence on oil. The third sub-concept, *Revitalization of the Systems*, is different from previous two concepts in supporting them, but has more active meaning to refresh existing facility and to meet the social requirements for the wastewater works.

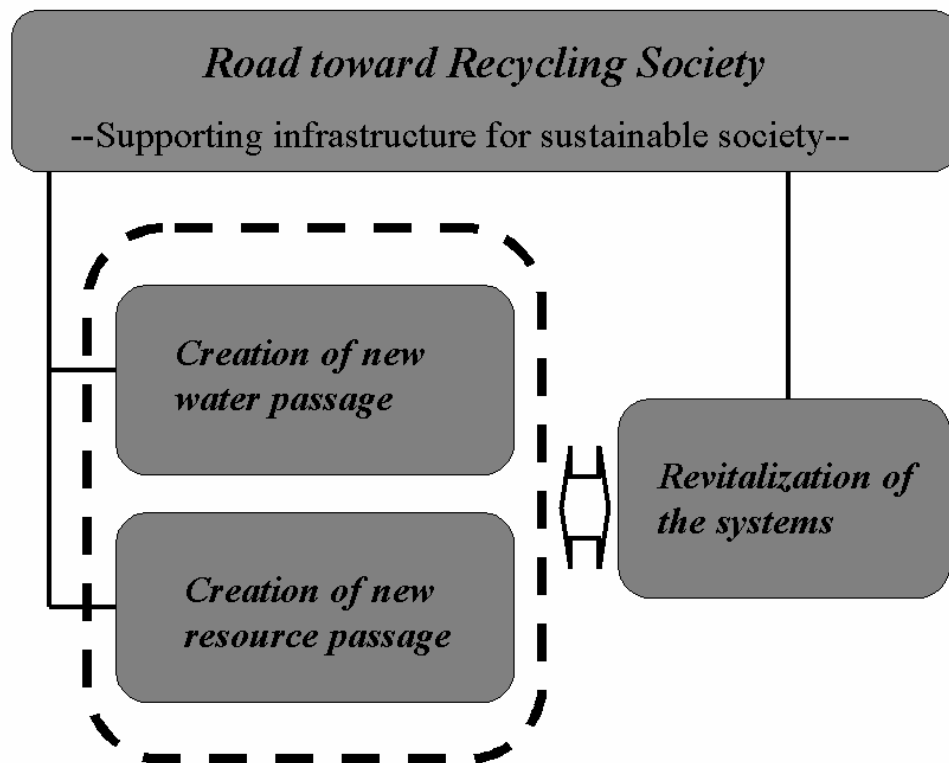


Figure 2. Relation between main concept and three sub-concepts

The *Creation of new water Passage* and its policy development

The *Creation of new water passage* implies to recover health water cycle in basin area by improving wastewater systems. This will be attained with evolving following three core-ideas:

- Recycle and reuse stored rainwater, purified wastewater and incoming ground water into the systems thoroughly,
- Optimize facility location based on aiming on water reuse and
- Redesign facility structure fitting for water reusing.

Healthy water cycle will be realized through encouraging infiltration of storm water to the ground along with reusing of stored storm-water and treated-wastewater. Storm-water infiltration can be realized with storm -water system designing based on infiltration first not draining first. Along with infiltration first policy, introduction of storm-water storage facilities to systems stimulate increment of reusing of water. Direct reuse of treated wastewater also should be inspired with advanced treatment.

Storm-water utilization and treated-wastewater recycle may require deferent configuration and location of the facilities from existing ones. Although conventional decision way for the location and capacity of treatment plant is based on how effectively we can collect wastewater to a plant, the location and capacity should be decided according to the demand of water. In this new way, the location and capacity may be greatly different from existing plants. Same idea also should be applied to storm water systems. The viewpoint of how effectively we can make recycling systems facilitates reorganization and rehabilitation of water networks.

The structure of the storm water systems also may be changed greatly when we introduce the new concept into designing of detail structures. For example, storm water drains becomes open channels instead of pipe systems along with applying percolating structure and ecologically friendly configurations, in another terms near natural systems and nature friendly systems.

The *Passage for Resources* and its policy development

The *Passage for Resources* aims resource recovery through wastewater works and thus supply recovered resources to communities. Introducing this scheme aims less release of global warming gas from the wastewater systems by promoting energy saving in the systems and boosting for using greenhouse-gas-free energy to local communities such as biomass energy.

This will be realized following three ideas:

- Realize self-supporting in energy use for treatment systems,
- Become a top runner of new-energy application by wastewater works and
- Supply energy & resources actively to local communities from wastewater works.

These three ideas need to be accounted in more specifically. The first idea, realization of self-supporting in energy usage for treatment systems, aims in promotion of energy saving, producing new energy in the systems, and trying independence from outer energy supply for facility operations. The second idea, becoming top runner for new energy, proposes wastewater works to be a top runner of new-energy user and producer. The third idea, supplying energy & resources that are recovered from wastewater works to local community, intend to become energy and resource center through wastewater works.

The Revitalization of the Systems and its policy development

The *Revitalization of the Systems* proposes effective maintenance of existing facilities and improvement of the systems to support the two other sub-concepts, *Creation of new water Passage and Creation of new resource Passage*. Basic policies for realizing this concept are extended into following three ideas:

- Transform maintenance policy from reactive to preventive type,
- Improve facilities to meet social demands including multi purpose usages and
- Integrate new facility constructions and maintenance works into asset management.

For these purposes following three working category is considered in actual fields: works for safety, works for exploiting of facilities and works for improvement of functions. The works for safety suggest proactive measures for accident due to poor maintenance works such as road corruptions caused by corroded pipes, anti-earthquake measures, and contribution to local community for providing port of distress. The works for exploiting of facilities means promotion of multipurpose usage of existing facilities. The works for improvement of functions implies not only simply improving of facilities but also active management in accordance with overall review of system plans including to meet new concept for Road toward Recycling Society.

Conclusion

The 21st century is an era that we will face many difficulties in terms of shortage of resources and climate changes. To cope with theses situations we need new concept and policy for our wastewater systems to abate these impacts. As the new concept for 21st century wastewater systems, *The Road toward Recycling Society* is proposed through one-year committee discussions. The new concept is dividend into three sub-concepts that are *Passage of Water*, *Passage for Resources* and *Revitalization of the Systems*. Each sub-concept contains specific polices to promote actual works. We have just started evolving wastewater works based on this new concept, thereby the actual promotion is small at this moment but have a great expectation in a future to be a key infrastructure of recycling society.

References

Ministry of Land Infrastructure and Transport: Report on Wastewater System Vision 2100; *The Road toward Recycling Society*. September 2005.

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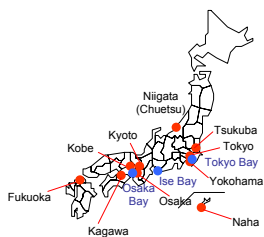


Overview of Sewage Works in Japan

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Overview of Japan

- Japan is an archipelago stretching over a great distance from north to south with a vast range of climatic zones
- About 80% of the territory is either mountain or forested land



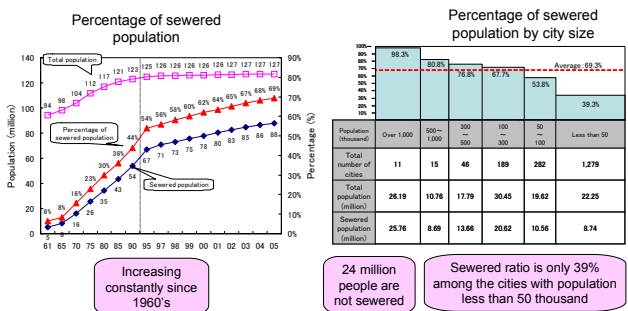
Comparison between USA and Japan

	USA	Japan
Population (million)	281	127
Area (billion m ²)	9,628	378

2

Dissemination of sewerage

- Sewage work in Japan was developed rapidly since 1960's
- Regional divide is one of the distinguishing characteristics of sewage works in Japan
- Narrowing the gap of regional divide remains a major challenge



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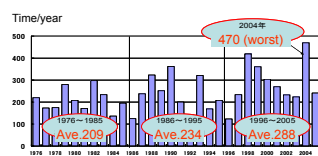
Prevention of inundation

- Recently, heavy rain that exceeds over the presumption of sewerage plan occurs frequently in urban area of Japan, causing the inundation and death accidents in underground facilities
- In order to protect lives and urban system, various measures are taken in sewerage facilities such as publication of hazardous maps, management of retention facilities, remote control of sewerage facilities, etc

Damages by inundation in urban area

- Stormwater flowing to underground facilities (Fukuoka, 2003)
- Water-covered roads (Tokyo, 2004)

Increase in occurrence of heavy rain



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Recovery against Seismic Damages

- Since there is a lot of active fault located in Japan, the potential for large-scale earthquake may occur at any time
- For the sewerage facilities built before 1998, more than 80% is not earthquake resistant
- Measures to secure the minimum function of sewerage at the incident of large-scale earthquake is promoted urgently and intensively

Damages to sewerage facilities at Niigata-Chuetsu earthquake in 2004

- Leakage of wastewater
- Protrusion of manhole

Examples of measures

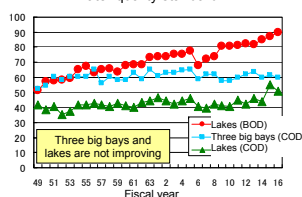
- Improvement of resistance to earthquake in sewer pipes especially under the main roads
- Improvement of resistance to earthquake in pumping station and STP
- Preparation of toilet directly connected to manhole
- Development of pipe network to connect each STP

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Promotion of advanced treatment

- As a consequence of eutrophication, red tide and blue tide still occurs frequently in lakes which are sources of water supply and three big bays
- For example, advanced treatment ratio remains very low level, although the majority of influx of nitrogen and phosphorus comes from sewerage
- Therefore, intensive promotion of advanced treatment is mandatory especially in three big bays, enclosed water bodies including lakes, and sources of water supply

Achievement ratio of water quality standard



Implementation of advanced treatment

- 14% of total population implemented advanced treatment
- Advanced treatment ration in three big bays are as follows:

Tokyo Bay	3.6%
Ise Bay	17.3%
Osaka Bay	14.1%

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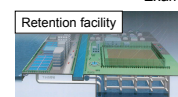
Control of CSO

- In CSO, untreated wastewater is discharged during rain, resulting in contamination of public water bodies
- Enforcement ordinance in Sewerage Law was revised to promote the measures to control CSO by 2014 in principle

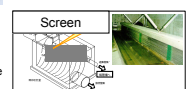
Examples of measures

Implementation of measures to control CSO

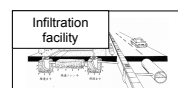
- 191 cities implemented CSO measures out of total sewered cities (1,899 cities)
- 20% of total population implemented CSO measures



Store the stormwater during rain, and treat it in sunny days



Remove garbage in stormwater



Reduce stormwater collected in sewerage

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Utilization of resources

- Amount of water treated in sewerage is about 14 billion m³, and it can be used as important source of water for landscape use, flush toilets, etc (reclaimed water: 0.19 billion m³ (1.4%))
- Increasing amount of sewage sludge is utilized as fertilizer and construction materials conventionally (recycled sewage sludge: 2.17 million DS-t (67%)).
- Recently, focusing on the characteristics of carbon neutrality, conversion to bio-gas and sludge fuel is promoted as countermeasure to global warming

Utilization of advanced treated wastewater for landscape use in Tadotsu, Kagawa Prefecture

Energy use as bio-gas in Yokohama

Bio-gas used as fuel for CNG vehicles in Kobe

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The Road toward Recycling Society

[illegible]

The Road toward Recycling Society

- The concept aims to change the 20th century type wastewater system to 21st century type
- It consist of three sub-concepts:
 - Creation of new water passage ∴ water-networks to exploit manifold function of water
 - Creation of new resource passage ∴ recover and supply resources such as bio-solid
 - Revitalization of the systems ∴ refresh existing facilities to meet social requirements

Relation between main concept and three sub-concepts

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graph TD; A["Road toward Recycling Society  
--Supporting infrastructure for sustainable society--"] --- B["Creation of new water passage"]; A --- C["Creation of new resource passage"]; A --- D["Revitalization of the systems"];
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The diagram illustrates the relationship between the main concept and its three sub-concepts. At the top, a green rounded rectangle contains the text "Road toward Recycling Society" and "—Supporting infrastructure for sustainable society—". Below this, a dashed black line encloses two pink rounded rectangles: "Creation of new water passage" and "Creation of new resource passage". To the right of these two, outside the dashed line, is another pink rounded rectangle labeled "Revitalization of the systems". A vertical line connects the top green box to the "Revitalization of the systems" box. A horizontal line connects the dashed box to the "Revitalization of the systems" box, with a small icon of a pair of scissors or shears positioned between them.

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Creation of new water passage

- New water passage implies to recover health water cycle in basin area
- Three goals to be achieved:
 - Recycle and reuse stored rainwater, purified wastewater and incoming ground water into the systems thoroughly
 - Optimize facility location based on aiming on water reuse
 - Redesign facility structure fitting for water reusing

Supply of water for fire-fighting
using storm water retention facility

Creation of favorable water
environment in Osaka

The diagram illustrates a 'Multipurpose water retention network' integrated into an urban landscape. It shows a cross-section of the ground with various retention structures. A blue callout box points to the 'Multipurpose water retention network' label. Three pink callout boxes provide specific details: 'Retention of water in heavy rain' points to a large underground storage tank; 'Storage of water for fire-fighting' points to a smaller, elevated storage tank; and 'Storage space in case of emergency' points to a large, open retention area. A pink callout box labeled 'Network for infrastructure' points to the overall system layout. The background shows a city skyline with buildings and green spaces.

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Creation of new resource passage

- New resource passage aims recovery through wastewater works and supply to communities
- Three goals to be achieved:
 - Realize self-supporting in energy use for treatment systems
 - Become a top runner of new-energy application by wastewater works
 - Supply energy & resources actively to local communities from wastewater works

Self-supporting in energy in STP

Resource collection, regeneration and supply system

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Revitalization of the systems

- Revitalization proposes effective maintenance of facilities and improvement of the systems to support the two other sub-concepts
- Three goals to be achieved:
 - Transform maintenance policy from reactive to preventive type
 - Improve facilities to meet social demands including multi purpose usages
 - Integrate new facility constructions and maintenance works into asset management

Utilization of optical fibers in sewer pipes for development of information exchange

This diagram illustrates the integration of optical fibers into sewer pipes to facilitate information exchange. A central sewer pipe is shown with multiple optical fibers (labeled 'Optical fibers in sewer pipes') running through it. These fibers are connected to various information sources and services, including: Weather facility, location, events, Administrative services, Traffic condition, Shopping, Management information, and Inspection information. The fibers are also connected to a central 'Management data of sewerage facilities' database, which is linked to a 'Monitoring' station and a 'Pumping facility'.

Asset management of sewerage facility through IT

This diagram illustrates the asset management of sewerage facilities through IT. A central 'Management data of sewerage facilities' database is connected to various IT components, including: a 'Monitoring' station, a 'Pumping facility', an 'Optical fiber' network, a 'Web site', and a 'Mobile phone'. The database is also connected to a 'Sewer pipes' network, which is linked to a 'Monitoring' station and a 'Pumping facility'. The database is also connected to a 'Web site' and a 'Mobile phone'.

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