Challenges Faced by Sewage Works in Japan
挑戦する下水道

To date, sewage works in Japan have placed priority on the expansion and development of sewerage systems. Having nearly accomplished this goal, we now must meet new needs from citizens in Japan by 1) bringing about a clean water environment, 2) creating flood-resistant cities, 3) building recycle-based societies, and 4) realizing and maintaining comfortable sewerage services. Aiming to answer public expectations, sewage works will continue facing these challenges in terms of people, water, and the earth.

日本では、これまで下水道の普及拡大を第１の目標として取り組んでまいりましたが、さらに国民のニーズとして①清らかな水環境の実現 ②大雨に対して安全な都市づくり③リサイクル型社会の構築 ④快適な下水道サービスの実現・維持 などを求められています。こうした国民の期待と「人」、「水」、「地球」の３つの視点から今後は挑戦します。
Roles and Future Plans of Sewerage Systems
Creating a Life of Comfort with Sewerage Systems

The sewerage and wastewater management department of the Ministry of Land, Infrastructure and Transport (MLIT) established the sewerage policy research committee with the Japan Sewage Works Association, and the committee conducted a review of the future role of sewage works and policies to realize that role. The particular attention paid to the public’s point of view by the committee resulted in the recommendations in the chart below.

Eight Basic Functions of Sewage Works
下水道の8つの基本機能

1. Realizing hygienic and comfortable living as early as possible 衛生的で快適な生活を早期に実現
2. Guaranteeing security and safety 安全・安心を確保
3. Improving enrichment and vitality of towns まちのうるおいと活力を向上
4. Building a sound water cycle 健全な水循環系を構築
5. Ensuring stable water resources 安定した水資源を確保
6. Controlling and reducing the risk in water bodies 水系リスクを管理・低減
7. Protecting the ecosystem 生態系を保全
8. Reducing environmental load by focusing on recycling 循環を基調とし、環境負荷を削減

The Needs of Japanese Consumers
国民のニーズ

- A clean water environment
- Creating flood-resistant cities
- Building recycle-based societies
- Realizing and maintaining of comfortable sewerage service

Achievements in Environmental Standards
環境基準の達成

- Early installation of flush toilets
- Safe and tasty water
- Clean swimmable water for rivers and oceans
- Safe towns without flooding
- Environment-friendly societies
- Comfortable living through sewerage systems
- Realizing and maintaining of comfortable sewerage service
下水道にはこんなに沢山の役割が！
下水道で快適なくらし

国土交通省都市・地域整備局下水道部と日本下水道協会は、下水道政策研究委員会を設置して、これからの下水道の役割と実現策等について検討を行いました。特に国民の視点に立ち取り組んだ結果、下記の図のようなことが提案されています。

<table>
<thead>
<tr>
<th>番号</th>
<th>重点事項</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A) Prompt spreading of Wastewater Treatment 汚水処理の早期普及</td>
</tr>
<tr>
<td>B</td>
<td>B) Advancement of Wastewater Treatment 汚水処理の高度化</td>
</tr>
<tr>
<td>C</td>
<td>C) Reduction and Reuse of Sewage Sludge 下水汚泥の減量化・再利用</td>
</tr>
<tr>
<td>D</td>
<td>D) Stormwater Control Measures 雨水対策</td>
</tr>
<tr>
<td>E</td>
<td>E) Wet Weather Water Quality Control by CSO Control 合流式下水道改善等の雨天時水質対策</td>
</tr>
<tr>
<td>F</td>
<td>F) Creation of a Water Environment and Green Landscape in Urban Areas 都市の水・緑環境整備</td>
</tr>
<tr>
<td>G</td>
<td>G) Effective Use and Efficient Management of Existing Sewerage Systems ストックの有効活用・効率管理</td>
</tr>
<tr>
<td>H</td>
<td>H) Rehabilitation, Renovation and Reconstruction of Facilities 施設の改築・更新・再構築</td>
</tr>
</tbody>
</table>

出典：中長期的見通しにおける下水道整備・管理のあり方について 下水道政策研究委員会報告より
Spreading Sewerage Systems in Every Corner of Japan

Sewage works are indispensable to healthy and hygienic living. Water supply and sewerage systems are particularly vital in the prevention of waterborne infectious diseases. Small-scale wastewater treatment plants and special technologies to lay pipes are playing an important role in reducing the number of localities without sewerage systems.

Relationship Between Waterborne Infectious Diseases and Percentage of Population Served by Water Supply Service and Percentage Sewered Population

日本の水系伝染病と水道・下水道普及率の関係
Variety of New Technologies
新技術メニューが盛り沢山

Cost Sharing: Interministry wastewater treatment facility construction works
(Ministries Intelligence Comprehensive System (MICS))
共同利用で節約(MICS事業)

Several sewerage systems can share a common wastewater treatment plant or other facilities. Constructing a common facility can enhance cooperation between communities while saving investment and improving efficiency of operation and maintenance.
複数の汚水処理施設が、共同で利用できる施設を下水道で整備することにより、ほかの汚水処理施設との連携して処理することが可能です。施設の共同化は、ムダな投資を抑えるとともに維持管理の効率化にもなります。

Mobile sludge dewatering vehicle
The vehicle mounted with a sludge dewatering machine goes round small treatment plants. One vehicle can be used to deal with sludge at several different treatment plants.
移動式汚泥脱水車
具体例としては汚泥脱水車をトラックに搭載し、小型の処理場を巡回します。1台の汚泥脱水車で複数の処理場の汚泥処理を済すことができます。

Inexpensive Treatment Plants
処理場が安くできます

A prefabricated oxidation ditch (POD) system is a small facility that is suitable for wastewater treatments in small municipalities. The factory-made units can be built in a shorter period of time and at a lower cost than traditional construction methods. Operation and maintenance are easier as well.
POD（プレハブ式オキシデーションデッキ）は、規模の小さい市町村の下水処理に適した施設です。プレハブ式を採用していますので短期間で造りますし、建設コストも安く、維持管理も容易です。

Quick Layout of Sewer Pipes:
Small-diameter pipe jacking method
管路を素早く敷設: 小口径推進

In smaller towns and villages, sewer pipes are usually constructed using the open-cut method. In urban areas, on the other hand, the small-diameter pipe jacking method, or no digging method, is often used. In Japan, as many as 40 different construction methods have been developed and used according to the ground condition in the area.
中小市町村の管路敷設は、一般的に開削で行われていますが、都市部の市街地では非開削による小口径管推進法が活躍しています。それぞれの地域に適するように今では40種類以上の工法が実用化されています。
Chapter 3. Japan’s State-of-the-Art Sewerage Technologies
Current Status and Efforts for the Future

第3章 日本のほこれる下水道技術と今後の取組

Advancement of Wastewater Treatment
汚水処理の高度化

Advanced wastewater treatment systems contribute to prevent outbreaks of red tide and blue tide caused by eutrophication. They can remove a large amount of nitrogen and phosphate that cannot be removed by secondary treatment. Currently, measures to control nitrogen and phosphate are required for closed seas, such as Tokyo Bay, Ise Bay, and the Inland Sea of Japan (Setonaikai). Advanced wastewater treatment capacity is planned to be added to many wastewater treatment plants. Wastewater treated by an advanced wastewater treatment can be used in a water-recycling system or water-themed landscapes.

Place for Recreation and Relaxation
市民にいこいの場を

The Recovery of Streams
＜せせらぎの復活＞
Nagasaki Town, Yamanashi
山梨県長岡町

Biotope filled with water from advanced wastewater treatment facilities provide a precious habitat for many forms of life while giving local people the opportunity to enjoy a little environmental education. Because demand for water-themed landscapes is increasing in urban areas, the roles of sewerage systems are becoming more important.  

高度処理水を使ったビオトープは、生物の多様性の保護とを兼ねた、地域の環境教育の場としても利用されています。都市の水線環境が求められているなかで、下水道の役割もますます大きくなってい
Refining water quality for even better results
水質にみがきをかけてさらに水質向上

Cleaning Up Lakes
Konanchubu Wastewater Treatment Plant on Lake Biwa in Shiga Prefecture
滋賀県琵琶湖南部下水処理場

Carrier-Added Activated Sludge Process
担体添加活性汚泥法

A treatment method in which a group of carriers is added to aerobic or anoxic tanks of recycled nitrification/denitrification process. This method is designed for the biological nitrogen removal. The addition of carriers to activated sludge will help microorganisms with low growth rates like nitrifying bacteria to survive in the tank because the bacteria can inhabit on the carrier. This is an effective method to upgrade the existing sewerage facilities where the volume of the reactor tank is limited.

As of the end of fiscal 2000, the advanced treatment needed to meet the environmental standards set for the water quality preservation of designated lakes is carried out at 18 facilities, including the Konanchubu Water Purification Plant in Shiga Prefecture, a part of the Lake Biwa regional sewage system.

2000年度末現在、水質環境基準達成のための指定湖沼の水質保全を目的とした高度処理は、滋賀県琵琶湖流域下水道の湖沼中間処理場など18カ所で実施されています。

MAP Method Using Seawater for P Recovery
海水を利用したMAP法

In the anaerobic-oxic activated sludge process for phosphorus removal, especially when an anaerobic sludge digestion tank is equipped in the system, magnesium is added to the recycle flow of sludge treatment line so that MAP (magnesium ammonium phosphate), which is poorly soluble, is crystallized, and phosphorus can be removed and collected from the flow. A special method using seawater as a source of magnesium in crystallization of MAP is being put into practical use.

In practice, in cases where an anaerobic digestion tank is not equipped in the system, phosphorus removal through MAP may not be realized. This is why recent studies have focused on improving the efficiency of MAP crystallization for phosphorus removal.

MAPの结晶化させるためのマグネシウム源として海水を用いる方法が実用化されています。
Reduction and Reuse of Sewage Sludge: Sludge Can Be Turned into Various Materials

In 1999, approximately 7,500 tons of sludge was generated from wastewater treatment plants, accounting for 18% of total industrial waste. Because landfill space is limited, reducing and reusing sewage sludge is very important. Through the reusing of sludge, sewerage systems can contribute to creating a recycling-based society.
To be the Main Player in the Recycling-based Society
リサイクル社会の主役へ

New Life as Building Materials
建設材料に生まれ変わります

Bricks and Tiles
レンガ・タイル
Yokohama City
横浜市

The incinerated ash of sewage sludge can be used as a material to make bricks, tiles, and other building materials. Many kinds of tiles are available, including tiles for interior and outside walls, flooring tiles, and mosaic pieces. Bricks are made by applying pressure to mold 100% incinerated ash.

下水污泥の焼却灰を原料にレンガやタイルなど建設資材として再利用することができます。内装や外装に用いるタイルや床タイル、モザイクなど種類も豊富です。レンガは、焼却灰100%を原料として加圧成形した焼成レンガです。

Ingredient for Concrete Products
コンクリート製品の原料になります

Cement Ingredient
セメント資材

The chemical component of the incinerated ash of sewage sludge is close to the component of clay used in making cement. Therefore, the ash is used as a cement ingredient in secondary concrete products, such as concrete pipes and manholes.

下水污泥焼却灰の化学成分は、一般にセメント用粘土原料の化学成分に近いため、通常のセメントの原料の一部として使用することができます。そのため、コンクリート管やマンホールなどコンクリート二次製品等の材料として利用されています。
Stormwater Control Measures: Creating Flood-Resistant Cities

The annual precipitation in Japan is twice as high as the world average. The typhoon season always brings torrential rainstorms that cause severe flood damages throughout the country. Especially in concrete-covered urban areas, where the runoff of stormwater is fast, sewerage systems play an important role in the effective protection of flooding by draining stormwater fast.

日本の年間降水量は世界平均の約2倍です。台風シーズンには、集中豪雨が大きな浸水被害を各地で引き起こします。特にコンクリートで覆われた都市では、雨水の流出が早いため、都市内に降った雨水を速やかに排除し、浸水の防止を積極的に行うことが、下水道の重要な役割の一つになっています。
Stormwater Control Measures in Many Places
こんなところで雨水対策が…

Sewerage System for Stormwater Runoff Control
雨水流出抑制型下水道

Sewage works have been carried out to promote flood prevention measures against large-scale rainstorms that occur every five years or so. For example, stormwater infiltration inlets and permeable pavements control the runoff, and storage manholes, stormwater storage pipes and bypass pipes are used to lessen the sewerage system's peak load. Different methods are used according to the size of the city.

下水道事業は、5年に1度の大雨に対する浸水防除を図る対策を市街地で進めています。具体的には、雨水浸透マス、透水舗装による流出量の抑制や貯留マンホール、雨水貯留管、バイパス管による流出量のピークカットなど、都市規模に合った手法が採用されています。

Keeping Track of Rainfall in Real Time
降雨状況をリアルタイムでキャッチ

Rainfall Radar System
雨量レーダーシステム

The rainfall radar system provides real-time rainfall information, which is necessary for the maintenance and management of sewerage systems. The accurate operation of wastewater treatment plants and pumping stations are carried out based on information from the radar system. Private individuals can access the current rainfall information on the Web site provided by the Tokyo Metropolitan and Osaka City government.

雨量レーダーシステムは、下水道の維持管理に必要な降雨情報をリアルタイムで把握できるので、処理場・ポンプ場などの運転管理を行うことができます。東京都や大阪市では市民がホームページにアクセスすることで降雨状況を知ることができます。
Improvement in the Combined Sewer Overflow Control

In Japan, the combined sewer system that drains stormwater and wastewater in the same pipes to treat, are being used especially in large cities. Although this system allows for the rapid promotion of flush toilets and flood control measures simultaneously, it sometimes permits untreated wastewater to be discharged into public water bodies along with stormwater when it rains. To prevent this problem from happening, comprehensive measures to improve the combined sewer system have been made.

Excess wastewater will be discharged into a river instead of being sent to a treatment plant during a rainy period. Small treatment plants on campuses will be closed during rainy periods. An increase in the use of combined sewer systems has led to the consolidation of small and middle-sized treatment plants and their replacement with larger, more effective treatment facilities.

Japan's capacities for wastewater treatment plants, which have always been limited, are currently being extended to cope with the swelling number of municipalities, while also looking into operating efficiency to maintain electricity consumption. The accumulated raw sludge is disposed of in landfills. The amount of wastewater is reduced by applying tertiary treatment with effective filters and aeration. The activated sludge is also dewatered and then dried before storage in landfills to reduce the area required for storage. The effluent water is treated in a monophasic system.
High-Rate Coagulating Sedimentation Process

One of the measures for the improvement of combined sewer overflow control is an upgrade in the efficiency of primary treatment at plants, using high-rate coagulating sedimentation process and high-rate filtration process etc. In the high-rate coagulating sedimentation process, micrond acts as a nucleus for the suspended solids in the wastewater, which are coagulated with a flocculant, thus increasing the gravity of the flock and enabling rapid coagulation. The process is useful for wastewater treatment when there is heavy rainfall over a short time span.

The first flush is temporarily diverted to reservoir pipes due to substantial pollutant load when it begins to rain. With this reduction in initial load, pollution of public water bodies is decreased during rainy weather. Shield tunneling method is an excellent way to build large tunnels and stormwater pipes, and various shield tunneling methods suited to the topology and geology of Japan are under development.

Stormwater Reservoir function both to improve the combined sewer system and control flooding. Adopting the use of precast concrete products can save time and cost in construction while building sturdier structures.
More Uses for Reclaimed Water
再生水で広がる水利用

Reuse of Treated Wastewater
Not all of the purified wastewater from treatment plants is directly discharged into rivers and oceans. Treated wastewater is a precious water resource, and its efficient use has been promoted. In addition to the conventional uses of treated wastewater, such as in flush toilets, new uses have been introduced. Melting snow on roads, replenishing dried out riverbeds, and creating urban landscapes with an aquatic theme are exemplified.

Amount of Reused Water (approx. 150 million m$^3$ per year)
下水処理水の用途別再利用状況（150億m$^3$/年）

Tree Chart of Recycling Treated Wastewater
処理水資源のイメージの木

Source: Sewage Works in Japan 2001
出典: 日本の下水道 2001年
Use of Treated Wastewater in Cold Climates
寒冷地ならではの利用法も・・・

Snow Melting System Using Treated Wastewater
下水処理水による融雪
Aomori City, Aomori

In snowy regions, treated wastewater is used in snow-melting ditches and tanks, snow-flowing pipes and other facilities. A temperature difference between treated wastewater and air is used to melt the snow.

Environmental Restoration Using Treated Wastewater
処理水で自然環境再生

Hanamigawa Dragonfly Pond
花見川トンボ池
Chiba Prefecture

Treated wastewater is used to restore the natural habitat at the Hanamigawa Treatment Plant in Chiba Prefecture. A pond using advanced treated wastewater was built to examine whether dragonflies could live and breed with sewage treated wastewater. In 2001, 17 species of dragonflies, which belong to four families, were observed. Such restoration programs are important in deepening people’s understanding of sewer systems.

水処理水を利用した自然環境の再生が、千葉県の花見川処理場で行われています。ここでは高度処理水を利用したトンボ池を造り、下水処理水でトンボ類の生息・繁殖が可能かどうか調査を行っています。2001年には17種類のトンボが確認され下水処理水に対する理解を深める好例となっています。
Effective Use and Efficient Management of Sewerage Systems: Little Wasted Space in Existing Facilities

Efforts to use the space inside existing sewer pipes and in the wastewater treatment plants more effectively have been made. For example, parks and sports facilities have been built over treatment plants as a public service. Also, optical fiber cables have been installed inside the sewer pipes to enable efficient sewer system management. They also contribute to building an advanced information society.

Optical Fiber Cables for Sewerage System Management

Optical Fiber Cables in Sewer Pipes

Optical fiber cables have been used for the management of the sewerage system to upgrade it and increase efficiency. In an attempt to enable the early creation of a broadband information network, the Sewerage Law was revised in 1996, freeing ordinary telecom carriers to lay optical cables within sewer pipes. Since sewer pipes are already directly connected to houses and office buildings, construction time and costs are reduced in comparison with laying cables from scratch, enabling results with a minimal investment.

Wastewater Treatment Plant 処理場
City Hall 市役所
Corporation 企業
Private home 個人住宅
Manhole マンホール
Sensor センサー
Catch basin 用水マス
Sump pit ヒルビット
Pumping Station ボンプ場
Red line is optical Fiber 赤い線は光ファイバーの布設

Optical Fiber Cable is the key to upgrading the sewerage system. It allows for the efficient management of wastewater, reducing costs and time. By installing optical fiber cables within existing sewer pipes, the system becomes more advanced and efficient.
Efficient Use of Sewage Facilities
下水道施設の有効利用

Budokan
Kamakura City

In overcrowded cities, the space above wastewater treatment plants or pumping stations is precious. To use the space above the plants comprehensively and effectively, various approaches have been taken to provide the community with more public space and better landscape. Some of the more common uses of this space include tennis courts and other sports facilities and parks or open areas. Specific examples include an emergency evacuation space in Kawasaki, the Citizen Plaza in Yokohama, and the Budokan martial art gymnasium in Kamakura.

Use of Space above Sewerage Facilities
上部利用施設用途

<table>
<thead>
<tr>
<th></th>
<th>Wastewater Treatment Plant</th>
<th>Pumping Station</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks and open areas</td>
<td>81</td>
<td>14</td>
<td>95</td>
</tr>
<tr>
<td>Sports facilities</td>
<td>83</td>
<td>5</td>
<td>88</td>
</tr>
<tr>
<td>Buildings</td>
<td>12</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Emergency evacuation</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>183</td>
<td>23</td>
<td>206</td>
</tr>
</tbody>
</table>

Arakawa Nature Park
Tokyo

Arakawa Nature Park is a part of a treatment plant and is opened to the public. It has baseball fields, tennis courts, volleyball courts, and other recreational facilities for the local community.

Hybrid Pumping Station
Fukuoka City

A concert and play theater, Pon Plaza, stands in the space above Shinmukojima pumping station in Fukuoka City. The plaza is used for cultural events and community building activities by local citizens.

Kamakura City

Arakawa Nature Park is a part of a treatment plant and is opened to the public. It has baseball fields, tennis courts, volleyball courts, and other recreational facilities for the local community.

處理所の一部が公園として開放されています。この公園は「荒川自然公園」と呼ばれ、公園内には野球場、テニスコート、バレーボールコートなどがあり、市民のリクレーションの場として利用できます。
Rehabilitation and Point Repair of Facilities
施設の改築と修繕

In urban areas, where sewage works started earlier than in other areas, pipes, wastewater treatment plants, and pumping stations are wearing out. These facilities are inspected for damage and wear in preparation for rehabilitation or point repair work. Through such work, the functions of facilities and equipment are improved to meet future needs. New technologies for rehabilitation and point repair work are also being developed.

Rehabilitation of the Culvert
カルバートの改築

A culvert installed in the 1920s. (Signs of advanced aging)
1920年代に布設された下水管（老朽化）

The inside of the culvert is reinforced by the pipe rehabilitation method.
管更生工法により管内面を補強
Improving Function through Reconstruction
再構築で機能アップ

Reconstruction work is conducted to improve security in times of disaster, make better use of the facility, and advance the conservation of water quality.

(Before reconstruction)
(再構築前)

(After reconstruction)
(再構築後)

Maintenance and Management Are Equally Important
維持管理も大切な仕事です

<table>
<thead>
<tr>
<th>Sewer pipeline 循環</th>
<th>Cleaning 清掃</th>
<th>Inspection 調査</th>
<th>Repair 構修</th>
<th>Pump ポンプ</th>
<th>Grid 水道</th>
<th>Sludge treatment 工業</th>
<th>Water quality analysis 水質汚泥分析</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80.8</td>
<td>71.0</td>
<td>80.7</td>
<td>65.0</td>
<td>74.0</td>
<td>71.3</td>
<td>62.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total outsourcing は全部委託</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Partial outsourcing は一部委託</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Conducted by the local government は直営</td>
</tr>
</tbody>
</table>

Outsourcing of Operation and Maintenance
維持管理業務の民間委託

The wider areas the sewer system covers, the more efficient the operation and maintenance of sewer pipes and treatment plants need to be. To improve efficiency, more of these tasks are being outsourced to private corporations.

下水道が普及するにしたがって、管理・処理場の維持管理を効率的に行う必要があります。このため維持管理業務のうち委託可能なものについては、民間の持てる技術力を積極的に活用しています。
Learn about Sewerage Systems while Having Fun
遊びながら楽しく学べます

Sewerage Science Museum in Osaka City
大阪市下水道科学館

Osaka City opened the Sewerage Science Museum to disseminate information about sewer systems to more people. At the museum, visitors can see how an entire sewerage system while exploring the underground world. A conservatory used by the heat generated by wastewater and treated wastewater, the Water Theater, a display on resource recycling, and a water garden using advanced treated wastewater can also be enjoyed and learned on the museum's premises.