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Kitakyushu Model Subsector: Interplay between Solid Waste and Urban Flood Risk



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About Tokyo Development Learning Center (TDLC)

The Tokyo Development Learning Center (TDLC) program is a partnership of Japan and the World Bank. TDLC supports and facilitates strategic WBG and client country collaboration with select Japanese cities, agencies and partners for joint research, knowledge exchange, capacity building and other activities that develop opportunities to link Japanese and global expertise with specific project-level engagements in developing countries to maximize development impact.

Background and Acknowledgements

This research was prepared by the Tokyo Development Learning Center (TDLC) under the auspices of the Social, Urban, Rural, and Resilience Global of the World Bank Group. Its objective is to enhance the current Kitakyushu Model by adding a subsector on the linkage between solid waste management and disaster risk management, particularly flood events.

The Kitakyushu Model is a methodology developed in Kitakyushu City, Japan to provide appropriate solutions for environmental challenges to pursue sustainable urban development. It strives to be a methodology that allows cities to easily apply sustainability more broadly and in a holistic fashion, beyond isolated projects and individual advice. Kitakyushu City's experiences and strategies have been refined over the years to incorporate the real changes and challenges gained through both past success and mistakes. Therefore, the methodology is presented in a technically rigorous, but user-friendly framework to realize real urban transformation.

The team would like to acknowledge gratefully Government of Japan through Tokyo Development Learning Center (TDLC) program. The research was led jointly by Yuko Okazawa and Daniel Levine, and the document was prepared by Earth System Science Co., Ltd. The team gratefully acknowledges the peer reviews and inputs from the following World Bank Group colleagues: Kremena Ionkova, Salim Rouhana and Haruka Imoto. The team is especially grateful for the contribution of Kitakyushu City officials.

Executive Summary

We are living in the era of rapid urbanization. Population influx into urban areas has exacerbated city capacities and services around the globe. Of its many challenges are urban flooding and solid waste management. Adequate capacity is often lacking in each sector, and the two interplay as solid waste accumulates and blocks existing drainage channels, resulting in inundation, damages, and public health concerns.

The World Bank and the City of Kitakyushu (Kitakyushu), Japan has partnered to develop this model, which focuses on this interplay of solid waste and urban flood risk. The purpose of this model is to:

- Present actions to city planners that will help address their urban flood risk that results from inadequate solid waste management

- Present the Kitakyushu experience in a user-friendly form to guide or offer suggestions to other cities around the globe

The model is composed of three sectors, as shown in Figure 1. Addressing uncollected, accumulated waste requires resident support and initiative. Public Involvement and Education is thus critical to address gaps in city waste services and to nurture healthy citizenship.

Table 1 provides an overview of the model actions. These actions are organized by relevant sector, but Figure 1 better presents the relationships of actions to each other. The relationships are described per model concepts, below.

Concept 1: Independent City Government Sectors and Activities

The ultimate cause of waste-clogged drains is uncollected and unmanaged urban solid waste. A city, thus, needs to invest in establishing basic services as its utmost priority. W1, W2, and W4 are hence highlighted in Figure 1. Similarly, regardless of waste dumping issues, a city needs to manage its drainage infrastructure. These uniquely different city activities often belong to two different city departments, and each needs to commit to serving their residents and providing necessary services. Proper functioning of these individual parts is critical to reaching a larger, common goal of creating a thriving and livable city environment. Actions that pertain to Concept 1, actions that are unique to each sector include E3, E4, W2, W3, W4, D3, and D4 as shown in Figure 1.

Concept 2: All Unite as City Residents

City services are always evolving and, hopefully, improving. Yet, it will never be perfect; there will always be service gaps, such as littering, unintended waste accumulation in drainage canals, and localized urban flooding. City residents, community organizations, leaders, and industries can help fill in these gaps, and to do so require a sense of solidarity. In Kitakyushu, everyone identifies themselves as a city resident and a member of their community, including managers of private companies and city officials, recognizing that city issues are their issues. Residents can help clean their own city, and each resident, under whichever societal role they play, can invest time and effort to create a more beautiful, livable city. Hence, the “public involvement and education” sector binds this model together. Actions that pertain to Concept 2 include E1, E2, W1, W5, W6, D1, and D2 as also shown in Figure 1.

The whole is greater than the sum of its parts. Each actor, including the city government, needs to take responsibility and initiative to improve the city in which they live. It is our hope that this model can help cities around the globe do so.

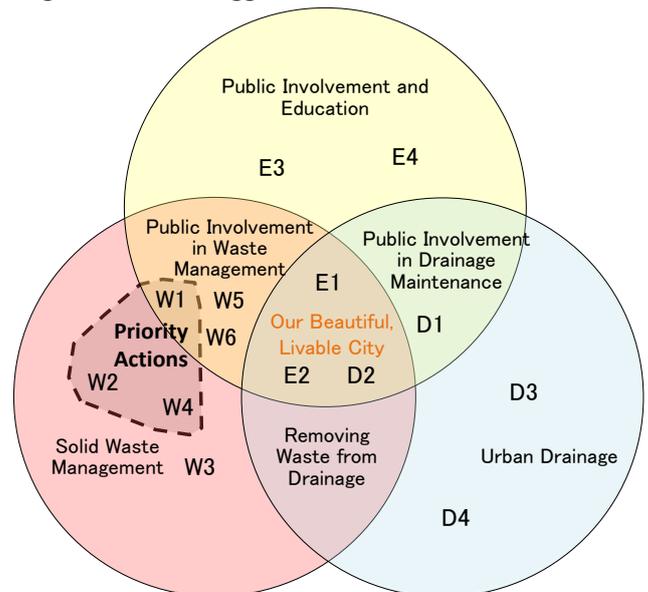


Figure 1. Model Overview

Table 1. Overview of Model Actions

Public Involvement and Education
<i>Actions to Enhance Public Involvement</i>
E1. Relationship Building <ul style="list-style-type: none">E1-1. Establish Means of CommunicationE1-2. Set Common Goals/Slogans
E2. Resident Involvement in Providing Services <ul style="list-style-type: none">E2-1. Organize Public/Stakeholder MeetingsE2-2. Develop a Policy to Support Resident InvolvementE2-3. Send Government Staff to the Field
<i>Actions to Educate Residents</i>
E3. Education in Schools <ul style="list-style-type: none">E3-1. Teach Students about the Local Society and Environmental CitizenshipE3-2. Hold Students Accountable for the School Environment
E4. Education of the Public <ul style="list-style-type: none">E4-1. Inform Residents of City Activities and ProgressE4-2. Organize Public Events and ProgramsE4-3. Establish Museums and Learning Facilities
Solid Waste Management
<i>Actions to Establish Basic Waste Management Services</i>
W1. Waste Storage for Collection <ul style="list-style-type: none">W1-1. Fix Waste Bins at Each HouseholdW1-2. Use Portable Containers at Each HouseholdW1-3. Use Standard Plastic BagsW1-4. Set Collection Stations for Groups of Households
W2. Waste Transport <ul style="list-style-type: none">W2-1. Use Collection VehiclesW2-2. Use Compaction Collection Vehicles
W3. Waste Treatment (Incineration)
W4. Final Disposal
<i>Actions to Improve Waste Management</i>
W5. Waste Reduction <ul style="list-style-type: none">W5-1. Separate WasteW5-2. Collaborate with ManufacturersW5-3. Charge Fees for Waste Disposal
W6. Maintaining a Waste-Free City Environment <ul style="list-style-type: none">W6-1. Identify Waste Accumulation/Dump SitesW6-2. Collect Bulk Waste PeriodicallyW6-3. Install Waste Bins in Public AreasW6-4. Encourage Residents to Maintain a Clean Environment
Urban Drainage
<i>Actions to Maintain Drainage Capacity</i>
D1. Local Adaptations to Capture Debris <ul style="list-style-type: none">D1-1. Cover Open Drains (wood or any other locally available material)D1-2. Cover Open Drains (concrete/metal grating)D1-3. Install Intermediary Screens within Drainage Channels
D2. Waste Clean-Up, Drain Cleaning, and Maintenance <ul style="list-style-type: none">D2-1. Perform Scheduled System Cleaning and MaintenanceD2-2. Perform Ad Hoc Local Drain CleaningsD2-3. Inspect the System Prior to Rain EventsD2-4. Establish a Hotline and Respond to Debris Accumulation/Backup ReportsD2-5. Hold Clean-Up Events
<i>Actions to Expand/Improve the Drainage System</i>
D3. Systemwide Drainage Planning Considerations <ul style="list-style-type: none">D3-1. Plan Using Sustainable Urban Drainage System/Low Impact Development PrinciplesD3-2. Convert to Partial Separate Sewer SystemsD3-3. Utilize Open Spaces, Ponds, and Detention BasinsD3-4. Relocate Informal Settlements around Waterbodies
D4. Design Level Considerations <ul style="list-style-type: none">D4-1. Secure Discharge Points/Points of InterestD4-2. Create or Revisit Design Storms and Runoff AssumptionsD4-3. Redevelop or Manufacture New Materials and DesignsD4-4. Expand Drainage System in Coordination with Other Construction

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Acronyms and Abbreviations

CBO	Community Based Organization
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
ESD	Education for Sustainable Development
GDP	Gross Domestic Product
GHG	Greenhouse Gas
Kitakyushu	City of Kitakyushu
LID	Low Impact Development
NGO	Non-governmental Organization
NPO	Nonprofit Organization
O&M	Operation and Maintenance
POI	Point of Interest
R&D	Research and Development
SSS	Separate Sewer System
SUDS	Sustainable Urban Drainage System
UNESCO	United Nations Education, Scientific, and Cultural Organization
USD	United States Dollar

1 Introduction

1.1 Background: the Relationship between Solid Waste and Urban Flood Risk

We are living in an era of rapid urbanization. 2008 marked the year when half of the world's 6.8 billion people became urban residents (The World Bank, 2017). If this trend continues, 66% of the world's population is expected to be living in urban areas by 2050. Sub-Saharan Africa is the least urbanized but is the fastest growing area of the world (Ziraba et al., 2016).

This population influx has increased pressures on cities around the globe as many city governments struggle to provide a safe and secure living environment for their residents. Of its many challenges are solid waste management and urban flood risk management, and the nexus of these two sectors is an issue receiving increasing attention. Basic public services in each are often lacking in the developing world, and the two sectors interplay as solid waste blocks or restricts existing drainage channels, resulting in or worsening inundation during rain events. Figure 1-1 provides a conceptual schematic, showing how urbanization can overwhelm city public services, leading to waste accumulation in drainage systems and increased urban flood risk.

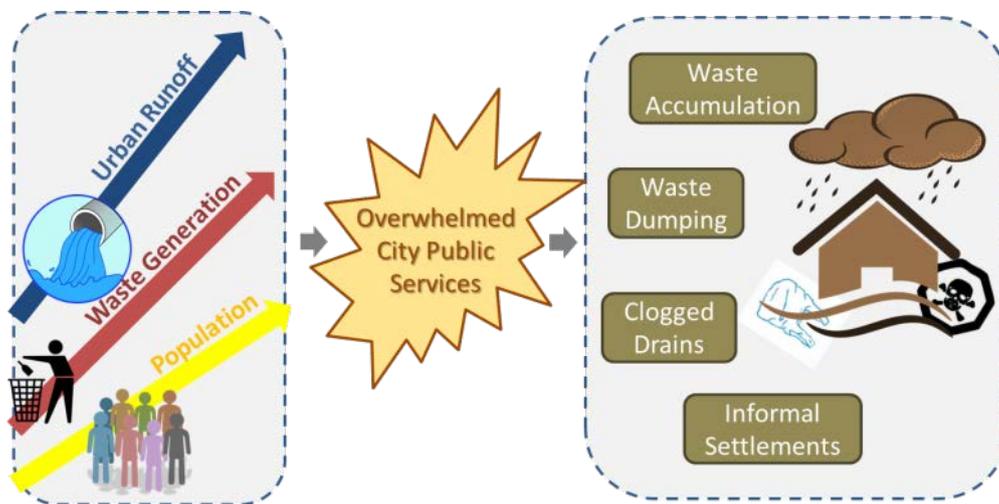


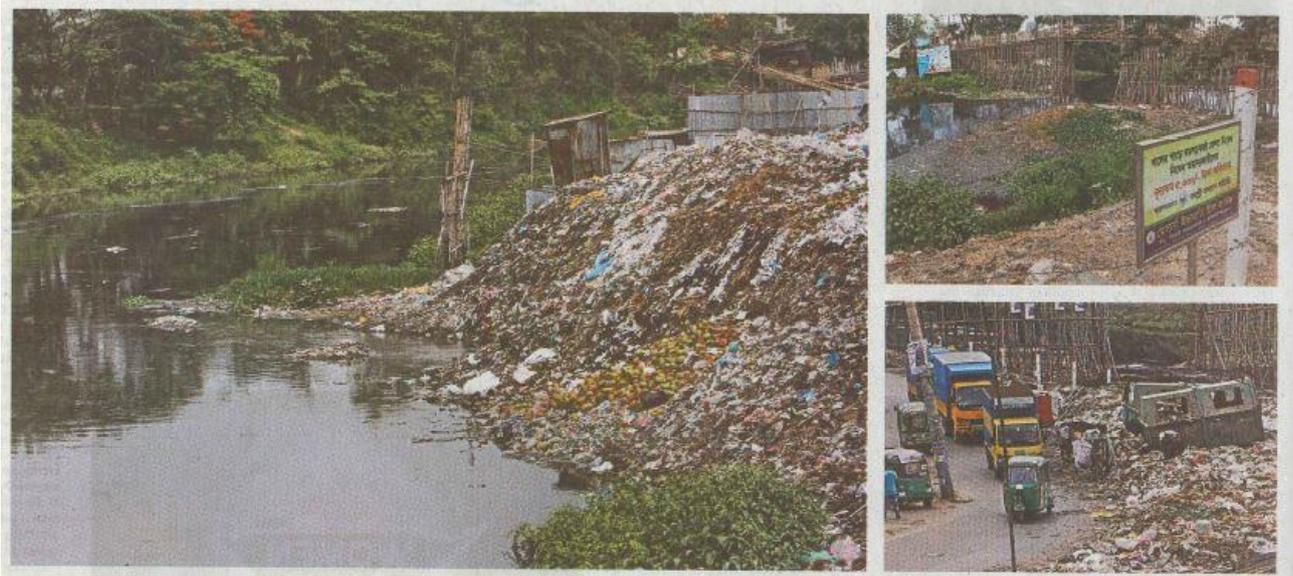
Figure 1-1. Conceptual Schematic of Interplaying Solid Waste and Urban Flooding Factors

Solid waste management is beginning to be incorporated as a low-regret option into flood management programs (Lamond et al., 2012). The World Bank's 2012 Cities and Flooding Guide, for example, includes a 20 page section on waste management, highlighting it as a non-structural measure for integrated flood risk management.

Many of today's cities expand at a rate much faster than flood risk management plans are developed and infrastructure is installed. Existing systems are additionally ill equipped to accommodate changing and increasing runoff patterns caused by climate change and increase in impervious areas. These pressures are felt the most acutely in informal settlements in developing cities, where impromptu dwellings often expand into flood-prone, low-lying areas or existing drainage channels.

Meanwhile, urban migration concentrates waste generated. Industrialization further increases and diversifies waste generated per capita, resulting in a faster rate of waste generation than actual urbanization. Of the various types of urban waste, such as commercial, industrial, medical, and animal wastes, municipal or household waste is likely the greatest quantity generated (Jha et al., 2012). Yet, less than an estimated 30 percent of urban waste in developing countries is collected (Ziraba et al., 2016). Due to the lack of waste collection services, alternatives, and awareness of health and sanitation concerns, residents resort to dumping waste into nearby drains, waterways, and open spaces. Figure 1-2 are pictures from a Bangladeshi newspaper in May 2017, depicting waste dumping in the Banasree Canal and nearby roadsides within the capital city of Dhaka. Open dumpsites inside drains or waterways overwhelm an already stressed drainage system, increasing the frequency and severity of urban flooding. Annual floods in

Kampala, Uganda, and other East African cities are blamed, at least in part, on plastic bags, which block sewers and drains (Jha et al., 2012). Another powerful image from Madagascar tells the story of the negative interplay between solid waste management and urban flood management (Figure 1-3).



Source: Haq, 2017

Note: Caption states: "Incessant dumping of waste in the capital's Banasree canal is not only suffocating the water body but also contributing to the continual waterlogging problem in the area. Though there is a signboard saying anyone would be fined Tk 5,000 for dumping waste on or next to the water body, locals continue to ignore it. Meanwhile, the roadside area beside the canal has been transformed into a waste dumping zone, from where garbage is also being spilled into the canal."

Figure 1-2. Waste Dumping in Canals in Bangladesh



Figure 1-3. Waste Dumping in Canals in Madagascar

Poor drainage and contamination of urban runoff poses multiple concerns. Standing water caused by dumped plastics or clogged drainage channels acts as breeding or feeding sites for vectors, increasing risks of communicable diseases in a densely populated environment. Displacement due to flooding often disrupts access to clean water and sanitation, sometimes resulting in a public health crisis such as cholera and E. coli outbreaks. Polluted waters also contaminate surface and groundwater resources, impacting access to safe drinking water post-disaster and long into the future. These pressures compound more intensely in impoverished urban areas; the poor have the least access to public services and have the least

capacity to prepare for and rebuild after disasters, placing them in a vicious cycle of poverty. The cumulative impact of the lack of solid waste management and urban flood risk management on a city's economic growth, the health of its residents and families, and community dignity is extensive and long-lasting.

Further, improperly managed waste dumps, including open landfills, are sources of greenhouse gas (GHG) emissions. While GHG emissions do not directly impact the local community, cumulative impacts of climate change can. Increases in extreme weather events and natural hazards, including intense rain events, heighten the risk of urban flooding, multiplying the challenges cities face.

If solid waste management and urban flood risk management are so critical, why aren't these services being provided? Lamond et al. explored case studies of solid waste management impacting urban flood risk from across the globe, which are summarized in Table 1-1 (2012). Results showed that city governments are often overwhelmed with numerous other challenges, have other priorities, and/or lack sufficient resources. Awareness of health and sanitation issues is generally low both in government and among residents. Waste management is often seen as a low status occupation with low wages, leading to absenteeism. In some cities, community and private enterprises are the only active waste management entities, generating jobs and revenue from recycling and waste sorting, but their impact is often small-scale and insufficient as waste from nearby areas quickly flows in. In other areas, non-governmental organization (NGO)/nonprofit organizations (NPO) and government intervention were effective over the short-term but did not have long-lasting impact. Box 1-1 provides a case study, showing how the World Bank is aiming to address these issues.

No single approach will ever be universally successful. Addressing this inter-sector issue requires a combination of actions that suits that locality, involving various actors, including community members, the private sector, and the city government. This subsector model presents the experiences of Kitakyushu City (Kitakyushu), Japan as one way to tackle solid waste management and urban flood risk issues.

Box 1-1. Project Example from the World Bank

Case of Monrovia, Liberia: Cheesemanburg Landfill and Urban Sanitation Project

Much of the flooding disasters that have befallen Monrovia and other cities in Liberia in the last ten years have been caused in large measure by the significant amount of uncollected waste that blocks waterways and streams. Flooding due to clogged drains and canals filled with trash is a climate concern. The biggest culprit of waste is plastic waste. During the rainy season a large part of the densely-populated part of the city experiences frequent flooding, often making driving impossible for hours. On these occasions, solid waste that is not collected blocks the drainage systems and causes polluted surface water to stagnate. This can also affect ground water supply to these communities. The polluted water breeds malaria and other disease vectors and thus a significant number of people suffer from typhoid, diarrhea, malaria and are forced to get treatment as in or out patients.

By contributing to provide waste collection services, the Project directly addresses a key local concern, namely flooding caused by clogged drains which disproportionately affects the most vulnerable in Monrovia. Additionally, improved waste collection services will remove waste from communities and reduce contamination of the local environment. Proper waste disposal and monitoring of surrounding soil and water tables will help protect nearby communities from contaminated soil and drinking water.

Table 1-1. Global Case Studies on Interplay of Solid Waste Management and Urban Flood Risk

Case Study	Problem Identified	Community Awareness	Municipal Action	Community Action
Accra, Ghana	Blockage of drainage causes flooding	Residents not aware	Authorities appear overwhelmed	Residents regard it as the role of the government
Bamako, Mali	Poor waste management a major factor in 1999 flood	Awareness was raised during the program	Structural drainage improvement was carried out	Local waste collection system set up. Disposal is still a problem
Cotonou, Benin	Indiscriminate dumping of waste	Some have taken action	Peripheral areas neglected as the focus is on the city center	Locals trained to collect and gain revenue from waste
Guyana, Guyana	Clogged and inadequate drainage leading to flooding	Identified by residents as important	Authorities have other priorities	In one ward a community based organization (CBO) had cleared drains, this ward had not flooded
Jakarta, Indonesia	Blocked channels cause widespread flooding	Residents aware of the problem	Government plans to dredge channels but hampered by informal settlements	Local community based schemes successful but waste is carried from upstream areas
Lagos, Nigeria	Flooding due to blocked drainage	High awareness in community	New city wide strategy of waste disposal	Very few community initiatives
Managua, Nicaragua	Waste in the rivers worsen flooding	Awareness is poor	Network of micro dams to collect rubbish and silt	Low compliance, flooding still an annual event
Maputo, Mozambique	Flooding caused by inadequate drainage in the city	Awareness low but being targeted by education programs	Some urban drainage improvement programs	Communities still dump waste in drains, causing major problems in 2010
Marikina, Philippines	Flooding partly due to waste clogging the river	Residents made aware by the program	River dredging and penalties for dumping	Residents comply but waste still arrives from further upstream
Mexico City, Mexico	Waste blocks drains and leads to flash flooding	Appears to be low awareness	Programs focus on other priorities	No evidence of community action
Mumbai, India	Plastic bags blamed for flooding	Poor awareness	Ban on use of plastic bags	Poor compliance with ban

Source: Lamond, et al. (2012).

1.2 Kitakyushu City and the Kitakyushu Model

Figure 1-4 shows the general location of Kitakyushu. Kitakyushu is located on the northern edge of Kyushu Island, one of the four main islands of Japan. Today's Kitakyushu city government was established in 1963, when five smaller "cities" were merged into one municipality. An industrial area throughout the 1900s, iron and steel manufacturing led the city's development and growth. Global companies, such as Nippon Steel and Sumitomo Metal, Mitsubishi Materials Corporation, and TOTO are still located in the Kitakyushu today.



Source: Google Maps

Figure 1-4. Location of Kitakyushu City

The heavy manufacturing industry, however, had led to severe environmental pollution by the mid-1900s. Smog covered the city affecting children's health. Oceans turned orange and had been coined "the Sea of Death" as shown in Figure 1-5. The 1960s was the turning point. Kitakyushu's women started protesting and demanded changes to address these environmental issues and to improve everyone's daily lives. Their movement spread to involve communities, private companies, and the city government, and together, Kitakyushu improved. Industries invested in becoming socially and environmentally responsible, and yet, not a single factory was shut down or relocated, and economic growth continued. By the 1980s, wildlife was back in the clear seas to the point the shrimp harvesting industry restarted operations.



Figure 1-5. Environmental Pollution in the 1960s

This Kitakyushu experience has been recognized internationally, starting in 1990 when the United Nations Environmental Programme recognized Kitakyushu as a "Global 500 Roll of Honour." Kitakyushu also began sharing their experiences and lessons learned to other cities around the world. The Kitakyushu International Techno-cooperative Association (KITA) was established in 1980 and the Asian Center for Low Carbon Society in 2010. Kitakyushu developed its Kitakyushu Model as a part of their international assistance efforts. The document helps with urban master planning and provides guidance on how to achieve environmentally conscious, sustainable, urban development. The Kitakyushu Model consists of the "Kitakyushu Story," the "Sustainability Framework," and sectors such as "Waste Management" and "Water Management." The Kitakyushu Model aims to be a methodology that allows cities to holistically design their own development, beyond a single project. The model has been used for the following projects.

- Green Growth Promotion Plan of the City of Hai Phong, Vietnam
- Waste management and recycling projects in Kota Surabaya, Indonesia

Following its own experience, Kitakyushu expects cities to engage with all parts of society so that everyone collaboratively creates a living environment of which they can be proud.

1.3 Subsector Model Purpose

This subsector model is an addition to the existing Kitakyushu Model that focuses on the interplay of solid waste and urban flood risk. The World Bank, in collaboration with Kitakyushu city government, prepared this model as a part of the City Partnership Program. Documentation of Kitakyushu's practical "how to" experiences serves as the basis for learning and knowledge sharing activities that brings officials from developing countries and Kitakyushu together.

The purpose of the model is to:

- Present actions to city planners that will help address their urban flood risk that results from inadequate solid waste management
- Present the Kitakyushu experience in a user-friendly form to guide or offer suggestions to other cities around the globe

This subsector model is not intended to be a standalone document that can holistically cover each of these broad fields. In other words, this subsector falls under and supplements already existing Kitakyushu Model sectors of "Waste Management" and "Water Management."

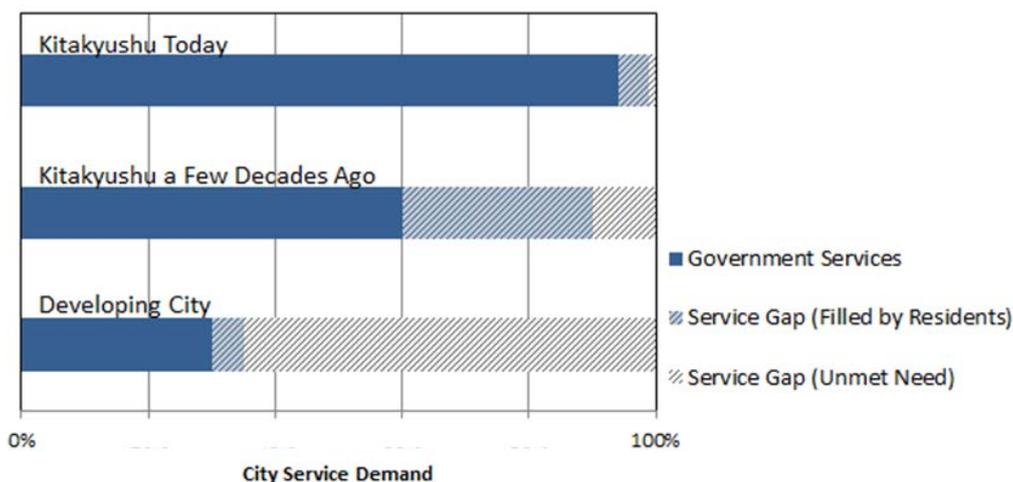
1.4 Solid Waste Management and Urban Flood Risk: The Kitakyushu Experience

While perhaps incomparable to the extent of waste accumulation and flooding issues facing today’s cities around the globe, Kitakyushu has gone through its share of growth pains during the latter half of the 1900s. Illegal settlements alongside city rivers and streams were obstacles to implement planned flood risk management projects, such as levees. Municipal waste collection services had been in operation since the city’s establishment, but open dumping and littering were issues into the late 1980s. Individuals and nearby stores and restaurants used to dump waste directly into the Kantake and Murasaki Rivers, which runs through Kitakyushu.

Kitakyushu recognizes that waste dumps in and near waterways have compounding and multifaceted effects on urban flood risk. However, a long-term solution requires that the causes of these issues be dissected and addressed. In effect, each of these sectors, waste management and urban flood risk management, needs to be tackled fully, and for the most part, independently. A solution needs to involve a long-term waste management system that collects generated waste and recycles or disposes of it. The interplay of waste and flood issues disappears once sufficient waste collection and disposal is achieved, as in Kitakyushu. Similarly, regardless of the extent of waste dumping issues, a city needs to manage urban flood risk through both infrastructural and non-structural means. Investment in solutions that directly addresses causes, and not just the symptoms, should be a city’s utmost priority. A city government, hence, should consist of departments responsible for these usually separate sectors.

At the same time, never can a city government or any responsible entity manage solid waste and urban flood risk perfectly. There will always be gaps in services, gaps in regulatory oversight, insufficient resources, and unforeseen needs and consequences. This gap is manifested, for example, in the small percent of waste being dumped in the streets of Kitakyushu today or the 70 percent of uncollected urban waste in a developing country, as depicted in Figure 1-5. The extent of this gap can be greater during times of heavy capital investment when services are initially being established, as in the bar, “Kitakyushu A Few Decades Ago.” Shortages of human, financial, and technical resources can often be acute.

How can service gaps be filled if the reason the gap exists is due to the city government being overwhelmed? In the case of Kitakyushu, city residents who had demanded a better living environment helped fill in the gap by, shown as the colored, hatched portion of the bars in Figure 1-6. Residents cleaned waste and maintained drainage capacity in their surroundings. Residents would call the city government to inform them of any issues beyond their control. Residents would ask for assistance to open heavy drainage covers so that the community could get inside and clean the drains. Local private companies also took it on themselves to clean the areas surrounding their work buildings. As types of generated waste diversified, these companies offered to invest and change their production line to reduce and to be able to reuse waste generated from their products. The greater the service gaps, as it usually is earlier in a city’s development, the greater the need for such collaboration.



Note: This figure is strictly conceptual. Data that quantifies what percent of demand for public services is met is not available.

Figure 1-6. Conceptual Examples of Service Demand and Service Gaps

In Kitakyushu, the common experience of addressing severe environmental pollution had broken down previously existing barriers between actors. Kitakyushu had built a solid foundation of trust on which residents, communities, private companies, and the government could work together towards a common goal.

Importantly, the city government recognized the value of maintaining and encouraging this collaborative environment. Each actor needed a sense of self-initiative, capacity to take responsibility for their roles, and a healthy dose of mutual dependency. The environmental department, which was also responsible for waste management services, took leadership and rallied everyone together to “Make Our City Beautiful.” By spreading and driving home this message, the city government created an atmosphere of cooperation instead of finger-pointing both inside and outside of the city government. The river department organized river dredging and cleaning, although it mostly consisted of accumulated waste. The road department cleaned drainage canals lining roads. The wastewater/drainage department cleaned out waste from larger mains and detention ponds. The waste management department offered staff and tools to support community cleaning efforts led by citizen groups. Sometimes, these groups eventually evolved to become their own NGOs needing less and less government support to provide important services. This means, city departments, individual city workers, and residents offered maybe minor but nonetheless critical human resources and time to “Make Our City Beautiful.”

The city government additionally invested to keep residents informed and aware of city activities and needs. The government made use of mass media, organized public education events, built museums, and taught children about how their city and society functions. This sense of cross-sector and multi-actor collaboration is the essence of Kitakyushu and this model. The sense of unity and purposeful action to encourage and maintain this unity are what connects the otherwise separate departments and sectors.

**Box 1-2. Example of Model Concepts in Play: Kitakyushu and River Management
- Rebirth of Murasaki River -**

Industrial agglomeration and population increase resulting from urbanization are positive outcomes of economic development. On the negative side, however, large amounts of industrial and household wastewater are released into the rivers, leading to appalling living conditions such as water pollution, sludge deposition, and acrid odors. The deterioration of the riverfront environment also leads residents into believing that disposing waste into rivers or drainage canals is an acceptable act. Such actions further destroy the environment, weakening the natural flood control functions of rivers and thus making the adjacent areas more susceptible to flood risks. Putting an end to such vicious cycles is a common challenge many cities face today.

Kitakyushu City has rich experiences to share in this aspect. In the past, the city has suffered from post-urbanization water pollution and informal waste disposal. Its rivers lost some of their natural flood control capacity. The public sector and the private sector worked together to overcome the city’s challenges.

Here, we organize the issue of waste disposal into the river as shown in Figure 1-7. Urbanization results in industrial agglomeration and population increase, thus causing an increase in industrial and household wastewater that flows directly into the rivers. This leads to water pollution, and the residents’ “awareness” towards interacting with and protecting the water(river)front environment decreases. Lower awareness makes residents more likely to dispose waste into the river, thus weakening the flood control capacity of the river and making the surrounding areas more exposed to flood risks.

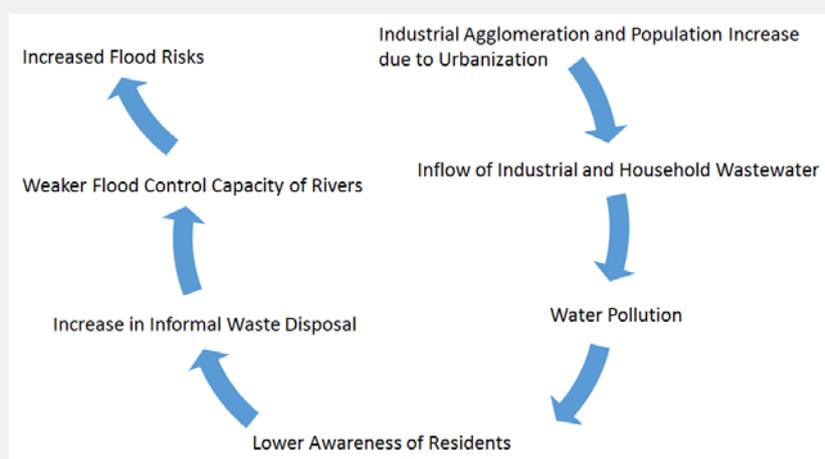


Figure 1-7. Increased Flood Risks due to Informal Waste Disposal into Rivers: Vicious Cycle caused by Lack of Awareness of Residents

Kitakyushu City addressed this challenge by reviving Murasaki River through multiple projects including the Environmental Renovation Project and the My Town My River Renovation Project. Figure 1-8 shows the city’s actions and the derived benefits. To alleviate water pollution, the city imposed stricter regulations on industrial wastewater and developed a better sewage system to decrease the amount of household wastewater flowing directly into rivers. Furthermore, the city increased awareness and urged residents to take protective actions towards the river by leading city-wide community development initiatives, heavily engaging residents as well as the private sector. This created a public momentum towards protecting and maintaining a clean river environment, thus resulting in a decrease in informal waste disposal. Water pollution was no more, and the flood control capacity of the river was strengthened. The city’s actions successfully decreased flood risks.

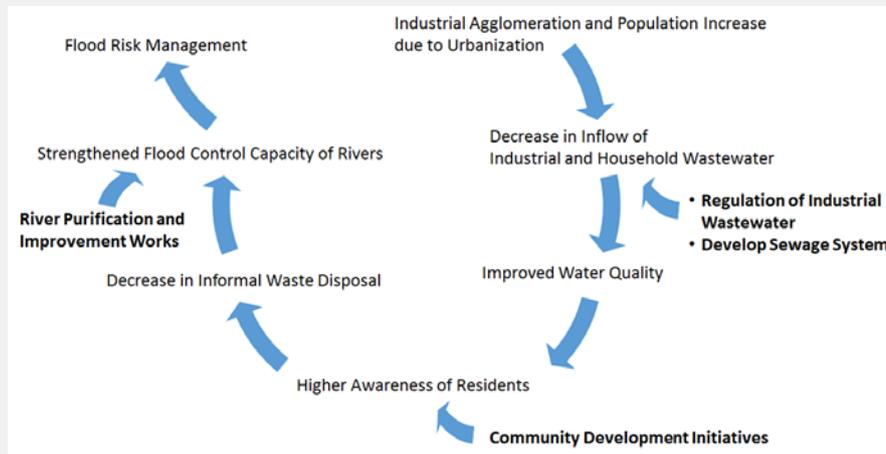


Figure 1-8. Increased Flood Risks due to Informal Waste Disposal into Rivers: Positive Cycle starting from Residents’ Improved Consciousness

1. Pollution in Murasaki River (from 1960s to 1980s)

The Murasaki River, running from south to north through the center of Kokurakita-ku (Kokura North Ward) of Kitakyushu City, was suffering from water pollution in the past. It is confirmed that green laver used to grow naturally in Murasaki River until the end of Meiji era, but since entering the Showa era, the pollution in Murasaki River became severe (Sanitation Team, 1967).

From the old times, the areas around Murasaki River have been home to paper mills and steelworks. The uncontrolled discharge of industrial wastewater from these factories was the major cause for the river’s pollution. During the post-war rapid economic development in Japan, more and more factories and people moved to the central area of Kokurakita-ku, dramatically increasing the amount of industrial and household wastewater. In 1967, the coverage rate of sewage systems was only 10.1percent in Kitakyushu City, and a large part of the wastewater flowed directly into Murasaki River. To make matters worse, on either bank of the river were illegal barrack housings constructed due to the post-war housing deficit. In around 1965, 597 households and 2,000 residents lived illegally along the Murasaki River, and human excrement flowed freely into the river along with household waste (Figure 1-9). The disposed waste precipitated to the riverbed, decayed, and emitted methane gas in addition to polluting the water. Water quality became poor, and the river lost its natural flood control capacity, thus increasing flood risks.

According to records, many sites along the Murasaki River suffered from inundation during the flood in June, 1953. Within the city, the inundation area was as large as 5,100 ha (Fukuoka Prefecture, 2013).



Source: Secretariat of the Council for Murasaki River, 1980

Figure 1-9. Murasaki River in 1979

2. Rebirth of Murasaki River (from 1960s)

Kitakyushu City put effort into the development of sewage systems from the late 1960s. The coverage rate increased from only 16 percent in 1969 to 50 percent in 1977, and the water quality of Murasaki River was significantly improved (Figure 1-10 and 1-11).

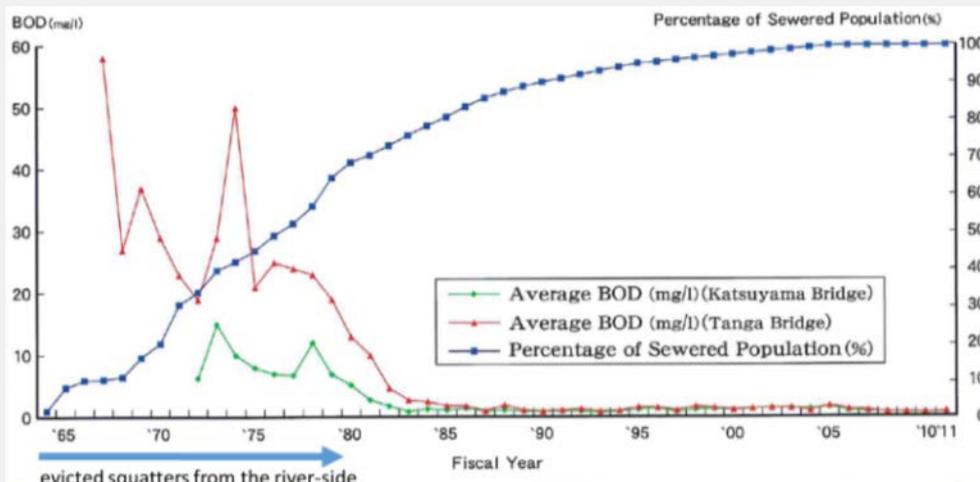


Figure 1-10. Changes in Water Quality of Murasaki River

Meanwhile, initiatives to purify the river and renovate the riverfront environment were driven forward along with the demolition of illegal structures and resettlement of illegal residents. In 1966, Kitakyushu City and Fukuoka Prefecture together founded the Council for Murasaki River to conduct preliminary surveys regarding illegal residents, to hold local informative sessions, and to assist residents in finding new housings and land. City officials negotiated with each resident one by one, listened to what requests residents had, and took care of the residents until they were resettled to municipal housings and other locations. The demolition of illegal structures was completed by 1980 (except for one structure which was forcefully demolished). The development of sewage systems, river improvement works such as dredging and bank protection works, and planting of riverside greenery took place at the same time.

In 1980, the fireflies came back to Murasaki River and were released at many sites within the city. Citizens came to think “Fireflies cannot live in a dirty river. We must not throw away waste into rivers.”, thus improving the residents’ “awareness” and leading to civic movements to protect the river.

Furthermore, the My Town My River Renovation Project which started in 1990 aimed to transform Murasaki River into a river loved by the residents and focused on flood control and community development in the surrounding areas. For flood control, the city enlarged the river width and reconstructed the bridge to increase the discharge capacity, thus securing the safety level of flood control. For community development, roads, parks, and urban projects were integrated so that the whole city would be centered around Murasaki River. Also, the city gathered ideas from the public, and two were actually implemented; a window to look inside the river was installed at the Environmental Museum of Water, and events are held on water at Suhana Plaza.

At Kitakyushu City, the public sector and private sector worked together for community development and successfully restored the water quality of Murasaki River. The residents’ “awareness” is improved, leading to voluntary actions to protect the river environment. At the same time, the issue of informal waste disposal was solved, and flood risks are better controlled.



Figure 1-11. Current State of Murasaki River

Box 1-2 prepared by Institute for Global Environmental Strategies, Kitakyushu Urban Center

1.5 Key Concepts of the Subsector Model

Given the Kitakyushu experience, this subsector model is based on the following two concepts.

Concept 1: Independent City Government Sectors and Activities

Establishing adequate services should be the city government's number one priority. One department can be responsible to establish, maintain, and operate a waste collection and management system, and another be entitled with the responsibility to manage urban flood risk and install urban drainage infrastructure. Each department has its own mandate that it needs to fulfill and each sector need requires significant time and investment. While the focus of this model is on the interplay of solid waste management and urban flood risk, implementation of basic infrastructure and systems need not be multisector. They can nonetheless still be critical components towards a vision of creating a thriving and livable city environment.

Concept 2. All Unite as City Residents

While the majority of activities and actions may pertain only to one particular sector or actors, city departments, governments, private companies, and residents must not lose sight of the common vision. In Kitakyushu, the ultimate sense of unity lies in how everyone identifies themselves as a city resident and a member of their community, including managers of private companies and city officials. A manager of the steel industrial plant would then have incentive to decrease water and air pollution to help city residents, his community, and his family. The government official working on establishing waste management services would be willing to put in the extra effort because the service is for his city, community, family, and himself. Everyone shares the same positive and negative impacts from the city's changing human and natural environment. This high level of awareness of people's interconnectedness is what makes the Kitakyushu experience and model unique and what creates opportunities for collaboration.

1.6 Subsector Model Scope

As Kitakyushu's experience and Concept 2 shows, collaboration and a sense of common purpose among various actors of society are essential to fill in gaps in city services. The interplaying issues of solid waste management and urban flood risk can only be addressed by nurturing all actors' sense of responsibility and initiative and by developing this collaborative relationship. For this reason, this subsector model introduces the "Public Involvement and Education" sector at the forefront, before it continues to the two technical sectors, as listed below and shown in Figure 1-12.

- Public Involvement and Education
- Solid Waste Management
- Urban Drainage

The subsector model presents actions in each of the three sectors that together help address waste accumulation in drainage canals. Actions in each sector include those that are fundamental and pertain solely to that sector, such as education in schools, construction of sanitary landfills, or development of urban drainage infrastructure. The areas of the circle that overlap in Figure 1-12 consist of actions that are cross-sector, such as cleaning out drainage canals or holding a waste pick-up event in a community park. The model's primary focus is on these areas of overlap, the actions that fill in service gaps. Still, no one will clean a local drainage canal, if there is no reliable means to dispose of that collected waste. Hence, this model also touches on necessary sector specific actions, which are priority government actions and tend to be more specialized and technical. All these actions are bound together by a common goal of making a beautiful, livable city.



Figure 1-12. Model Scope and Interrelated Sectors

The scope of this model is limited to the following:

- **Domestic Solid Waste** – Generated urban waste consists mostly of household waste and its generation is the most dispersed, relative to commercial or industrial waste.
- **Urban Flood Prevention Measures** – This model excludes any emergency flood response actions, including any that may specifically deal with waste management.
- **City-Level Planning** – Regulations, policies, and actions may be necessary at the national or basin-wide scale. However, the audience of this model is the municipal planner, and hence will consist of actions relevant from his/her perspective. For example, flooding caused by an overflowing river due to inadequate flood risk management at the river basin scale is not within the scope of this model. Instead, the focus is more on inundation caused by rain events and inadequate urban drainage capacity.
- **Kitakyushu Experiences** – There are numerous ways to address problems. Actions described in this model are limited to those chosen by Kitakyushu.

1.7 Subsector Model Structure

The subsector model consists of five sections as listed below. The model structure generally follows that of existing Kitakyushu Model sectors, although there are minor differences in section titles and the usual section on performance indicators has been merged into Section 4 Actions. The relationship of this subsector model sections to the common planning process is shown in Figure 1-13.

- **Section 1 Introduction**
Presents the background and overview of the subsector model
- **Section 2 Baseline and Policy Review**
Presents a checklist of data to be collected and analyzed
- **Section 3 Developing a Strategy**
Presents general considerations important in developing an overall strategy
- **Section 4 Actions**
Presents actions and options to implement to achieve the strategy set in Section 3
- **Section 5 Financing**
Presents financing considerations to implement actions and options presented in Section 4
- **Section 6 Conclusion**
Summarizes and concludes the subsector model

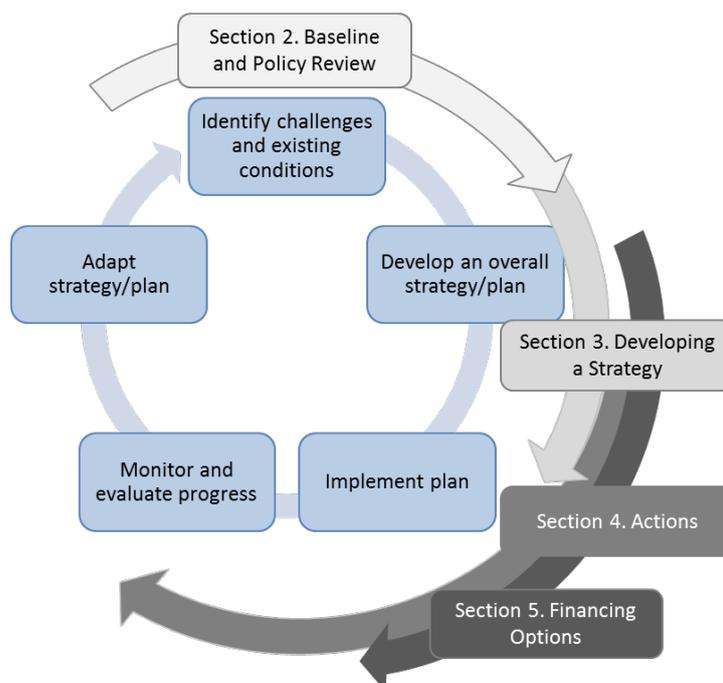


Figure 1-13. Model Sections and its Relationship to the Planning Process

2 Baseline and Policy Review

2.1 Purpose

The baseline and policy review is the first stage in the development of a city-wide solid waste management strategy and an urban flood risk management strategy. Primarily an information gathering exercise, the review's purpose is to obtain information and understand existing and expected future conditions, which will then inform policy direction, strategy, and potential actions. Information gathering may be supported by additional research-based work and technical feasibility studies to help develop a robust evidence base on which to base new policy proposals. This work should be led by sector specialists in consultation with local, regional and central governments, as well as important stakeholder groups.

As described in Section 1, solid waste issues interplay with urban flood risk issues, because city solid waste management services are inadequate. In line with model Concept 1, reviews for each of the three model sectors can be performed mostly independently. At the same time, review content should somewhat overlap and include identification of current conditions and challenges specifically concerning solid waste accumulation that causes standing water and increases in urban flood risk. Existing resident or industry involvement in waste management or flood risk management related activities should also be investigated.

2.2 Undertaking a Baseline and Policy Review

The baseline and policy review should relate to a stated point within time (e.g. last full calendar year or fiscal year). Information sources most likely include those from local, regional, and national governments. The review should also pertain to relevant sectors: public involvement and education, solid waste management, and urban drainage.

Table 2-1 provides a suggested checklist of information that should be obtained during this process. The review should be undertaken by specialists in each of the three sectors. This specialist can be consultants, technical advisors, or government representatives. Refer to Kitakyushu Model sectors "Waste Management" and "Water Management" for additional suggestions and context.

Table 2-1. Baseline and Policy Review Checklist

Category	Contents
Public Involvement and Education	
Institutional	<ul style="list-style-type: none"> Existing local, regional, and national policies, strategies, plans, and rules Existing local, regional, and national policies, strategies, plans, and rules for other related sectors (e.g. solid waste management, river management, storm water/sewer management, community development, climate change adaptation and mitigation, energy, water resources, development plan)
Organizational	<ul style="list-style-type: none"> Organizational structure Roles and responsibilities Human, technical and financial resources Communication and reporting among related departments and stakeholders
Finance	<ul style="list-style-type: none"> Available budget Subsidies, grants, and/or loans to communities and industries Procedures and characteristics of how funds flow from national and regional governments to the city
Schools	<ul style="list-style-type: none"> Literacy rate Enrollment, graduation, and dropout rates Proportion of children out of school

Category	Contents
Public Involvement and Education (cont.)	
Community Associations and Groups	<ul style="list-style-type: none"> • Types of formal and informal organizations and relationships that tie the community together • Community boundaries and their leaders • Level of awareness of solid waste management, river management, stormwater/sewer management and environmental education • Diversity of religions, cultures, and ethnicities, and historic and existing conflicts or challenges • Demographics, including vulnerable populations • Resident or community level needs
Socioeconomic	<ul style="list-style-type: none"> • Population and human migration trends • Formal and informal settlements • Income and expenditure at households • Poverty characteristics • Characteristics of any migratory/nomadic populations • Existing development plans
Environment	<ul style="list-style-type: none"> • Environmental characteristics such as water quality, air quality, noise quality, and recreational values of surroundings • Ecological characteristics and health, such as fauna, flora, and endangered species
Solid Waste Management	
Institutional	<ul style="list-style-type: none"> • Existing local, regional, and national policies, strategies, plans, and rules • Existing local, regional and national policies, strategies, plans, and rules for other related sectors (e.g. river management, storm water/sewer management, education, community development, climate change adaptation and mitigation, energy, water resources, and development plan.)
Organizational	<ul style="list-style-type: none"> • Organizational structure • Roles and responsibilities • Human, technical and financial resources • Communication and reporting among related departments and stakeholders
Finance	<ul style="list-style-type: none"> • Available budget • Subsidies, grants, and/or loans to communities and industries • Procedures and characteristics of how funds flow from national and regional governments to the city
Waste Characteristics	<ul style="list-style-type: none"> • Current and expected future waste volume, composition, and characteristics • Identification of waste sources (such as manufacturers)
Waste Accumulation and Dumping	<ul style="list-style-type: none"> • Current volume, location, and extent of waste accumulation issues • Possible causes of waste accumulation • Waste accumulation impact to the immediate environment and human health
Management	<ul style="list-style-type: none"> • Existing and planned waste management services and any challenges • Current collection and transport methods and their challenges • Locations of waste collection and disposal based on infrastructure development plan • Available human, technical, and financial resources • Available land for any necessary solid waste management-related infrastructure • Current community or private company initiatives to perform waste management services, including scavengers • Future prediction of waste market growth • Current conditions and opportunities for private businesses in the solid waste management sector
Society/Community	<ul style="list-style-type: none"> • Existing NGOs, CBOs • Community needs • Vulnerable areas and city's social demographics

Category	Contents
Urban Drainage	
Institutional	<ul style="list-style-type: none"> Existing local, regional, and national policies, strategies, plans, and rules Existing local, regional and national policies, strategies, plans, and rules for other related sectors (e.g. solid waste management, city planning, landuse planning, river and flood management, education, community development, climate change adaptation and mitigation, and water resources)
Organizational	<ul style="list-style-type: none"> Organizational structure Roles and responsibilities Human, technical and financial resources Communication and reporting among related departments and stakeholders
Finance	<ul style="list-style-type: none"> Available budget Subsidies, grants, and/or loans to communities and industries Procedures and characteristics of how funds flow from national and regional governments to the city Support for research and development (R&D)
Infrastructure	<ul style="list-style-type: none"> Location, sizes, designs, and constraints of relevant infrastructure, such as drainage channels, main arteries, storage basins, pump stations, wastewater treatment plants, and levees. Future growth plans and changes in drainage patterns and needs
Water Resources	<ul style="list-style-type: none"> Precipitation patterns, river flow patterns, groundwater levels, and infiltration rates Past flood or inundation events and their extents Drainage water quality and its impact on receiving waters
Society/Community	<ul style="list-style-type: none"> Existing NGOs and CBOs Community needs Vulnerable areas and city's social demographics
Environment	<ul style="list-style-type: none"> Environmental characteristics such as water quality, air quality, noise quality, and recreational values of surroundings Ecological characteristics and health, such as fauna, flora, and endangered species

3 Developing a Supplemental Action Plan

3.1 Strategies and Action Plans

A strategy informs a government or a government department’s direction for the next several years. It usually consists of an overall common vision and goals along with more measurable objectives. Specific actions to be implemented fall underneath these objectives, as depicted in Figure 3-1.

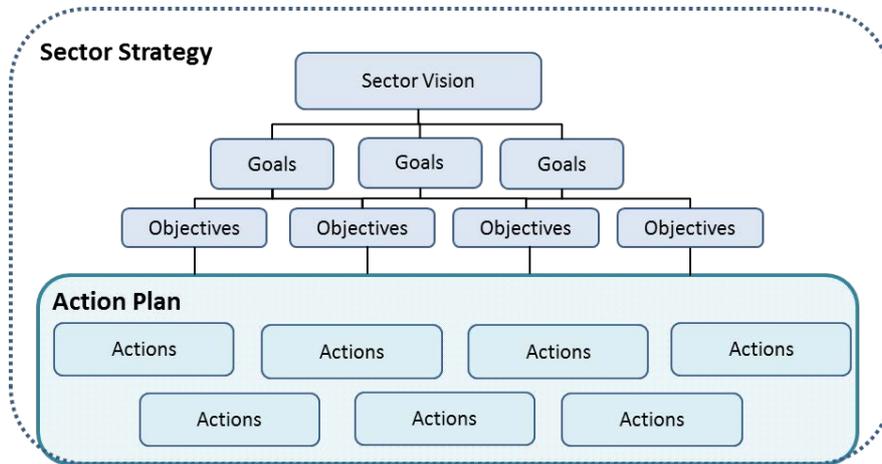


Figure 3-1. General Strategy Structure

This model aims to address interplaying issues of solid waste management and urban flood risk. Inclusion of public involvement and education is also critical to develop and maintain a healthy, lively city. Each of these three sectors could have their own strategy with its own goals, objectives, and action plans. Instead of encouraging city governments to develop yet another strategy specific to this cross sector model, this model suggests development of a supplemental action plan. This action plan can support already existing strategies, as depicted in Figure 3-2. The urban drainage sector is not shown for clarity.



Figure 3-2. A Supplemental Action Plan that Supports Existing Strategies

Figure 3-2 portrays that there could be common objectives between different sectors, shown by the orange objective. Some actions that generally pertain to public involvement and education could be instrumental in meeting a solid waste management objective, or vice versa. There could be actions that are inherently inter-sector, such as organizing a public cleaning event, depicted by the orange actions in Figure 3-2.

Similarly, solid waste management and urban drainage can have overlapping objectives and actions, such as installing drainage covers or screens to catch waste in runoff and cleaning accumulated waste out of gutters. As one example, Kitakyushu added a solid waste management component for a flood project in Indonesia. The capacity to think cross-sector when planning strategies and projects can be critical in reaching the larger common city vision.

This model presents actions that city planners can employ to develop a comprehensive supplemental action plan, which supports and fills in gaps in the public involvement and education, solid waste management, and urban drainage sectors. Specific objectives and relevant, necessary, and practical actions depend entirely on each city's unique situation.

3.2 Governance Structure

Clearly delineating institutional governance structures, or roles and responsibilities of each stakeholder, is critical to successfully implement a strategy or a cross-sector supplemental action plan. Table 3-1 presents typically relevant stakeholders and their suggested functions that pertain to solid waste-urban flood risk management.

Table 3-1. Stakeholders and their Typical Functions and Responsibilities

Organization	Functions/Responsibilities
National	<ul style="list-style-type: none"> • Develop and implement national policies/strategies • Formulate, pass, or issue laws, regulations, and/or national orders • Establish a funding/grant system to local governments • Invest in Research and Development • Monitor and evaluate national government performance
Regional	<ul style="list-style-type: none"> • Develop and implement regional policies and strategies that align with or supplement national regulations/guidelines • Formulate and implement regional ordinances • Establish funding/grant system to local or city governments • Invest in Research and Development • Monitor and evaluate regional government performance
City	<ul style="list-style-type: none"> • Develop and implement policies, strategies, plans, and ordinances that align with or supplements national and regional regulations/guidelines • Secure funding/grants form regional and/or national governments • Procure resources • Plan, design, and construct facilities • Perform daily operation and maintenance (O&M) • Receive and evaluate subsidy applications submitted from CBOs, local industries, and other stakeholders • Disperse subsidies to CBOs, local industries, and other stakeholders • Support community and industrial activities • Educate the public and provide information • Monitor and evaluate city government performance
Community	<ul style="list-style-type: none"> • Clean local residential areas (e.g. gutters and waste collection stations) • Support city government activities • Encourage local activism
Industry	<ul style="list-style-type: none"> • Clean local commercial areas (e.g. road gutters and waste collection stations) • Support city government activities (e.g. R&D, respond to business opportunities) • Reexamine operations to reduce resource use and increase resource use efficiency

Table 3-2 displays how Kitakyushu delegates or delegated roles and functions internally to various city departments to meet their solid waste management and urban drainage related goals. Each department also has an active public outreach and involvement component, shown in the rightmost column. A clear separation of roles and responsibilities facilitates effective cross-department communication and collaboration. Again, the most practical and effective delegation of roles depends on each city's unique situation.

Table 3-2. Delegation of Roles within the Kitakyushu City Government

Department¹	Relevant Functions/Responsibilities	Public Involvement
River Department	<ul style="list-style-type: none"> • Protect the city from river-caused flooding • Construct levees • Dredge and clean rivers and waterways 	<ul style="list-style-type: none"> • Organize/support river cleaning events • Support “Friends of the River” resident volunteer groups
Roads Department	<ul style="list-style-type: none"> • Plan, design, and construct city roads • Design and install roadside gutters and drainage channels along with road construction • Clean and maintain drainage gutters 	<ul style="list-style-type: none"> • Organize/support “Road Supporter” resident trash pickup volunteer groups
Wastewater/ Drainage Department	<ul style="list-style-type: none"> • Manage urban inundation risk • Plan wastewater and urban drainage infrastructure for the entire city • Design and construct major drainage pipelines, pump stations, detention basins, and treatment plants • Maintain and clear accumulated waste/debris from inside the drainage system, once they pass through the gutters • Manage and address water pollution caused by discharge 	<ul style="list-style-type: none"> • Host school field trips at the wastewater treatment plant • Respond to calls and requests from the public concerning drainage issues and drain cleaning
Environmental Department	<ul style="list-style-type: none"> • Provide waste collection, transport, waste treatment, and disposal services • Provide recycling services 	<ul style="list-style-type: none"> • Support “Friends of the Park” resident trash-pickup and cleaning volunteer groups • Lead environmental education • Host school field trips at the incineration plant • Teach children about the waste life cycle and how to sort waste correctly at home
Environmental Education Department	<ul style="list-style-type: none"> • Teach students about the environment, their city, sustainability, and environmental citizenship • Inform and educate the everyday resident • Establish related museums, programs, and events 	

Note:

1. This table presented all “departments” as separate entities, but some may fall under the same umbrella “agency,” while other departments may be independent. For example, Environmental Education in Kitakyushu is a part of the Environment Department. The details of the organizational hierarchy, however, are not important, since they are unique to each city government.

4 Actions

4.1 Overview of Actions

The solid waste-urban flood risk subsector model consists of three sectors: 1) public involvement and education, 2) solid waste management, and 3) urban drainage. This section lays out specific actions per each sector. The intent is to have city government planners select and/or adapt those that are the most relevant to their situation and strategies to develop a supplemental action plan, as explained in Section 3.

Table 4-1 provides an overview of all actions covered in this model.

Table 4-1. Overview of Model Actions

Public Involvement and Education	
<i>Actions to Enhance Public Involvement</i>	
E1. Relationship Building	
	E1-1. Establish Means of Communication
	E1-2. Set Common Goals/Slogans
E2. Resident Involvement in Providing Services	
	E2-1. Organize Public/Stakeholder Meetings
	E2-2. Develop a Policy to Support Resident Involvement
	E2-3. Send Government Staff to the Field
<i>Actions to Educate Residents</i>	
E3. Education in Schools	
	E3-1. Teach Students about the Local Society and Environmental Citizenship
	E3-2. Hold Students Accountable for the School Environment
E4. Education of the Public	
	E4-1. Inform Residents of City Activities and Progress
	E4-2. Organize Public Events and Programs
	E4-3. Establish Museums and Learning Facilities
Solid Waste Management	
<i>Actions to Establish Basic Waste Management Services</i>	
W1. Waste Storage for Collection	
	W1-1. Fix Waste Bins at Each Household
	W1-2. Use Portable Containers at Each Household
	W1-3. Use Standard Plastic Bags
	W1-4. Set Collection Stations for Groups of Households
W2. Waste Transport	
	W2-1. Use Collection Vehicles
	W2-2. Use Compaction Collection Vehicles
W3. Waste Treatment (Incineration)	
W4. Final Disposal	
<i>Actions to Improve Waste Management</i>	
W5. Waste Reduction	
	W5-1. Separate Waste
	W5-2. Collaborate with Manufacturers
	W5-3. Charge Fees for Waste Disposal
W6. Maintaining a Waste-Free City Environment	
	W6-1. Identify Waste Accumulation/Dump Sites
	W6-2. Collect Bulk Waste Periodically
	W6-3. Install Waste Bins in Public Areas
	W6-4. Encourage Residents to Maintain a Clean Environment
Urban Drainage	
<i>Actions to Maintain Drainage Capacity</i>	
D1. Local Adaptations to Capture Debris	
	D1-1. Cover Open Drains (wood or any other locally available material)
	D1-2. Cover Open Drains (concrete/metal grating)
	D1-3. Install Intermediary Screens within Drainage Channels

D2. Waste Clean-Up, Drain Cleaning, and Maintenance

- D2-1. Perform Scheduled System Cleaning and Maintenance
- D2-2. Perform Ad Hoc Local Drain Cleanings
- D2-3. Inspect the System Prior to Rain Events
- D2-4. Establish a Hotline and Respond to Debris Accumulation/Backup Reports
- D2-5. Hold Clean-Up Events

Actions to Expand/Improve the Drainage System**D3. Systemwide Drainage Planning Considerations**

- D3-1. Plan Using Sustainable Urban Drainage System/Low Impact Development Principles
- D3-2. Convert to Partial Separate Sewer Systems
- D3-3. Utilize Open Spaces, Ponds, and Detention Basins
- D3-4. Relocate Informal Settlements around Waterbodies

D4. Design Level Considerations

- D4-1. Secure Discharge Points/Points of Interest
- D4-2. Create or Revisit Design Storms and Runoff Assumptions
- D4-3. Redevelop or Manufacture New Materials and Designs
- D4-4. Expand Drainage System in Coordination with Other Construction

Figure 4-1 depicts the relationship of each sector and their actions to each other within the overall model concept.

As explained in Section 1.4 and Section 1.5, there are services that the city government can and should provide that pertain specifically to that sector. These include W2, W3, and W4 for the solid waste management sector, which consist of city government actions that invest in establishing a waste management service system. Similarly, E3 and E4 deal with informing and educating city residents and stakeholders, so that they will more readily participate in grassroots and/or city-led activities. Actions D3 and D4 pertain to planning and structural considerations important when expanding and improving urban drainage infrastructure.

In contrast, actions located in areas of overlap generally involve more expensive resident

involvement and are cross-sector. They consist of organizing and teaching residents to put out waste for city collection, reduce waste, and to maintain a waste-free city environment (W1, W5, W6). Similarly, D1 involves structural adaptations to drainage channels that prevent waste accumulation and blockage of runoff drainage, which can sometimes be done under resident initiative. D2 consists of actions that clear waste out of the drainage system by a combination of city government and local resident efforts, and hence is located at the center of Figure 4-1. E1 and E2 are actions that city governments can take to encourage resident involvement in maintaining a beautiful, livable, city environment. These are also placed at the center of Figure 4-1. The areas of overlap are the primary focus of this subsector model.

Table 4-2 lists example objectives that a city planner may establish in Section 3 and presents suggested combinations of short term and long term actions that may help the city reach those objectives. Consistent with Section 1, these example action combinations show that for many sample objectives, a basic but functioning waste management system is a baseline requirement. Cities need to invest in establishing such systems as their first priority in addressing waste accumulation issues.

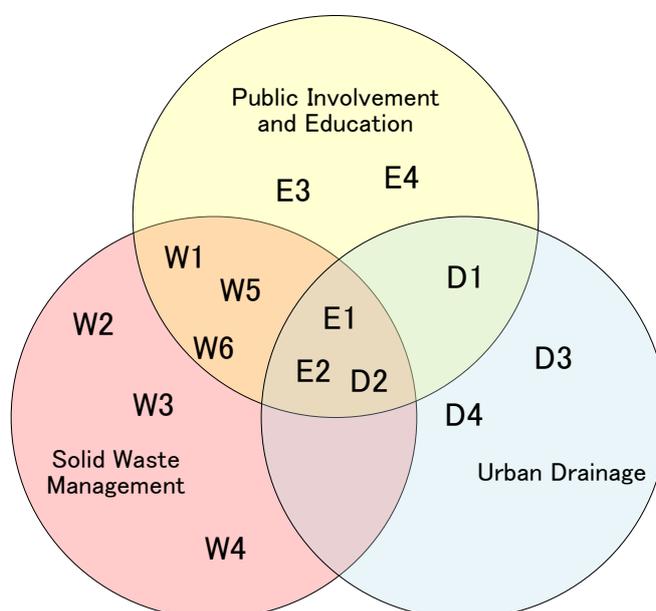


Figure 4-1. Actions and the Overall Model Concept

Table 4-2. Example Objectives and Possible Combination of Actions to Reach that Objective

Minimum Necessary Conditions	Immediate Actions	Longer-Term Actions
Example Objective 1: Residents and local entities become more involved in maintaining their immediate surroundings.		
<p>W1, W2, W4</p> <p>Residents must have a way to dispose of collected and cleaned waste.</p>	<p>E1-1, E2, E4-1, E4-2 W6-4, D2-5</p> <p>The city government should develop a relationship with residents or entities (E1-1) and inform them of the government's intent (E2, E4-1). Encouraging residents to maintain a clean environment (W6-5) or organizing clean-up events (E4-2, D2-5) can be important first steps.</p>	<p>E1-2, E3, E4 D2-4</p> <p>Immediate actions need to be sustained over the long term. Building a sense of common purpose (E1-2) and educating residents (E3, E4) can build a sense of agency. Establishing hotlines where residents can reach government personnel (D2-4) can also strengthen communication and existing relationships.</p>
Example Objective 2: Clean a large drainage canal/river and maintain drainage capacity.		
	<p>E1-1, E2-2, E2-3, E4-1 D2-5</p> <p>In organizing a clean-up event (D2-5), the city government needs to start by developing a relationship with to-be participants (E1-1, E2). The event and its positive impacts should also be publicized (E4-1).</p>	<p>W1, W2, W4, W6 D1, D2</p> <p>Over the long term, the city needs to establish reliable waste services to provide an alternative to waste dumping (W1, W2, W4). Additional investment in preventing waste dumping may also be beneficial (W6). Further, proper maintenance and cleaning of local drainage channels (D1, D2) would reduce waste accumulation downstream.</p>
Example Objective 3: Reduce waste in the waste stream.		
<p>W1, W2, W4</p> <p>Residents must have a way to dispose of collected and cleaned waste.</p>	<p>E2, E4-1 W5-1, W5-3</p> <p>Waste separation (W5-1) allows the city to treat and recycle or dispose of each type of waste as most suitable. Charging for waste services (W5-3) financially encourages residents to reduce waste. Resident involvement and understanding (E2, E4-1) is critical for both these steps</p>	<p>E1-2, E3, E4, W5-2</p> <p>Over the long term, collaboration with industry and businesses is required to develop a resource-recycling waste management system (W5-2). Increase in resident awareness would further help support such efforts that rely on long term investment (E1-2, E3, E4).</p>
Example Objective 4: Increase worker commitment and address absenteeism in the waste management sector.		
<p>W1, W2, W4</p> <p>A waste service system must be in place for there to be demand for workers</p>	<p>E4-1, E3-1 W1-3, W1-4, W2-2, W3, W4, W5-1, W5-3</p> <p>Worker commitment can be improved by providing better working conditions and by increasing social value of the work they perform. Use of plastic bags (W1-3), compaction vehicles (W2-2), incineration (W3), and sanitary landfills (W4) decrease odors throughout the process. Use of plastic bags, teaching residents to segregate and dispose of trash correctly (E4-1, W5-1), and setting collection stations (W1-4) also increases worker safety and ease. Waste collection workers can also teach students about waste in schools (E3-1)</p>	<p>E1-2, E3, E4</p> <p>Over the long term, city residents need to become more aware of the role waste management plays in their everyday lives and communities. Establishing a common city-wide goal (E1-2) as well as educating children and the public (E3, E4) are critical.</p>
Example Objective 5: Reduce waste flowing through the drainage system.		
<p>W1, W2, W4</p> <p>Residents must have an alternative to dumping waste into nearby canals.</p>	<p>D1, D2-1, D2-2, D2-3</p> <p>Installing covers over drainage channels (D1-1, D1-2) and if possible screens throughout the system (D1-3) will prevent waste from entering the drainage system. The city government or residents will need to clean the waste that is caught (D2-1, D2-2, D2-3).</p>	<p>E2-1, E2, E4-1 W6-2, D2-4</p> <p>Over the long term, public outreach (E2-1, E2, E4-1) will encourage resident involvement. The government can also establish hotlines so that residents can inform the city of any issues (D2-4, W6-2).</p>

Neither actions presented in this model nor their example uses are prescriptive. They are suggestions to city governments, city planners, and sector departments as methods to address the interplay of solid waste management and urban flood risk issues. Users should consider, adapt, and develop these actions so that they fit and work in the local cultural, social, economic, and environmental context and that city’s future vision. Only then will an action plan be meaningful and sustainable.

4.2 Structure of Sectors and Actions

Each sector is organized into two main subsections. The first subsection provides a quick overview of the sector, an explanation of how it is relevant to the interplay of solid waste management and urban flood risk, and a description of Kitakyushu’s development for that sector. To provide consistency and context for the story of Kitakyushu development, this subsection includes a figure that lays out Kitakyushu’s population, number of households, and Japan’s gross domestic product (GDP) per capita from 1960 to today. Kitakyushu City staff has confirmed that Japan’s GDP growth patterns are consistent with that of Kitakyushu. Sector relevant event timelines are provided below these graphs.

While Kitakyushu’s history is not directly applicable to other cities today, the intent is to provide a relatable reference. For example, a city planner who knows his/her country’s GDP and population can roughly look at what time in history Kitakyushu may have been in a similar situation, and refer to sector activities Kitakyushu had been focusing on at that time.

The second subsection under each sector presents sector actions. A table lists the actions that will be described and a figure organizes them according to what the actions are primarily meant to accomplish and their ease of implementation. The figures also intend to provide relatable context or information to help guide other city planners.

The remainder of the second subsection consists of action descriptions, presented in a consistent and concise format. Each action group begins with a head page that shows relevant actions, their characteristics, and their advantages and disadvantages based on Kitakyushu’s experiences (Figure 4-2). A gray bar for each action provides a quick overview of the timeframe, affordability, technical capacity, partners, and their involvement level for that action. The definitions of each are provided in Figure 4-2.

X1. Action Group Name				
Purpose/Introduction <i>[Introduces the action, describes the purpose, and explains its relevance to solid waste-urban flood management]</i>				<i>[Figure]</i>
X1-1. Action Name				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Capacity</u>	<u>Partners</u>	<u>Involvement Level</u>
<i>Short: 1~2 years</i>	<i>A range from \$ to</i>	<i>Low, Mid, or High,</i>	<i>Stakeholders to</i>	<i>Intensity of</i>
<i>Mid: 3~5 years</i>	<i>\$\$\$ relative to</i>	<i>relative to other</i>	<i>involve outside the</i>	<i>involvement of</i>
<i>Long: > 5 years</i>	<i>other actions within</i>	<i>actions within the</i>	<i>city government</i>	<i>identified partners</i>
<i>Recurrent</i>	<i>the same group</i>	<i>same action group</i>		<i>(Low, Mid, High)</i>
Advantages		Disadvantages		
• xxxxxxxxxxxxxxxx		• xxxxxxxxxxxxxxxxxxxx		

Figure 4-2. Sample Action Group Head Page

Finally, each action is described, consisting of the following information:

- Description
- Necessary Existing Conditions
- Important Considerations
- Financing and Resources
- Operation and Maintenance
- Performance Indicators
- Case Studies of the Kitakyushu Experience

Depending on the action group or action, some of the above information is presented as a part of the action head page, if the content is relevant to all actions within that group.

Some of the actions, especially those that are cross-sector, are closely related and their action descriptions can be similar. For example, D2-5 “Hold Clean-Up Events” can be said to be an example of E2-2 “Develop a Policy to Support Resident Involvement” or E4-2 “Organize Public Events and Programs.” Actions are not necessarily mutually exclusive, and while some descriptions could be repetitive, they were also not intended to be read from cover to cover. These action descriptions are structured so that it will allow users to select specific actions sheets that interest them. Section 4.1 and each sector introduction both provide context that can assist model users. Further, there are references to other related actions within each action description.

4.3 Public Involvement and Education

Collaboration between the city government and residents, community groups, industries, and private companies forms the foundation of the Kitakyushu experience. Investment in the public involvement and education sector helps address the interplaying issues surrounding waste accumulation in drainage canals that extend beyond a city government's capacity to manage in that moment in time. Specifically, investment in this sector addresses the following two needs.

- Residents and industries need to take initiative and responsibility, within their capacity and whelm, to create the society or community in which they prefer to live
- Residents, industries, and the city government need to collaborate and work under a common purpose or understanding

Public involvement is time and energy intensive, requiring activities such as holding meetings and workshops, and maintaining open communication channels, which can slow down decision-making processes and project execution. However, projects that have resident support are more sustainable. Similarly, investments in relationship building and nurturing residents that take initiative and responsibility over their immediate surroundings have immeasurable benefits over the long term.

Benefits of public involvement include but are not limited to the following.

- Raises residents' awareness, motivation, and sense of autonomy
- Builds relationships between residents and the government for smoother communication and collaboration in the future
- Nurtures trust that improves sustainability and ease of implementing projects and city activities
- Provides the government with resident feedback and ideas to improve city services and programs
- Helps ensure longevity of projects and programs
- Promotes coproduction, where resident activities are functional components of city services, such as
 - Cleaning out local gutters and drainage channels
 - Separating or putting out waste for city services to collect, treat, and dispose or recycle
 - Identifying issues, such as accumulated waste or blocked drainage, and reporting it to proper authorities

In this model, the terms "public" and "residents" are used broadly. The intent is not necessarily to exclude other possible stakeholders, such as private businesses and community organizations. They are mentioned when specifically relevant. However, as described in Concept 2 of the model, all city government workers, private company workers, and community leaders are simultaneously city residents, with shared common interests. From this perspective, the terms "public" and "residents" are used to comprehensively include everyone who holds multiple roles within society.

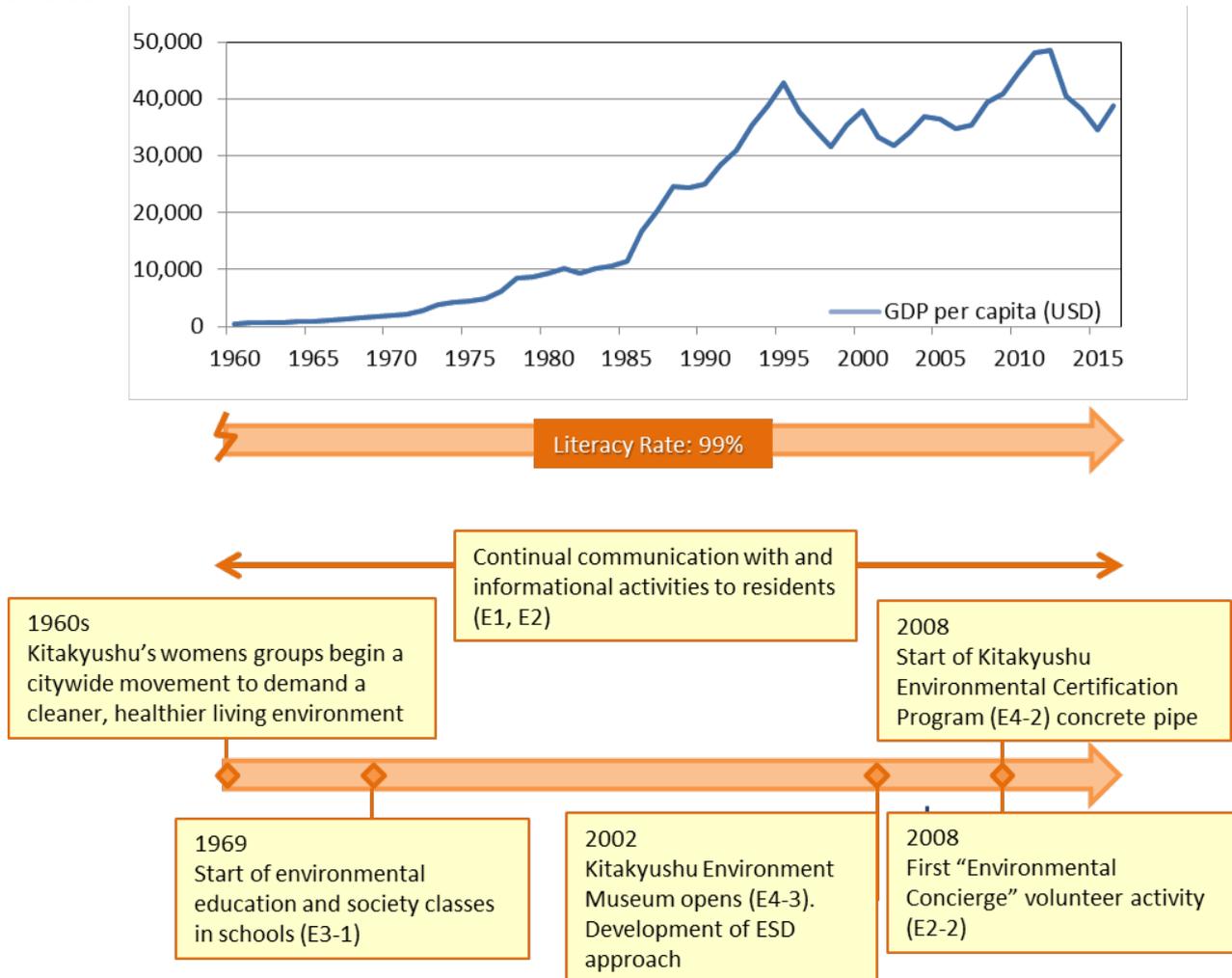
4.3.1 Public Involvement and Education and Kitakyushu Development

As explained in Section 1, the Kitakyushu experience is that of residents' activism. Residents demanded a better living environment in the 1960s when air and water pollution from industrialization reached levels that caused human health concerns. The city government, residents, community groups, and industries then worked together to successfully develop a cleaner, healthier Kitakyushu.

Residents, however, were continually active in other sectors as well. They advocated for and elected the "Toilet Mayor" in 1968, demanding construction and extension of wastewater and drainage services. In the waste management sector, residents abided by city requests when putting out trash for collection, whether it be waste bins, plastic buckets, or plastic bags. In the urban drainage sector, residents cleaned out nearby drainage channels. Neighborhood associations organized themselves to clean larger drainage mains. These neighborhood associations have existed for a long time and continue to operate today, maintaining and managing local public facilities.

Simultaneously, the city government has invested for decades in communicating with residents, informing residents of city activities, and organizing public/stakeholder meetings. City government workers have been told by leaders to lower the barriers between the government and the public. The government has found waste pickup and cleaning activities are especially inclusive, providing opportunity from the elderly to young children to participate. Such events help nurture trust among participating members.

Kitakyushu residents have long been receptive to government initiatives. An important factor for this is the high literacy rate in Japan, as depicted in Figure 4-3. 99 percent literacy is also representative of Kitakyushu. Almost everyone could read by the mid-1900s, due to nationwide investment in public education. This additionally implies that residents have basic knowledge, such as math, science, and social studies, and share school-based experiences, such as being a part of a defined community. Figure 4-3 shows that the literacy rate in Japan was independent of GDP trends. The high human resources capacity or potential in Kitakyushu perhaps had allowed for the quick and extensive resident involvement in various citywide activities.



Sources:
 GDP per capita: Economic and Social Research Institute, 2015 and International Monetary Fund, 2017
 Literacy rate: Central Intelligence Agency, 2013

Figure 4-3. Public Involvement and Education and Kitakyushu Development

Nonetheless, Kitakyushu continued to invest in education of its residents, increasingly focusing on environmental education. Environmental education refers to education that 1) teaches children and residents to be responsible citizens, and 2) increases awareness on environmental issues, including waste management, flood management, and climate change. Environmental education in Kitakyushu officially started in 1969. More investment heavy educational actions, such as opening museums and educational facilities and organizing environment-themed events and exhibitions, only took place after Kitakyushu became wealthier, as can be seen in Figure 4-3. At around the turn of the century, Kitakyushu began investing in environmental education at a more holistic level, aiming to nurture city residents who would help Kitakyushu become one of the “world’s environmental capitals.” As an example initiative, standardized teaching guides and workbooks for environmental education in city elementary schools were completed in 2006 and 2009, respectively.

Today, Kitakyushu stands by Education for Sustainable Development (ESD) principles, which “empowers people to change the way they think and work towards a sustainable future (United Nations Educational,

Scientific, and Cultural Organization [UNESCO] 2017).” The City further breaks this down to include “connect, relate to, share a vision with and collaborate with co-residents.” Kitakyushu’s understanding of ESD embodies the government, residents, community groups, and businesses’ intent to holistically create a better, healthier living environment for all. As a concrete example of how residents stand by their “let’s help each other” principle, Kitakyushu was one of the few cities that accepted waste and debris from northeastern Japan after the 2011 earthquake disaster. Usually, resident opposition prevents such intercity collaboration from being fruitful.

4.3.2 Actions for Public Involvement and Education

The public involvement and education sector consists of actions presented in Table 4-3. These actions can be organized into two large groups, one which focuses specifically on public involvement in city government activities (Actions E1 and E2), and the second which takes a more long-term perspective and focuses on educating residents to be responsible citizens and raises their awareness of environmental issues (Actions E3 and E4).

Table 4-3. Overview of Public Involvement and Education Actions

Public Involvement and Education	
<i>Actions to Enhance Public Involvement</i>	
E1. Relationship Building	
E1-1.	Establish Means of Communication
E1-2.	Set Common Goals/Slogans
E2. Resident Involvement in Providing Services	
E2-1.	Organize Public/Stakeholder Meetings
E2-2.	Develop a Policy to Support Resident Involvement
E2-3.	Send Government Staff to the Field
<i>Actions to Educate Residents</i>	
E3. Education in Schools	
E3-1.	Teach Students about the Local Society and Environmental Citizenship
E3-2.	Hold Students Accountable for the School Environment
E4. Education of the Public	
E4-1.	Inform Residents of City Activities and Progress
E4-2.	Organize Public Events and Programs
E4-3.	Establish Museums and Learning Facilities

Figure 4-4 presents the above actions relative to their ease of implementation. Actions that are more complex to implement may require more technical expertise or resources or higher financial investment. Actions that are presented towards the left side are relatively simpler to implement. Figure 4-4 is strictly conceptual and what is appropriate and feasible in each country or city differs depending on realities and conditions on the ground.

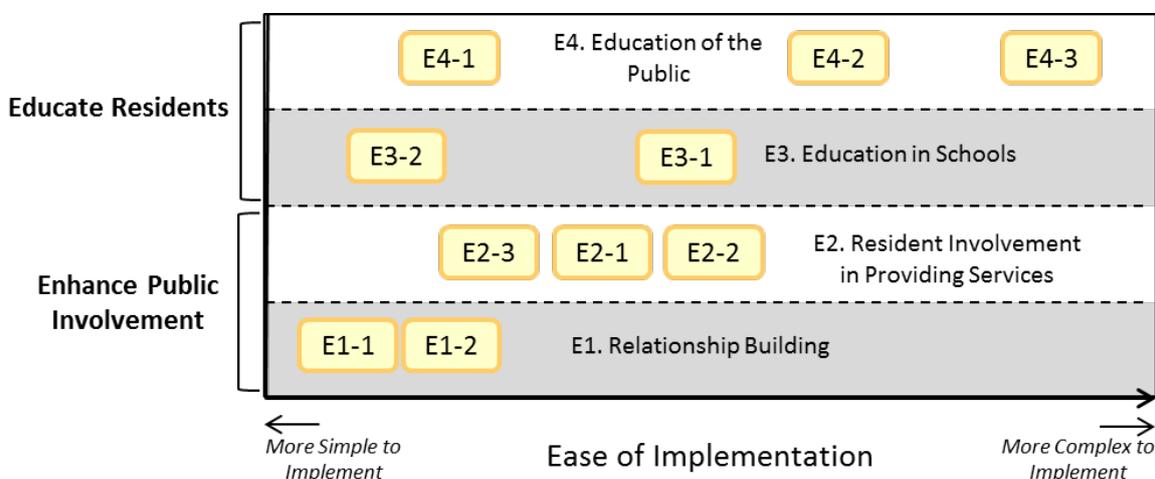


Figure 4-4. Ease of Implementation of Public Involvement and Education Actions

Actions to Enhance Public Involvement

E1. Relationship Building

Purpose/Introduction

An awareness of the interrelationship between city residents, CBOs, various government departments, and private companies is the foundation that allows for collaboration on projects and government initiatives. While participatory actions also help facilitate learning and build connections, the sole purpose of actions presented in E1 is to connect different actors, increase awareness, and to build relationships.



E1-1. Establish Means of Communication

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Mid	\$	Low	Community Leaders, Industries, Schools, NGOs/NPOs, Community Groups	High

Advantages

- Identifies partners and develops relationships with them
- Allows for smoother communication when necessary for government activities

Disadvantages

- Developing relationships and communicating can be difficult if there are no community leaders

E1-2. Set Common Goals/Slogans

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Mid	\$	Low	Community Leaders, Industries, Schools, NGOs/NPOs, Community Groups, Mass Media	Mid

Advantages

- Establishes a common goal or vision to promote collaboration throughout the city
- Having a common goal further increases togetherness and streamlines future activities

Disadvantages

- May require a long time for residents to understand feel attachment to that goal/slogan

Operation and Maintenance

- Keep the partner/stakeholder inventory up to date
- Communication and collaboration with identified partners in specific activities help maintain and build on relationships and reinforce set common goals and understanding. (See E2)
- Educating children and the general public, including taking advantage of media outlets to keep residents informed of city activities also reinforces common goals and understanding (See E3, E4)

Financing and Resources

- City government staff to commit to public relationship building activities

Performance Indicators

- Number of partners, the coverage areas of partners, and diversity of partners with whom the city government can readily communicate
- Prevalence of the common goal/slogans in media, public materials, within government, and/or schools.

E1-1. Establish Means of Communication	
<p>Description</p> <p>Establishing relationships and communication venues allows for easy and thorough transmission of information to and from representatives of communities/CBOs and other partners, and through them to and from all stakeholders. Communication is necessary for gathering information and ideas, consensus building, and receiving feedback on planned, current, and completed activities. Contact information, such as representative names, phone numbers, community/school/company names, and emails should be compiled in an inventory.</p> <p>Necessary Existing Conditions</p> <p>None</p> <p>Important Considerations:</p> <ul style="list-style-type: none"> • Identify staff within the government who are well connected. Ask them to identify stakeholders or partners • Be aware that formal and informal community leaders exist. It may be necessary to establish relationships with both. • Consider a representative’s community boundary or sphere of influence. Who does it include? Who does it exclude? Think of alternative ways how to communicate with those who are excluded. • Consider specifically reaching out to vulnerable, disadvantaged, or minority populations, such as women, the poor, and minorities. Ensure the city has a way to communicate with these residents. • Clearly determine how this inventory will be maintained as well as shared. 	<p>The Kitakyushu Experience:</p> <p>Kitakyushu has numerous CBOs including women’s groups, welfare groups, youth associations, and neighborhood associations. Establishing relationships and communicating with CBO leaders have been effective in disseminating and collecting information. Many CBOs have supported city initiatives, such as ensuring their groups begin segregating waste per new guidelines or organizing residents to participate in a neighborhood clean-up day.</p>  <p>Source: Kitakyushu City Jichikai Sourengoukai (2017)</p>
E1-2. Set Common Goals/Slogans	
<p>Description</p> <p>Setting a common goal or having a catchy slogan can be one method to raise awareness and unify city residents and community groups to work towards that goal. Picking up the piece of trash that you dropped, for example, may seem insignificant, but if everyone abides it can greatly reduce litter found along city roads.</p> <p>Necessary Existing Conditions</p> <ul style="list-style-type: none"> • Means to propagate the goal or slogan <p>Important Considerations:</p> <ul style="list-style-type: none"> • The goal or slogan needs to be something the public can relate to and yet send a clear message. • Consider how the goal will best reach the intended audience. Should it be text messages? Television commercials? Brochures? Reach out to community leaders and contacts identified in E1-1. 	<p>The Kitakyushu Experience:</p> <p>Kitakyushu encourages residents, CBO, and private companies to participate in volunteer activities under a common slogan “Make Our City Beautiful.” People, for example, take initiative and gather to pick up trash in tourist and public areas.</p> <p>Kitakyushu also has created a city environmental mascot named Teitan, a play on words meaning “low carbon emissions” The mascot is printed on various city products, and he also has a twitter account. Teitan embodies the general idea of environmental awareness, including cleanliness of everyday surroundings.</p> 

E2. Resident Involvement in Providing Services				
<p>Purpose/Introduction</p> <p>City governments should encourage residents and community groups to take self-initiative and participate in environmental activities, such as maintaining their surrounding environment. The government can provide knowledge, information, structure, and human or material resources to support resident/community activities.</p>				
E2-1. Organize Public/Stakeholder Meetings				
<u>Timeframe</u> Recurring	<u>Affordability</u> \$\$	<u>Technical Level</u> Mid	<u>Partners</u> Community Leaders, Industries, NGOs/NPOs, Community Groups	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Increases cooperation Provides an opportunity to collect field level information Helps inform and improve planned activities 		<p>Disadvantages</p> <ul style="list-style-type: none"> May require many explanation meetings to build consensus 		
E2-2. Develop a Policy to Support Resident Involvement				
<u>Timeframe</u> Recurring	<u>Affordability</u> \$	<u>Technical Level</u> Mid	<u>Partners</u> Community Leaders, Industries, NGOs/NPOs, Community Groups	<u>Involvement Level</u> Mid
<p>Advantages</p> <ul style="list-style-type: none"> Raises awareness and/or interest Encourages residents to participate in activities Promotes residents to take self-initiative and conduct similar activities 		<p>Disadvantages</p> <ul style="list-style-type: none"> Requires some time and effort for the government to support residents, including, potentially personal time 		
E2-3. Send Government Staff to the Field				
<u>Timeframe</u> Recurring	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Community Groups, Residents, Schools	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Raises awareness and/or interest Encourages residents to participate in activities Provides an opportunity to collect field level information Reinforces relationships with residents 		<p>Disadvantages</p> <ul style="list-style-type: none"> May require working overtime and on weekends 		
Operation and Maintenance				
<ul style="list-style-type: none"> Supervise, monitor, and evaluate activities contributed by participating partner(s) Collect activity reports from groups that received government support. This information can be as simple as listing the date and location of the activity, number of participants, activity content, and any observations or comments. 				
Financing and Resources				
<ul style="list-style-type: none"> City government staff to organize and commit to public involvement activities Staff daily allowance and transportation costs Preparation of fliers, brochures, and graphics for explanations Any materials and tools, such as gloves and trash bags, depending on the planned activities 				
Performance Indicators				
<ul style="list-style-type: none"> Participant/partner level of satisfaction and/or understanding Number of questions from participants Number of explanation meetings held with stakeholders or the number of staff sent to the field to support resident initiatives Qualitative assessment of behavior changes in for example, solid waste management or drainage cleaning over the long term 				

E2-1. Organize Public/Stakeholder Meetings**Description**

Public meetings should be held at the start of new city projects or at milestones when resident input or participation is especially important. Interaction between residents and government can raise resident awareness and encourage them to take ownership for any activities for which they may be responsible. The overall project can additionally be improved by incorporating on-the-ground comments provided during the meeting. While time consuming with no concrete, immediate results, such processes are integral to secure project sustainability.

The city needs to conduct the following to prepare for public meetings.

- Clearly develop the project/meeting purpose, objectives, relevant concepts, and important dates
- Organize the meeting, including logistics, such as the time, date, and venue
- Prepare presentation materials
- Contact potential participants

Necessary Existing Conditions

- Understanding of local community dynamics, important stakeholder groups, and their leaders (see E1-1)

Important Considerations

- Consider when residents/target participants would be the most available. Are there better seasons/days/times to reach out to them? If needed, conduct a daily activity profile to learn of people's availabilities.
- Be aware of social norms. For example, can women participate in meetings with men? Be sensitive to ethnic differences, the elderly, gender role differences, and social status
- When preparing materials, adapt the contents to the overall literacy rate and level of understanding of the participants.

Financing and Resources

- Staff to prepare meeting materials
- Facilitator to conduct the meeting
- Venue rental costs and printing costs

**The Kitakyushu Experience**

In Kitakyushu, it is common practice for the government to organize explanatory meetings, especially when new activities, policies, or projects are being implemented.

For instance, when the city decided to collect fees per plastic trash bag, the city held explanatory meetings before and immediately after its implementation with each neighborhood association. Just for this new initiative alone, the city estimates they conducted about a total of 1,000 explanatory meetings throughout the city.

As another example, Kitakyushu held meetings in 1995 to brainstorm ideas with residents, schools, and community organizations about how residents wanted or envisioned their Bachi River to look. Their inputs informed the overall direction of the river restoration plan, completed in 1997 after about 100 meetings.



Elementary school children's vision of the future Bachi River

E2-2. Develop a Policy to Support Resident Involvement

Description

The city government can provide the following resources to support resident participation in government related activities.

- Financial support
- Technical support
- Materials for cleaning, learning, or community activities
- Prizes, awards, and/or recognition to communities and schools that contribute to maintenance of the city environment

A clear policy governing what is provided to whom, when, and how will help streamline planning for support activities. This consistency and predictability will also be beneficial to resident groups.

Necessary Existing Conditions

- Understanding of local community dynamics, important stakeholder groups, and their leaders (see **E1-1**)

Important Considerations

- Requires a clear government policy to provide consistent and defined support over the long term. For example, what types of activities should the government encourage and how?
- Clear rules and criteria that control and allow for fair distribution and allocation of resources should be developed.
- Although minimal relative to the overall government budget, the annual budget for support activities needs to be secured.

Financing and Resources

- Dependent on policy content and supporting activities
- Annual city budget
- Research for alternative funding streams, which non-city government, community groups or NGOs/NPOs may be eligible for applying

Operation and Maintenance

- Review and revise policy and criteria according to progress on chosen performance indicators

Performance Indicators

- Number of applications for support
- Total disbursed budget
- Number and type of activities contributed to in a given year
- Beneficial results of the support
- Number of new resident led activities or initiatives, such as new community groups or NGOs/ NPOs



The Kitakyushu Experience

Kitakyushu City provides tools, instead of money, to community groups/CBOs to encourage them to clean their communities, especially solid waste collection stations and street gutters.

Since 1989, Kitakyushu supports communities or organizations to establish “Road Supporters,” “Friends of the River,” and “Friends of the Park” groups, which organizes maintenance and clean-up events.

As another example of Kitakyushu support, Kitakyushu assists resident volunteers who work as “Environmental Education Supporters.” These volunteers encourage and promote environmental education among city residents. Volunteer activities, which centers around the Kitakyushu Environment Museum, began in 2001 when Kitakyushu sponsored and held the Japan Expo. Kitakyushu continues to support volunteer activities by, for example:

- Organizing monthly knowledge sharing/learning meetings
- Planning visits to environment-related facilities
- Providing materials and equipment
- Providing space or a productive environment for volunteers to gather

Option E2-3. Send Government Staff to the Field**Description**

One of the most effective ways to encourage resident/community participation or to encourage them to change habits is for the city government to demonstrate that itself. Talk the talk and walk the walk.

Sending staff to the field also provides a good opportunity to supervise and monitor resident or community participation levels and to further build relationships and communicate with residents. Ideas and comments collected from the field can then be reflected in subsequent government activities. Staff can be sent to support:

- Solid waste collection and cleaning activities
- Public education activities at schools, seminars, and exhibitions
- Environmental activities conducted by schools and community groups

Necessary Existing Conditions

- Understanding of local community dynamics, important stakeholder groups, and their leaders (see **E1-1**)
- Staff with appropriate technical and facilitation skills to provide resident support

Important Considerations

- Clear government policy to support staff involvement (see **E2-3**)
- Determine actual conditions in the field to determine where, when, and how many staff members to send
- Sending well known or higher level staff may have a greater impact in receiving publicity and hence may be beneficial for activities of high priority

Performance Indicators

- Number and hours of staff participating in activities

**The Kitakyushu Experience**

Kitakyushu encourages their staff to participate in local activities. Staff is active in road supporter groups, river cleaning events, and numerous other city and community led activities. Pictures remain today of times when the city mayor himself got dirty, cleaning out sludge in the city rivers in the 1960s and 1970s. By publicizing that the top city official himself was out cleaning the rivers, the city government tried to not only increase resident awareness but to also encourage more people to come out and participate in the next event.



浄化運動に参加した亀井福岡県知事(左)と谷市長

Actions to Educate Residents

Action E3. Education in Schools

Purpose/Introduction

Changing behavior can take a long time. One effective method is to teach children the value of taking initiative and responsibility for their immediate environment and collectively, their society. Elementary and middle schools can be important venues and opportunities to teach such environmental citizenship. Students can also help raise awareness and change behaviors of their family members.



E3-1. Teach Students about the Local Society and Environmental Citizenship

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Recurring	\$\$	High	Education Department, School Principals, Teachers	High

<p>Advantages</p> <ul style="list-style-type: none"> • Raises children’s awareness and/or interest • Children can teach and inform other family members • Strengthens relationships with city teachers and education departments 	<p>Disadvantages</p> <ul style="list-style-type: none"> • Requires coordination and collaboration with schools, principals, and teachers, which may be difficult depending on existing relationships
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E3-2. Hold Students Accountable for the School Environment

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Recurring	\$	Low	Education Department, School Principals, Teachers, Students	High

<p>Advantages</p> <ul style="list-style-type: none"> • Raises children’s awareness and/or interest • Instills values through action and developing habits, while having fun • Builds a sense of school community, teaches children about roles and responsibilities, and eliminates the need for janitors 	<p>Disadvantages</p> <ul style="list-style-type: none"> • Requires teacher supervision to organize and teach children how to clean their school • Giving children responsibility sometimes leads to children level politics and power struggles
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E3-1. Teach Students about the Local Society and Environmental Citizenship

Description

Starting to teach about the students’ local society and environmental citizenship requires two steps.

- 1) Preparing teaching and learning materials
- 2) Identifying field trip sites and partner organizations

1) Prepare teaching and learning materials

- Teaching materials should sufficiently guide the teacher so that all teachers can teach classes at a standard level regardless of their experience level. The material should include key ideas and takeaway points, best practices, and clear goals/results from each lesson, chapter, or school year.
- Learning materials should include pictures and illustrations that promote student understanding. Workbooks should provide spaces that allow students to directly add ideas and take notes. Content should be comprehensive and systematic to achieve objectives of each target age/grade.
- Materials should be prepared by teachers with cooperation from relevant government personnel.

2) Identify field trip sites and partner organizations

- Hands on learning or seeing real-life facilities can enhance learning that takes place in classrooms
- Identify what facilities or organizations students can visit to provide more context and understanding. Possible

The Kitakyushu Experience

To ensure effective curriculum development, Kitakyushu has a system of personnel exchange between Board of Education and the local city government. Hence, both the city government and educators are involved in planning and implementing environmental education classes. Such personnel exchanges also allow for knowledge sharing and capacity enhancement.

sites include city landfills, incineration plants, wastewater treatment plants, drinking water treatment plants, parks, detention basins, and museums.

- Reach out and partner with organizations or government departments responsible for those facilities. Prepare tours and any materials that cater to the visiting students' age and understanding. Develop a system that allows coordination and scheduling of student field trips from various classes and schools with the organization/department's schedule.

Necessary Existing Conditions

- Cooperation between the city education system and other city departments
- Principal and teacher understanding of the importance of and commitment to teaching about the students' immediate local environment and promoting environmental citizenship

Important Considerations

- Consider the target age and grade of the students when designing the curriculum, including literacy rate, ability comprehend and concentrate, and level of interest.
- Make the content accessible to the target age group. Think about how it can capture and keep the audience's attention and interest.
- Consider the capacity of teachers throughout the district when designing teaching materials
- Consider designing and branding the learning material as they will be distributed to all students
- Make use of your city's or society's experiences as much as possible
- Obtain feedback from both students and the field trip host so that these visits can be continually improved

Financing and Resources

- Experts/teachers/designers to prepare teaching and learning materials and develop a field trip system
- Cost for copying, bookbinding, and distribution
- Tools and equipment to provide each class

Operation and Maintenance

- Revise class content, materials, field trips, and overall goals as needed

Performance Indicators

- Number of classes taught in each school
- Student satisfaction and understanding
- Student/resident behavior changes over the years

The Kitakyushu Experience

In Kitakyushu, content of environmental education and social studies as a whole focus on the following physical extents per different age groups.

- 6-8 years old: their immediate surroundings (e.g. family, friends, school, playground)
- 9-10 years old: their community (e.g. community mapping, locations and roles of community facilities, such as stores, libraries, fire departments, and hospitals)
- 11-12 years old: their nation
- Over 13 years old: the world

Examples of specific activities include:

- Learning about where your trash goes and how to separate trash (3rd and 4th grade)
- Visiting the local wastewater treatment plant (4th grade)
- Learning how to separate trash from waste collection workers themselves, who come to school on a compactor vehicle

E3-2. Hold Students Accountable for the School Environment**Description**

The school environment is where children learn societal skills, including what it means to be an integral, responsible member of society. Making students clean and keep up their school environment have lifelong lessons, so that as adults, they would think to pick up waste on the streets or keep their living environment clean and sanitary. Cleaning a school or a classroom also requires delegating roles and knowing when to ask teachers for assistance, skills that are relevant also between residents or community groups and the city government. Children quickly learn to think twice about littering if they know that they would have to clean it later that day. They also learn how small contributions from each student can go a long way in making a comfortable learning environment.



Source: UNESCO, 2009

Necessary Existing Conditions

- Support of the Board of Education, the city government , and other relevant entities or organizations
- Principal and teacher understanding of the importance of having students clean their school

Important Considerations

- School cleaning should take place at the same time across the entire school. Set a time within the school day everyday. It may only need to be about 15 minutes.
- Divide students into groups. This can be done at the classroom level where the teacher or the students themselves break up into teams.
- Consider the school layout and break up cleaning needs into manageable chunks, for example, classrooms, hallways, bathrooms, common rooms. Assign student groups or classes to each.
- Consider the age of the students. It may make more sense to delegate cleaning bathrooms or the science room with fragile equipment to older students than first graders.
- Teacher may need to still be present to supervise and provide assistance as necessary.
- Once the students are old enough and the cleaning routine is set, they may be able to self-organize and self-delegate. Older students may be able to start teaching or providing tips to younger students on how to clean effectively. For example, how to best wring out a rag or sweep the classroom.
- Holding students responsible for cleaning may mean laying off janitors. Consider how to best go about this process so that it does not create backlash.

Financing and Resources

- Tools and equipment, such as buckets, rags, brooms, water, and soap

Operation and Maintenance

- Maintenance and repurchasing of old tools/equipment
- Periodic check of school cleanliness to identify need for improvement

Performance Indicators

- Effectiveness and cleanliness of the school environment
- Necessary level of teacher involvement
- Changes in student/resident behavior over the years

Action E4 Education of the Public				
Purpose/Introduction				
<p>The city government should reach out to and educate the general public, including illiterate adults, disadvantaged communities, and children who cannot attend school, with the intent to nurture strong citizenship. This outreach should be continuous over the long term so that city residents as a whole increase participation in their communities and through that government initiatives.</p>				
E4-1. Inform Residents of City Activities and Progress				
<u>Timeframe</u> Recurring	<u>Affordability</u> \$\$	<u>Technical Level</u> Mid	<u>Partners</u> Mass Media, Community Groups, Industries, Schools	<u>Involvement Level</u> High
Advantages		Disadvantages		
<ul style="list-style-type: none"> Disseminate information to a large number of people at once Can be one method to encourage residents to participate in current and future activities Increases understanding and awareness of local history, conditions, and issues 		<ul style="list-style-type: none"> Requires resources to prepare public-oriented materials Informing is one-directional communication. Other means are necessary for the government to receive any feedback 		
E4-2. Organize Public Events and Programs				
<u>Timeframe</u> Short	<u>Affordability</u> \$\$\$	<u>Technical Level</u> High	<u>Partners</u> Mass Media, Community Groups, Industries, Schools	<u>Involvement Level</u> High
Advantages		Disadvantages		
<ul style="list-style-type: none"> Increases understanding and awareness of local history, conditions, and issues Can directly cater to or involve social vulnerable groups Can be one method to encourage residents to participate in current and future activities 		<ul style="list-style-type: none"> Requires resources to prepare public-oriented materials Need land and space for the event or exhibition Impact is limited to those that attend 		
E4-3. Establish Museums and Learning Facilities				
<u>Timeframe</u> Long	<u>Affordability</u> \$\$\$	<u>Technical Level</u> High	<u>Partners</u> Planners/Engineers, Mass Media, Community Groups, Industries, Schools	<u>Involvement Level</u> High
Advantages		Disadvantages		
<ul style="list-style-type: none"> Increases understanding and awareness of local history, conditions, and issues Can directly cater to or involve social vulnerable groups Can be one method to encourage residents to participate in current and future activities Provides a permanent facility for educational purposes 		<ul style="list-style-type: none"> Requires resources to prepare public-oriented materials Need investment in land and facility structure as well as its O&M Impact may be limited to those that attend 		
Performance Indicators				
<ul style="list-style-type: none"> Long term changes in behavior over the years Changes in levels resident participation and coproduction in environmental activities over time 				

E4-1. Inform Residents of City Activities and Progress

Description

Informing and providing information is the first step to increase residents’ understanding of issues, their causes, their solutions, and past or ongoing activities within and/or outside their community.

Information dissemination options include the following.

- Brochures, pamphlets, fliers
- Videos/DVDs
- Posters
- Websites, online videos, social media
- Seminars
- Shows and advertisement on TV, radios, and newspapers
- Billboards and signs



Important Considerations

- Take extra precaution to make sure the data/information being disseminated is accurate, fair, and sensitive to any social issues experienced in the city
- Consider the literacy rate of the target audience
- Ensure the final product provides a clear message. Be creative with content, structure, and format
- Use imagery that has impact, such as before and after pictures that drive home the importance of an activity
- Consider accessibility of the final product as well as whether it draws people’s attention. Be creative with design
- Consider who may not be receiving this information. Think of alternative ways to capture this other audience.

Financing and Resources

- Human resources, including graphic designers and proofreaders
- Cost of production and distribution

Operation and Maintenance:

- Materials need to be kept up-to-date with the latest data/information

Performance Indicators

- Number of seminars held, participants in seminars, access to websites, and videos/DVD views
- Resident level of satisfaction and understanding with provided informational materials
- Changes in behavior over the years

The Kitakyushu Experience

Kitakyushu takes public relations seriously, and takes advantages of mass media, not only to disseminate important city information, but to also provide spotlight on commendable resident, community, or private industry activities. Sometimes, this means preparing a small article about how one neighbor saw a bicycle thrown away in the river and took it on himself to pull it out.

E4-2. Organize Public Events and Programs**Description**

Public events and programs help enhance residents' understanding of the city's environmental issues, their causes, their solutions, and past or ongoing activities within and/or outside their community in a fun, open environment. Public events can be catered to involve all residents including socially vulnerable groups.

Planning for public events and programs include the following steps.

- Developing the theme or concept of the event/program
- Identifying and organizing sponsors and volunteers
- Arranging the event/program (e.g. date, period, and venue)
- Publicizing the event (see **E4-1**)

Necessary Existing Conditions

- Commitment within the leading government department to hold such an event

Important Considerations

- When choosing the venue, consider whether it is:
 - Large enough
 - Accessible to the intended audience
 - Safe
- Ensure materials developed have a clear and coherent messages that draws attention and can be understood by the target audience/age groups (see **E4-1**)
- Consider which community organizations or private companies can participate to make a more interactive event. Refer to groups identified in **E1-1**.

Financing and Resources

- Human resources and support staff
- Budget for venue, public outreach, and any construction of temporary buildings

Performance Indicators

- Number and demographic of visitors
- Level of satisfaction and increased understanding of visitors

The Kitakyushu Experience

Kitakyushu organizes an environment-themed event called "Eco-Life Stage" every year to showcase environment-related activities, in which local residents, NPOs, businesses, schools, and the government are involved. About 80 to 100 organizations usually participate, and for them, the event also provides a promotional opportunity. The event aims to increase resident awareness while generating no waste and to minimizing electricity use.

The Kitakyushu Experience

Kitakyushu has established a Kitakyushu Environmental Certification program as one way to increase opportunities to learn about the local environmental efforts and increase resident awareness and interest. The certification covers the history of Kitakyushu, including how it addressed water and air pollution issues in the mid-1900s, as well as the city's more recent environment-related efforts.



E4-3. Establish Museums and Learning Facilities**Description:**

Museums and learning facilities help enhance residents' understanding of the city's environmental issues, their causes, their solutions, and past or ongoing activities within and/or outside their communities. Permanent educational facilities can be also used for school field trips, family outings, community group learning, and tourism.

**Necessary Existing Conditions:**

- Commitment to invest in museums and facilities

Important Considerations:

- When planning and designing the museum or facility structure, consider:
 - Location and its accessibility for the intended audience
 - Size and capacity to accommodate the intended audience
 - Consider the building's environmental impact and see if design and construction be altered to have less impact by, for example, using reusable materials or by powering the building with renewable energies.
- When designing the content of the museum or facility:
 - Develop main ideas and concepts the visitors should take from their visit
 - Ensure there is a clear message and that the information provided is accurate
 - Consider and match the different literacy rates and education levels of visitors
 - Combine use of text, images, videos, real objects, and interactive displays
- Public outreach materials may be needed to encourage visitors to come and to provide informational materials for visitors to take home. Consider preparing brochures, fliers, websites, DVDs, posters etc. See **E4-1**.
- Identify potential sponsors to help build and run the museum. Identify any volunteers who can be guides in the museum.

Financing and Resources

- Budget for construction, operation, and preparation of the museum and its displays and exhibitions.
- Budget to prepare publication and outreach materials
- Human resources to construct and operate the museum

Operation and Maintenance

- Revision of displays and exhibits

Performance Indicators

- Number and demographic of visitors
- Level of satisfaction and increased understanding of visitors

The Kitakyushu Experience:

Kitakyushu has the following museums and learning facilities. The city also provides environmental interpretation and education in the field.

Museums

- Environment Museum
- Firefly Museum
- Environmental
- Museum of Water

Learning facilities

- Eco-Town Center
- Water treatment plants
- Wastewater treatment plants
- Intermediate solid waste treatment plants
- Recycling centers
- Youth outdoor learning centers

Environmental Interpretation and Education

- Hand-on activities, such as walk rallies, crafts, cooking in the field
- Outdoor activities, such as river canoe, climbing, trekking, nature tours, campfire talks, cycling, and bird watching

4.4 Solid Waste Management

To address the interplay of domestic solid waste and urban flood risk, a city needs to first and foremost establish waste collection and transport systems. If domestic waste is effectively removed from the city landscape, it would prevent any from accumulating and blocking city drainage systems, which causes flooding and public health issues. Citywide services are critical to provide residents a clear way to dispose of waste generated.

However, if a city is to collect waste, there needs to be a place for the waste to go. Hence, investment in waste collection and transport must inherently include investment in the entire waste stream. The most simple and quickest approach is to establish a sanitary landfill, where waste can be responsibly disposed in a manner that minimizes environmental and health risks, as shown in Figure 4-5 as a combination of W1, W2, and W4. Kitakyushu additionally made early investments in waste treatment (incineration) to increase efficiency and sanitary conditions at the landfill, and hence is shown as W3 in Figure 4-5. These foundational services to establish waste collection and waste transport are referred to in this section as basic waste management services. Priority is placed on immediate improvements on living conditions within the city.

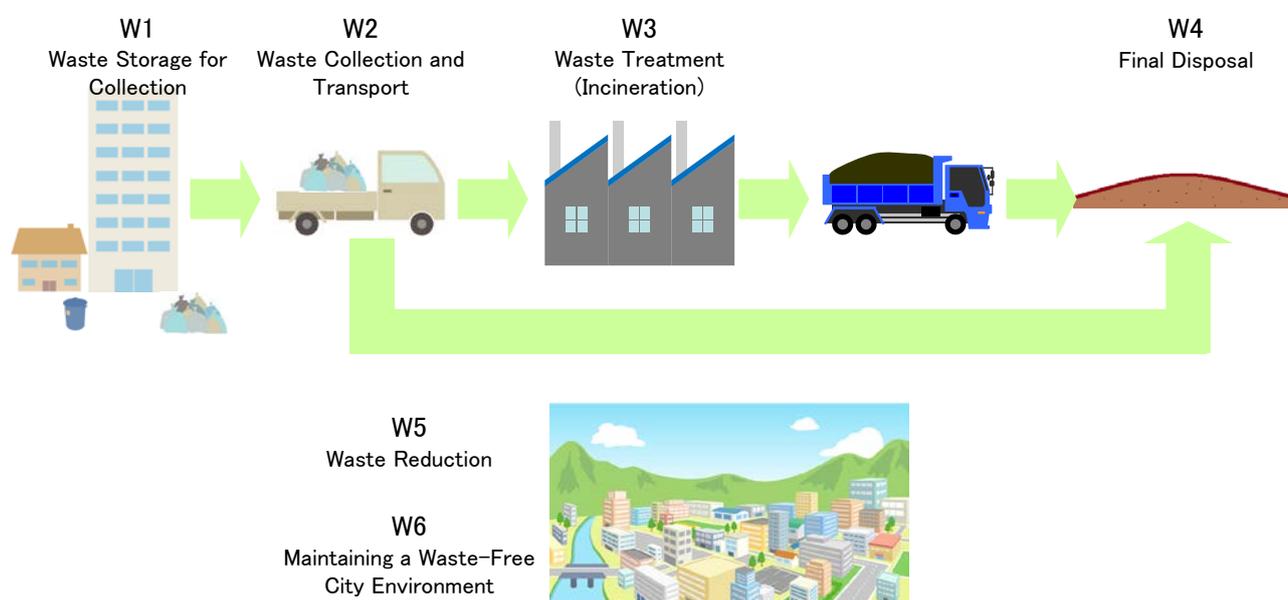


Figure 4-5. Service Flow of Basic Solid Waste Management

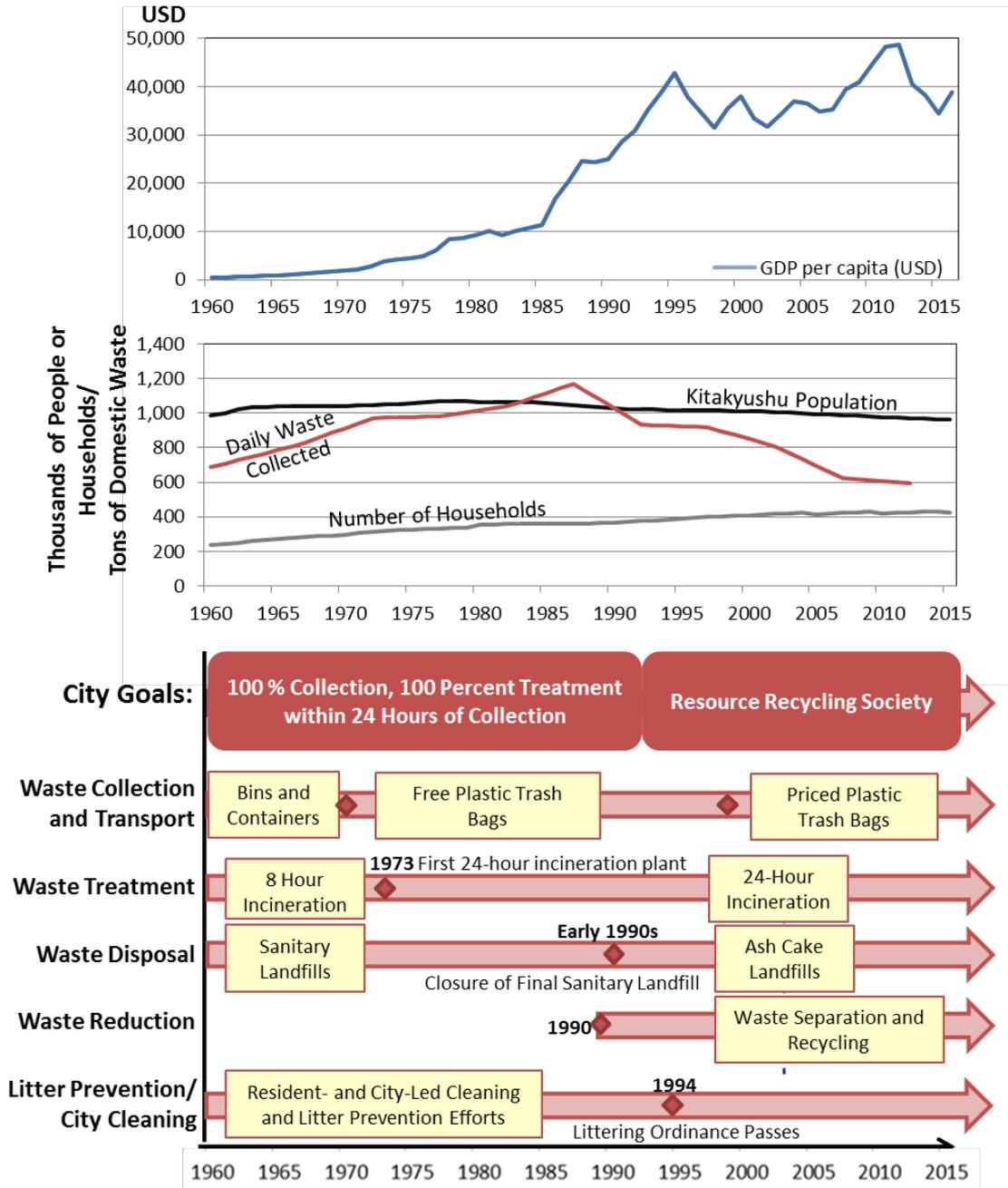
However, waste management services that lead to waste disposal is neither best practice nor the most socially or environmentally sustainable. This one-directional waste stream extracts raw resources from the environment to produce a product, which is maybe used once to fill a landfill at the end. Such use streams place heavy burdens on the environment and city services. Life-cycle thinking provides healthier alternatives by focusing on prevention, minimization, or reduction of resources use and by identifying opportunities to reuse, recycle, or recover resources from waste. Reducing environmental and resources demands throughout the product life cycle also helps reduce emissions of greenhouse gases and mitigate climate change. Kitakyushu is committed to this alternative, sustainable, life-cycle approach to waste management.

Nonetheless, the focus of this model is on the interplay of solid waste and urban flood risk. The model covers waste reduction (W5 in Figure 4-5) as important actions that improve waste services and directly help reduce flood risk. Extended discussion of product life cycles and recycling are, however, outside the scope of this model. Refer instead to Kitakyushu Model sector “Waste Management” for more in-depth information.

Finally, options to address residual waste that did not get collected by basic city services are collected in W6 under the title “Maintaining a Waste-Free City Environment.” Example actions include cleaning city public areas and identifying non-city-sanctioned dump sites. These actions, often requiring heavy resident involvement, fill in gaps in waste collection services to achieve a clean, livable city.

4.4.1 Solid Waste Management and Kitakyushu Development

Kitakyushu’s initial purpose for providing waste management services was to improve sanitary and living conditions in the city. Figure 4-6 shows that the amount of waste collected and GDP rose until roughly around 1990, independent from population growth. This increase is consistent with the global trend that industrialization itself increases waste generation. Data shown in Figure 4-6 is limited strictly to waste collected by city services, so it most likely underestimates actual waste generated.



Data Sources:

GDP per capita: Economic and Social Research Institute, 2015 and International Monetary Fund, 2017
 Kitakyushu Population, Number of Households, and Daily Waste Collected: Kitakyushu City, 2014

Figure 4-6 Solid Waste Management and Kitakyushu Development

The lower half of Figure 4-6 simultaneously shows that Kitakyushu made early investments in solid waste management services, predating the rise in GDP and possibly, improvements in living standards. By the 1960s, the city already provided some form of waste collection, incineration, and disposal services. Until the early 1990s, the city focused on improving effectiveness and efficiency of the existing system by, for example, improving collection systems, addressing littering, and improving incineration plants to be more

economical and environmentally responsible. Kitakyushu aimed to collect 100 percent of domestic waste and to treat and dispose of it within 24 hours.

However, waste generation not only increased but also diversified as the standard of living improved. Facing concern that the traditional treat and dispose method of waste management would become insufficient and strain existing landfills, Kitakyushu reexamined the entire waste stream and decided in the first half of the 1990s to shift city goals to become a resource recycling-based society. Kitakyushu invested in public outreach and resident meetings to ask everyone to sort waste into different categories, such as cans, different types of plastics, and paper, so that each could be recycled or treated accordingly. Plastic and paper recycling companies emerged. Manufacturing industries also committed to reforming their production and resource re-extraction lines, and took responsibility for recollecting used appliances and products. Overall, Kitakyushu did not experience much resistance from residents, as they were generally cooperative and supported the city's effort to become more sustainable.

Once in the 21st century, the city put into effect the Kitakyushu City Basic Environmental Plan, which set a new vision to become a low-carbon emitting, sustainable society. Kitakyushu sees solid waste management as an integral component in addressing climate change. Managing waste disposal appropriately by, for example, minimizing open dumping and reducing air pollution and gas emissions from waste incineration, can play a small but important part in mitigating global climate change. Reduction in resources use and promoting recycling of heavy metals can also decrease raw resources extraction demands and help save energy throughout the product life cycle. This further reduces GHG emissions. Kitakyushu recognizes that these local climate change mitigation efforts, if implemented on a global scale, could ultimately help reduce climate change impacts. Such impacts include the extent of unpredictable, extreme rain events, which plays a role in increasing urban flood risks today.

4.4.2 Actions for Solid Waste Management

Table 4-4 lists actions included in this subsection. Actions W1 to W4 are grouped together as actions that help establish basic waste management services. W1, W2, and W4 specifically lay important foundations that allow for most other actions in this model to be effective (Refer to Table 4-2). These actions pertain to the following goals of basic waste management services:

- Collect 100 percent of waste produced within the designated area (e.g. city or town limits)
- Treat and/or dispose all collected waste in the same day
- Set collection frequency and treatment methods that promote a sanitary environment

As depicted in Figure 4-6, Kitakyushu went through an early stage of establishing waste management services and improving resident living conditions before shifting focus to become a more waste-conscious, resource-recycling society. While priority goals or evolution of solid waste management services may still be consistent with this Kitakyushu history, cities today need not follow this progression exactly. Early efforts to reduce waste produced and collaborate with manufacturers to identify alternative resources recycling options can widen waste management options in the future. Hence, these actions are organized under W5.

Finally, this subsector concludes with W6, which consists of actions that generally involve residents to clean and manage waste left behind by city collection services, including those accumulated in drainage canals.

Table 4-4. Overview of Solid Waste Management Actions

Solid Waste Management	
<i>Actions to Establish Basic Waste Management Services</i>	
W1. Waste Storage for Collection	<ul style="list-style-type: none"> W1-1. Fix Waste Bins at Each Household W1-2. Use Portable Containers at Each Household W1-3. Use Standard Plastic Trash Bags W1-4. Set Collection Stations for Groups of Households
W2. Waste Transport	<ul style="list-style-type: none"> W2-1. Use Collection Vehicles W2-2. Use Compaction Collection Vehicles
W3. Waste Treatment (Incineration)	
W4. Final Disposal	
<i>Actions to Improve Waste Management</i>	
W5. Waste Reduction	<ul style="list-style-type: none"> W5-1. Separate Waste W5-2. Collaborate with Manufacturers W5-3. Charge Fees for Waste Disposal
W6. Maintaining a Waste-Free City Environment	<ul style="list-style-type: none"> W6-1. Identify Waste Accumulation/Dump Sites W6-2. Collect Bulk Waste Periodically W6-3. Install Waste Bins in Public Areas W6-4. Encourage Residents to Maintain a Clean Environment

Figure 4-7 presents the above actions relative to their ease of implementation. Actions that are more complex to implement may require more technical expertise or resources or higher financial investment. Actions that are presented towards the left side are relatively simpler to implement. Figure 4-7 is strictly conceptual and what is appropriate and feasible in each country or city differs depending on realities and conditions on the ground.

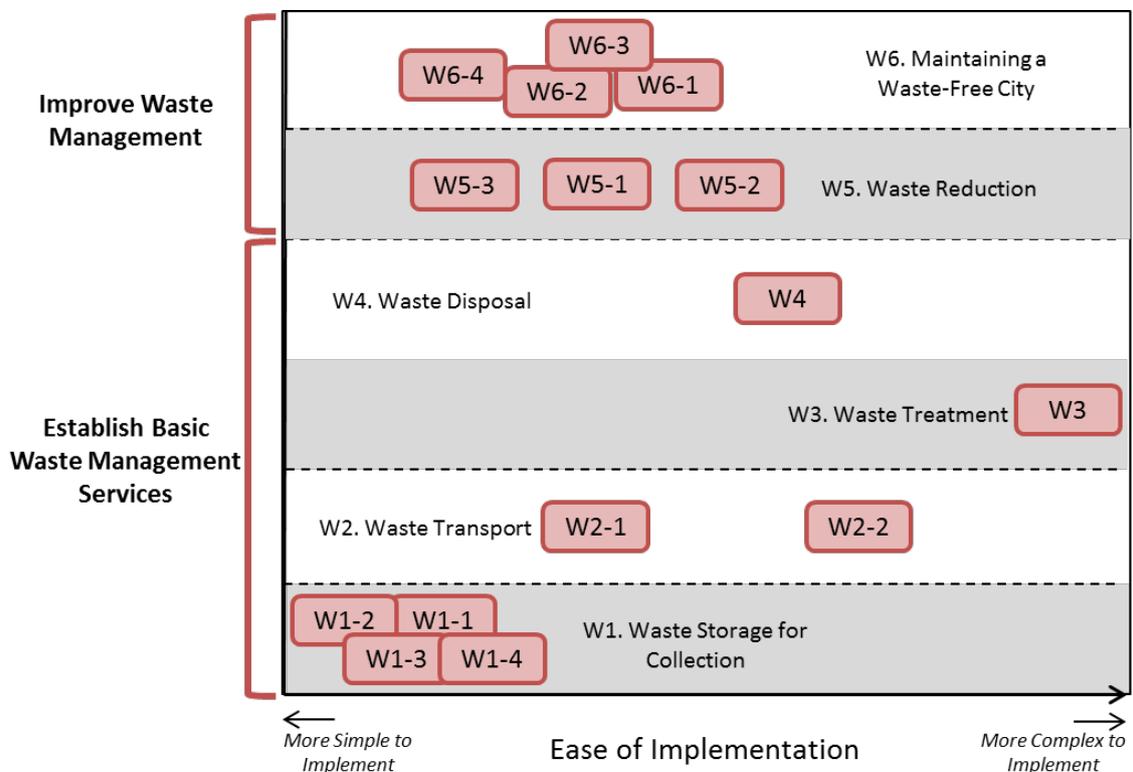


Figure 4-7. Ease of Implementation of Solid Waste Management Actions

Actions to Establish Basic Waste Management Services

W1. Waste Storage for Collection				
<p>Purpose/Introduction</p> <p>Daily domestic waste should be properly stored at each household or community for both ease of waste collection and hygiene. Proper waste storage and collection removes waste from any runoff during rain events and hence, removes it from entering the urban drainage system.</p> 				
W1-1. Fix Waste Bins at Each Household				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Mid	\$	Low	Residents, Community	High
<p>Advantages</p> <ul style="list-style-type: none"> • Cheap to build, using local resources • Cannot be stolen • Easy to maintain • Secures waste in one location 		<p>Disadvantages</p> <ul style="list-style-type: none"> • Can become unhygienic if not cleaned properly or structured inadequately (e.g. no covers) • Vulnerable to rain, vectors/animals, and scavengers • Difficult to collect waste for transport 		
W1-2. Use Portable Containers at Each Household				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Short	\$	Low	Residents, Community	High
<p>Advantages</p> <ul style="list-style-type: none"> • Can be easy and cheap to purchase • Easy to empty and clean • Has a cover to protect contents from rain and vectors • Secures waste in one location 		<p>Disadvantages</p> <ul style="list-style-type: none"> • Easily stolen or lost • Can be costly, depending on material • Vulnerable to scavengers 		
W1-3. Use Standard Plastic Bags				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Recurrent	\$\$	Mid	Residents, Community	High
<p>Advantages</p> <ul style="list-style-type: none"> • Standardizes the waste disposal method • Improves efficiency of waste collection • Limited need to clean, as waste collection takes care of the entire plastic trash bag. No bin or container to clean • Reduces injuries during waste collection 		<p>Disadvantages</p> <ul style="list-style-type: none"> • Requires budget and a continual supply and distribution of plastic trash bags • Increases use of plastic bags and pollution, especially if plastics are not treated and simply disposed 		
W1-4. Set Collection Stations for Groups of Households				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Recurrent	\$\$	Low	Residents, Community	High
<p>Advantages</p> <ul style="list-style-type: none"> • Easy to set and clean • If covered, can protect contents from rain and vectors • Keeps waste from spreading • Keeps waste out of public view • Simplifies waste collection and transport by limiting pickup points 		<p>Disadvantages</p> <ul style="list-style-type: none"> • May be difficult to find or come to a consensus about location • Someone needs to be delegated to maintain the collection station and possibly discourage scavengers • Can be vulnerable to rain, scavengers, vectors, and animals 		
Important Considerations				
<ul style="list-style-type: none"> • Determine if any entity is currently collecting certain types of waste. Scavengers or CBOs, for example, may be collecting recyclables and other waste that can provide financial income. Reach out to these entities and consider if and how they could participate in the city’s waste collection services. • Regardless of the storage and collection method, covering and enclosing waste is important to keep out rain and vectors and to keep waste from spreading. 				

Performance Indicators
<ul style="list-style-type: none"> • Amount and prevalence of waste accumulation • Hygienic condition in the designated/communities • Number of households following the designated waste collection and storage method • Compliance of residents to designated disposal method

W1-1. Fix Waste Bins at Each Household

Description

Fixing waste bins outside of each household clearly designates to both residents and waste collectors where to place/pick up waste. Fixed waste bins can be made of locally available materials, such as wood or bricks, although having a common design helps increase waste collection efficiency. Common designs can also improve aesthetics of scenery in the designated area/community.



Necessary Existing Conditions

- Willingness to pay for installation of fixed waste bins by each household
- Resident understanding and trust that waste will be collected if placed in these bins. Consider holding a resident meeting (E2-1, E4-1)

Important Considerations

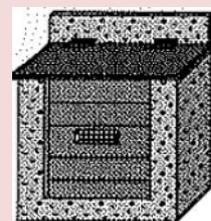
- **Affordability:** Determine how much it costs households to install fixed bins. Can households afford this cost? Does the government need to provide assistance? How long can the suggested design be used?
- **Size:** Determine size according to both amount and type of waste generated and planned collection frequency. Also consider whether the size is aesthetically and physically acceptable (e.g. is it so big that it will block traffic?)
- **Material:** Choose materials according to what is locally available and the desired longevity. Wood, for example, may decompose faster than brick if raw food waste is being stored
- **Design:** Entirely contain the waste to protect against animals, vectors, scavengers, odor, and weather. The bottom should be smooth and hard. Elevate the bin off the ground.
- **Ease of Use:** Design the bin so that it is easy for households and waste collectors to use. For example, elevating bins above ground and having doors that open at the front may be easier for households to use and clean the inside, and help waste collectors sweep or scoop waste out.
- Ensure the design and location is culturally and socially acceptable
- Consider whether residents in informal settlements require different needs

The Kitakyushu Experience

Kitakyushu residents installed and used fixed waste containers up until about the 1960s. The bins were made of concrete with a flip cover top and latched front door. The bins were placed over the drainage canal running by homes and lined and faced the street for easy waste collection. Setting permanent waste bins had the following benefits.

- Improved aesthetics of the neighborhood
- Improved hygiene
- Minimized waste from interfering with traffic
- Increased work efficiency and hygienic condition of waste collection.

Kitakyushu provided financial incentive to residents to purchase and install such containers.



Financing and Resources

- Budget for installation, whether by the government or households
- Resident time and effort to clean and repair these fixed waste bins
- Cost to disseminate information (e.g. websites, brochures, commercials)

Operation and Maintenance

- Periodic cleaning to maintain a hygienic environment
- Outreach to residents if disposal methods are not being followed

W1-2. Use Portable Containers at Each Household**Description**

Portable containers are an alternative to fixed waste bins. Portable containers can make waste collection more efficient, as the containers can be moved to suit household preferences and then carried to convenient locations to assist waste collection. Portable containers can be of various sizes and materials, such as

- Small plastic containers with covers
- Steel drums (no cover)

Necessary Existing Conditions:

- Willingness to pay for waste containers by each household
- Resident understanding and trust that waste will be collected if placed in these bins. Consider holding a resident meeting (**E2-1, E4-1**)

Important Considerations:

- Consider whether it is more feasible to have each household purchase a waste bin from nearby stores or manufacturers or whether it makes more sense for the city government to design standardized, effective portable waste containers.
- **Affordability:** Determine how much it costs households to purchase waste bins. Can households afford this cost? Does the government need to provide assistance? How long can the bins be used?
- **Size:** Each household could determine the size they need, according to the amount and type of waste generated, planned collection frequency, and ease of lifting and transporting.
- **Material:** Choose materials according to cost, durability, and weight. Plastic tends to be the cheapest and lightest but perhaps the least durable to weather and use.
- **Design:** A bin that is easy to transport and clean would be the most effective. If a city government is to design its own portable waste containers, consider adding wheels or covers attached by hinges so that the top does not blow away. Heavier plastics can be used to improve durability but keep the container light.
- **Collection Method:** Determine how to collect waste from portable bins. Do residents need to bring it out when the waste collection service comes? Alternately where should residents leave bins near the street, so that it does not interfere with traffic?
- Ensure planned systems are culturally and socially acceptable
- Consider whether residents in informal settlements require different needs and adjust accordingly

Financing and Resources:

- Budget to purchase containers, whether by the government or households
- Resident time and effort to clean waste containers
- Cost to disseminate information (e.g. websites, brochures, commercials)

Operation and Maintenance:

- Periodic cleaning to maintain a hygienic environment
- Outreach to residents if disposal methods are not being followed

**The Kitakyushu Experience**

Kitakyushu used light, portable, plastic containers up until about 1970. Use of bins made collection efficient and had the following benefits.

- Improved aesthetics of the neighborhood
- Improved hygiene
- Minimized waste from interfering with traffic
- Increased work efficiency and hygienic condition of waste collection.

However, there were some issues, such as

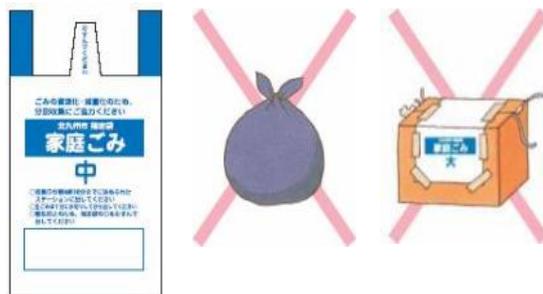
- Empty containers were easily blown around by the wind
- Plastic was easily damaged by sunlight
- Containers were easily stolen

Hence, each household had to keep an eye out for their containers or invest in new containers when needed.

W1-3. Use Standard Plastic Bags

Description

City plastic bags helps improve efficiency of waste collection because they contain waste not only during storage but also throughout the collection process. They also minimize pests/vectors and odors. Because each bag is used only one time, it need not be the most durable of materials.



Necessary Existing Conditions

- Resident understanding and trust that waste will be collected if placed in bags. Consider holding a resident meeting and disseminating information (E2-1, E4-1)
- Resident access to a continual supply of standardized plastic bags
- Distribution system of the city plastic bags to all households
- Willingness to use and potential pay for city plastic bags

Important Considerations

- Certain rules are necessary to control what types of plastic bags can be used. Each has advantages and disadvantages
 - City produces/purchases standardized clear bags and require that particular plastic trash bag to be used
 - Affordability: the city needs to consider cost of purchasing or producing standardized bags as well as a way to distribute these bags. Bags could be sold in local stores, which relatively simplifies the city’s role in distribution, or delivered directly to residents, perhaps by using the local postal system.
 - Cost to residents: Consider whether it is more feasible to have each household purchase city plastic trash bags or whether it makes more sense for the city government to distribute them free of charge.
 - Collection: Easiest and safest to collect, as appearance and size of bags are standardized and workers can see the contents inside the bag
 - The city designates use of transparent/translucent bags
 - Affordability: Cheaper for the city, as residents can use bags that are convenient to them.
 - Collection: Easy and safe to collect, for workers can still see the contents inside the bag.
 - Residents can use any plastic bag
 - Affordability: Easiest for residents, as they can use any bag that is convenient.
 - Collection: Less safe for workers, as opaque bags can hide possibly dangerous content that could injure workers. Surprisingly heavy bags can also lead to worker injuries, such as back pain, over the long term
- Collection system: Determine how and when these plastic bags should be left out for collection. Chosen locations should be frequently enough placed and located out of the way so that they do not interfere with traffic

The Kitakyushu Experience

Kitakyushu chose to provide residents with standardized, transparent plastic bags to dispose of waste starting around 1970. The city first conducted a pilot run of using these bags in specific areas, and then collaborated with neighborhood associations to establish this system throughout the city.

The city initially distributed free plastic trash bags to households, which was successful in establishing a proper waste collection system while nurturing society acceptance.

However, there was, understandably, opposition when the city later started to charge residents for the same plastic bags. It may be wiser to charge residents for bags from the beginning. Public outreach and consensus building would be critical to initiate a fee-based system. (See W5-3)

Financing and Resources

- Production cost of standard city plastic trash bags
- Distribution cost of the plastics bags (e.g. physical distribution means, human resources)
- Cost to disseminate information (e.g. websites, brochures, commercials)

Operation and Maintenance

- If the city is producing/purchasing its own bags, maintenance of that relationship
- Outreach to residents if disposal methods are not being followed

W1-4. Set Collection Stations for Groups of Households**Description**

Waste collecting stations could simplify waste collection processes, especially in areas where the housing density is high, there are many high-rise buildings, or narrow roads limit ease of waste collection.

**Necessary Existing Conditions**

- Cooperation among households at each collection station to maintain the collection station.
- Waste storage/disposal by portable waste containers or plastic bags

Important Considerations

- Setting station locations:
 - Consider the amount of waste that will be generated and the space available.
 - Make sure a collection station is not uncontrollably large.
 - Ensure it will not pose traffic safety issues.
 - Locate stations along easily accessible routes as much as possible.
 - Check that locations are culturally and socially acceptable
- Set clear collection times and dates and adhere to them.
- Establish rules about how to put out waste. Does it need any specific protection from pests/vectors? From precipitation? Is bad odor an issue?
- Support residents establish clear rules to maintaining the station. If they need to purchase any materials, such as nets, large but easily collapsible bins, and brooms, establish a fair, agreed on system to do so. Solicit help from or ask neighborhood associations or any other local CBOs to support this effort.
- Consider whether residents in informal settlements require different needs and adjust accordingly
- Consider whether there is need for government assistance to residents when setting waste collection station.

Financing and Resources

- Resident time and effort to maintain collection stations
- Cost for public outreach and disseminating information

Operation and Maintenance

- Periodic cleaning to maintain a hygienic environment
- Outreach to residents if disposal methods are not being followed

The Kitakyushu Experience

In Kitakyushu, waste collection stations are set for small groups of households or an entire high-rise building. Some problems included:

- Odor
- Waste scattering and leaching due to improper storage
- Punctured bags and waste scattering from animals/birds
- Improper dumping during non-designated times
- Improper maintenance

Households belonging to each collection station need to set clear rules to prevent the above problems, such as

- Setting a clear time for waste disposal (e.g. 6am-9am)
- Covering waste by nets or disposing waste bags into bigger crates to limit waste scattering
- Establishing cleaning duties among residents

It is essential to involve residents to ensure station maintenance. This may require investment in public outreach and providing information to inform residents.



W2. Waste Transport				
<p>Purpose/Introduction</p> <p>Proper waste transport requires selecting an affordable method, purchasing necessary vehicles and laborers, and setting practical waste collection routes that cover the entire jurisdiction. Furthermore, means to secure and protect waste on vehicles are needed so that waste scattering and odor issues are limited.</p>				
W2-1. Use Collection Vehicles				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Procurement: Short Operation: Recurrent	\$\$	Low	Private Companies (for outsourcing)	High
<p>Advantages</p> <ul style="list-style-type: none"> Allows transfer of large volumes of waste over a long distance 		<p>Disadvantages</p> <ul style="list-style-type: none"> Requires capital and O&M cost Requires workers for loading and lifting waste Unhygienic working environment Air and noise pollution 		
W2-2. Use Compaction Collection Vehicles				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Procurement: Short Operation: Recurrent	\$\$\$	Mid	Private Companies (for outsourcing)	High
<p>Advantages</p> <ul style="list-style-type: none"> Allows transfer of large volumes of waste over a long distance Easier to control waste Requires fewer workers A more hygienic working environment 		<p>Disadvantages</p> <ul style="list-style-type: none"> High capital and O&M cost Air and noise pollution Requires more technical knowledge for O&M 		
Operation and Maintenance				
<ul style="list-style-type: none"> Commit to collecting all waste in planned areas everyday Maintain records on collected waste volume, used fuel, and working hours Revise routes when necessary to increase efficiency Perform routine vehicle maintenance and repair vehicles 				
Performance Indicators				
<ul style="list-style-type: none"> Proportion of domestic waste collected in the city/community Locations that waste collection vehicles never come and the frequency of this occurring Number of total hours required to collect waste daily and weekly Number of working staff and their hours. Number of staff experiencing work-related injuries or sickness Number and type of complaints from residents 				
Alternative Actions				
<p>A more affordable alternative to purchasing or hiring vehicles is to rely on non-motorized vehicles/carts drawn by people, bicycle, or animals. Benefits include:</p> <ul style="list-style-type: none"> Low capital and O&M cost Air and noise pollution free Easier access into narrow streets, including informal settlements <p>Disadvantages include:</p> <ul style="list-style-type: none"> Each vehicle has limited transfer volume and coverage area Heavy reliance on human labor Waste easily spills from the vehicles/carts <p>Non-motorized systems of waste transport will more likely involve individual workers or CBOs. The city will need to work closely with these workers, agree on proper compensation, decide if the city will provide any tools and materials, and monitor and supervise their effectiveness.</p>				

W2-1. Use Collection Vehicles**Description**

Simple collection vehicles allow for transfer of large quantity of waste compared to using non-motorized vehicles, although larger vehicles cannot access narrower roads. Collection vehicles include the following options.

- Open trucks
- Tractors
- High-sided, open top vehicles
- Front-loading, high-sided, enclosed vehicle.

Open top vehicles need to be covered during waste transport to prevent waste from scattering.

Necessary Existing Conditions

- Understanding of locations of waste collection stations, and estimated waste to be collected at each stop

Important Considerations

- Plan collection routes that will cover all waste collection stations. Aim for efficiency.
- Collection should occur frequently enough to prevent unsanitary conditions.
- Determine the number and type of vehicles as well as the number of workers necessary
- Ensure vehicles have the capacity to transport the volume of waste to be collected along that route. Make sure that assigned vehicles can access and fit on those roads. Avoid times of heavy traffic or congested roads.
- If there are inaccessible neighborhoods, such as informal settlements, work with community leaders to develop a mutual solution.
- Determine whether there is a need for waste transfer stations to streamline waste collection. For example, if the final landfill or waste treatment site is far, it may make sense to establish a waste transfer station to “hand off” waste to another fleet of vehicles.
- Consider whether the city can hire one or several private companies to perform this service. While this will simplify city’s responsibilities, private companies may push back should less waste be generated in the future and the need for collection decreases.
- Consider the emotional and physical stress placed on waste collection workers, especially if society sees this job as of lower status. Cooperate with workers to improve work conditions, decrease odors and increase cleanliness. Consider having workers participate in educating children about waste.

Financing and Resources

- Budget to purchase or hire vehicles, workers, and necessary fuel
- Budget and capacity to purchase spare parts and perform necessary O&M
- Budget for work clothes, protective gear such as boots and gloves, and tools
- Human resources to plan, monitor, and implement collection routes

**The Kitakyushu Experience**

The Kitakyushu area began waste collection using open trucks prior to its establishment in 1963. Waste collection was provided 3 times a week to all residents, including to those living in informal settlements.

As refrigerators become more prevalent and raw food waste made up a smaller proportion of generated and collected waste, waste collection of this general waste was reduced to twice a week.

The Kitakyushu Experience

At the onset of city waste collection services, society considered waste collection workers to be of low social status. Working conditions were unsanitary, the work was physical, and the social norms placed additional mental and emotional tolls on the workers.



In Kitakyushu, the workers then staged strikes demanding improvements of their work conditions. Waste was uncollected during the strike period, and waste accumulated throughout the city for a week, which began causing human health concerns. Ultimately, the city government accepted union offers and improved worker working conditions by limiting working hours and wages. Today, working conditions have drastically improved, especially with the use of plastic trash bags, advances in technology that limits odors, and increases in resident awareness. Waste collection has become a respectable job.

W2-2. Use Compaction Collection Vehicles**Description**

Use of compaction vehicles increases the volume of waste each vehicle can carry as well as improve hygiene conditions for workers. However, higher technical capacity is needed to perform appropriate O&M of these vehicles. Compaction vehicles includes:

- Rear-loading hydraulic compactor
- Screw compactor
- Rating drum compactor

**Necessary Existing Conditions**

- Availability and affordability of compaction vehicles, spare parts, and O&M personnel
- Availability of trained workers and drivers to use these vehicles
- Understanding of locations of waste collection stations, and estimated waste to be collected at each stop

**Important Considerations**

- Plan collection routes that will cover all waste collection stations. Aim for efficiency.
- Be aware of waste that should not be compacted, for example aerosol cans that are still pressurized. If residents do not dispose of waste appropriately, it can lead to worker accidents and injuries
- Determine the number and type of vehicles as well as the number of workers necessary
- Ensure vehicles have the capacity to transport the volume of waste to be collected along that route. Make sure that assigned vehicle can access and fit on those roads. Avoid times of heavy traffic or congested roads as possible.
- If there are inaccessible neighborhoods, such as informal settlements, work with community leaders to develop a mutual solution.
- Determine whether there is a need for waste transfer stations to streamline waste collection. For example, if the final landfill or waste treatment site is far, it may make sense to establish a waste transfer station to “hand off” waste to another fleet of vehicles.
- Consider whether the city can hire one or several private companies to perform this service. While this will simplify city’s responsibilities, private companies may push back should less waste be generated in the future and the need for collection decreases.
- Consider the emotional and physical stress placed on waste collection workers, especially if society sees this job as of lower status. Work with the workers to improve work conditions, decrease odors and increase cleanliness. Consider having workers participate in educating children about waste.

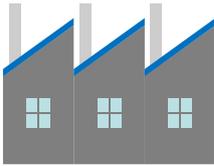
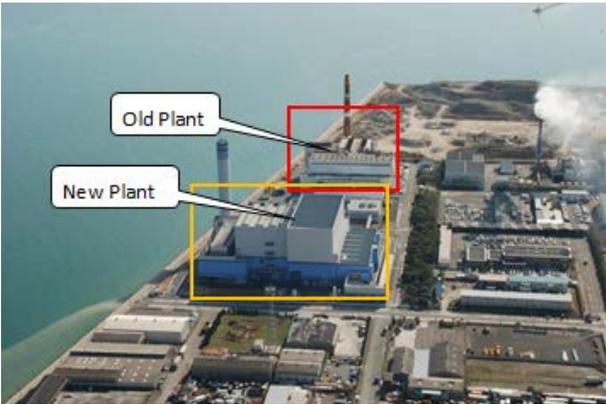
The Kitakyushu Experience

As mentioned under important considerations, some domestic waste should not be compacted, such as aerosol cans which can leak flammable gas during compaction. There are cases in Kitakyushu where workers are injured because residents dispose of these materials inappropriately.

As one way to address this issue, Kitakyushu disseminates information to residents, asking them to entirely use or release the can contents prior to its disposal.

Financing and Resources

- Budget to purchase or hire vehicles, workers, and necessary fuel
- Budget and capacity to purchase spare parts and perform necessary O&M
- Budget for work clothes, protective gear such as boots and gloves, and tools
- Human resources to plan, monitor, and implement collection routes

W3. Waste Treatment (Incineration)				
<p>Purpose/Introduction</p> <p>Incineration reduces waste volume to less than a quarter, increasing longevity of existing landfills. Incineration also kills any pathogens, so the resulting ash is more hygienic than waste left untreated. However, incineration plants need to be properly designed and operated to handle or reduce emissions of harmful pollutants. Planning, design, and construction require high capital investment and technical capacity.</p>				
<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Construction: Long Operation: Recurrent	\$\$\$	High	Engineers, Private Companies (if outsourcing)	High
<p>Advantages</p> <ul style="list-style-type: none"> Reduces waste volume and pollution in landfills, allowing for cleaner and longer use of the same landfill Manages large volumes of solid waste If running a 24 hour incineration plant, the plant can produce heat and electricity Ash produced at high temperatures can be recycled and mixed in with cement to form concrete Eliminates production of methane gas in landfills 		<p>Disadvantages</p> <ul style="list-style-type: none"> High capital and O&M costs Requires highly skilled engineers and technology to design, operate, and maintain the plant Proper incineration processes and treatment of emissions are necessary to control dioxin emissions and other sources of air pollution 		
<p>Description</p> <p>While it is possible to operate a non-24-hour incineration plant, it has many drawbacks, such as:</p> <ul style="list-style-type: none"> Relighting and reheating the plant to the necessary temperature everyday requires fuel, while once running, an incineration plant produces energy it needs to keep operating A 24 hour plant can produce enough energy to provide excess electricity and heat to nearby users Emissions and ash produced during warming up and cooling down includes harmful pollutants which are released into the environment <p>Hence, this action promotes and provides information for a 24-hour incineration system. It is estimated that a 24 hour system becomes possible with a daily waste incineration demand of 2,000 to 3,000 tons.</p>				
<p>Necessary Existing Conditions</p> <ul style="list-style-type: none"> Technical capacity to design, construct, operate, and maintain plants and facilities, including mechanics and operators Sufficient waste collection volume to make the incineration process efficient Workers on shifts that accommodate a 24-hour schedule Landfills to accommodate generated ash 		<p>The Kitakyushu Experience</p> <p>Land acquisition and getting resident agreement for construction of incineration plants (and landfills) are generally difficult. It usually instigates a not-in-my-backyard attitude and requires consideration of environmental justice issues.</p> <p>To obtain resident agreement, Kitakyushu offered to construct community facilities, such as playgrounds, a multipurpose sports field, a swimming pool, and gymnasiums, and develop incineration plant tour courses, as compensation for inconveniences.</p> <p>Construction of such facilities was possible, because Kitakyushu had acquired double the size of necessary land, looking ahead 30 to 40 years, when a new plant will have to be constructed. The city planned to construct the new plant while the old plant would still be in commission. Hence, these community facilities were built on open, unused land until construction for</p>		
<p>Important Considerations</p> <ul style="list-style-type: none"> Incinerate all collected waste within 24 hours for sanitary reasons Waste Characteristics: incineration process must match waste composition, volume, density, and water content Land Acquisition: <ul style="list-style-type: none"> Locate plants where there will be minimal impacts to the environment and communities but not too far 				

from the city and landfills.

- Choose a location that is also safe from natural disasters
- Consider the waste transportation route and whether existing roads can accommodate this increased truck traffic. Nearby residents may also not appreciate a constant stream of waste trucks. If needed, acquire land, plan, and construct alternative roads.
- Design: Consult specialists in the area. The incineration process should be at a high enough temperatures, for example, over 800 degrees C to eliminate dioxins in emissions, to reduce hazardous or toxic substances in emissions and in remaining ash
- Determine the number of plants according to waste volumes and ease of collection
- Realize that all machinery/processes/plants cannot be used during required maintenance and repair. Determine if the plant needs to be designed to include backup or excess incineration capacity to allow for proper maintenance
- Consider whether the city incineration plant needs to also accommodate waste other than domestic waste or if the city is going to require businesses to be responsible for disposing of their own commercial waste. If the city is to accommodate commercial waste, design the plant with incineration needs of that waste in mind.



Financing and Resources

- Capital and recurrent cost for plants and facilities
- Skilled human resources. If needed, consider outsourcing plant operations, maintenance, and/or repair to private businesses for increased efficiency and hiring of more specialized workers.
- A 24-hour incineration plant allows electricity and heat production to fuel the process itself and also to sell it back to the city or nearby industries.
- If the city is treating trash for non-household entities, such as commercial businesses or industries, consider if the city should charge them a fee for the service

Operation and Maintenance

- Ignition and extinction as necessary for 24 hours operation
- Monitor key plant indicators to ensure proper operations of plant processes, such as incineration temperature, air flow, and flow of waste through the process.
- Perform preventive maintenance and repairs as necessary
- Plant parts can be renovated in sections, but this rotational renovation results in the instrumentation and equipment process to be entirely replaced in about 30 years
- Consider full plant renovations to improve building structures and to install new technologies if relevant

Performance Indicators

- Various environmental indicators, such as air pollution concentrations, noise, and odor
- Number of complaints from residents
- Frequency and volume of waste that does not get incinerated within 24 hours
- Volume of waste treated daily

The Kitakyushu Experience

To improve safety and reliability of waste treatment and control impacts to the environment and residents Kitakyushu has taken the following actions.

- Prepare an accident prevention plan
- Establish a registration system for private sector incineration plants
- Require registered private businesses to prepare their own plans to minimize impacts to the environment and residents

The Kitakyushu Experience

Kitakyushu opened its first batch process-based incineration plant in 1952 for the following reasons.

- Lack of landfill space. Incineration allows for longer use of each landfill
- Waste is prone to quick decomposition and attracts vectors in Kitakyushu's warm, humid climate, while a lack of space means any landfill of untreated waste will still be located in close proximity to residents. Incineration provided a more sanitary option, for instance, reducing risk of diseases and rats, with less environmental justice issues

Kitakyushu opened its first 24-hour incineration plant in 1973 and hired a heavy industry-based private company to manage operations. 24-hour incineration was the chosen alternative, because:

- Waste volume increased
- Hazardous emissions would be reduced
- The incineration process would be more efficient and produce constantly higher quality ash

Kitakyushu estimated design capacity of the plant assuming a daily waste generation rate of 1kg per capita. The Japanese national government provided a 50 percent subsidy for the plants, as one way to help clean and mitigate for the environmental pollution in the area.

Alternative Actions

Refer to the sector model "Waste Management" of the Kitakyushu Model for alternative treatment methods, such as gasification, refuse derived fuels, and pyrolysis. Recycling, composting, and resources extraction could be approached also as alternatives to waste treatment that prevents waste from being landfilled.

Action W4. Final Disposal (Sanitary Landfills)

Purpose/Introduction

Open dumping has many disadvantages, such as generation of odor, spread of communicable diseases, groundwater pollution from leachate, generation of methane gas, and scavenger injures. Properly managed landfills, in contrast, provide a more hygienic environment with improvements to reduce environmental impacts.



<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Construction: Mid-Long Operation: Recurrent	\$\$\$	High	-	-

Advantages

- Reduces negative environmental impacts to water resources, air quality, and climate change with proper management
- Reduces risk of spread of communicable diseases

Disadvantages

- Requires expansive land or space
- Requires operation and maintenance, including heavy machines for spreading, compacting and covering waste on land
- Possible to generate gas and odor through poor O&M
- Possible to access waste picker with poor O&M

Description

Sanitary landfills are designed dumpsites, usually consisting of layers of soil/aggregate, liners, covers, and a way to release generated gas, so that environmental impacts can be minimized.

Sanitary landfills can be designed to accommodate a variety of waste. A landfill dedicated to disposing ash cakes from incineration plants would require less protection in both design and O&M compared to a generic landfill that accepts untreated waste.



Necessary Existing Conditions

- Sufficiently sized access roads that allows easy movement of heavy machinery and trucks for waster transport and site management
- Availability of necessary heavy machinery and their operators
- Technical human resources, such as environmental engineers and planners, with understanding of landfill design and pollution management
- Land or landfill spaces at affordable prices

Important Considerations

- Site selection
 - Perform geotechnical studies of potential sites. Choose a location that minimizes risk of groundwater/surface water contamination
 - Strike a balance between locating the landfill far enough to reduce negative impacts to nearby residents but close enough to waste collection areas or treatment plants to reduce transport cost. Inform residents and CBOs along heavily used routes.
 - Undergo a responsible land acquisition process. Consider the current use of land and if any services or people can or need to be relocated. Consider any negative impacts to nearby neighborhoods and inform them about the planned landfill. Reach out to current landowners and negotiate for an affordable cost. Follow national or city regulations of land acquisition and proper compensation.
 - Consider potential use of the land after the landfill is closed, instead of choosing a site that will permanently become useless.
- Design
 - Perform geotechnical studies. Design and install appropriate soil/aggregate layers, liners, gas collection trenches, and leachate collection and surface drainages.
 - Plan for sufficient covers to protect disposed waste from weather, water, and scattering by the wind
 - Design and install barriers to minimize unwanted residents and animals from accessing the site
 - Estimate not only current but expected waste generation volumes and characteristics into the future to

determine capacity of the site. Landfill design depends on the type of waste disposed and the risks they pose.

Ash cakes from high temperature incinerators are more stable than decomposing raw domestic waste.

- Restore the land after landfill closure and ideally, convert the land to other safe uses.
- Consider if any portion of landfill projects and O&M can or should be outsourced to private businesses for increased efficiency and/or hiring of technical personnel

Financing and Resources

- Budget for land acquisition and planning, design, and operation and maintenance of the landfill.
- Budget to purchase, operate, and maintain heavy machinery, such as trucks, bulldozers, sprinkle trucks, and compactors, for spreading, compacting and covering disposed waste
- Engineers, planners, construction workers, and O&M personnel
- Other tools and equipment needed for daily operations

Operation and Maintenance

- Compact and cover disposed waste daily to prevent odor, burning, growth of vectors, and attracting animals
- Prevent water pools from forming by compacting and covering waste in a uniform profile
- Monitor for and remove any animal nests
- Keep a record of key indicators (see below)
- Develop a system that keeps a tight control over who has permission to access the site.

Performance Indicators

- Nearby groundwater/surface water quality
- Number and type of complaints from residents, such as noise, scattering of waste, and other environmental impacts
- Number of working hours and staff injuries or sickness at the landfill
- Daily disposed waste volumes

The Kitakyushu Experience

Located in a land-scarce area and immediately next to the ocean, the easiest landfill location in Kitakyushu was offshore. Once filled, Kitakyushu uses these post-landfill sites as new land.

Actions to Improve Waste Management

W5. Waste Reduction

Purpose/Introduction

Waste reduction becomes increasingly important to lengthen the life of landfills. Increasing capacity of incineration plants and landfills are costly, so cities have incentive to find alternative waste disposal methods.



Simultaneously, diversification of waste presents opportunities to better make use of these resources. For example, glass bottles could be cleaned, sanitized, and re-used. Plastics can be recycled by reprocessing them into new plastic products. Paper can also be recycled into different paper based products, such as toilet paper. Organic waste could be composted to produce fertilizer, and household appliances can be dissected to re-extract rare metals for reuse. As a result of waste reduction and recycling efforts, waste collected from Kitakyushu households decreased by 34 percent from 2003 to 2015.

W5-1. Separate Waste

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Recurrent	\$	Low	All Residents, Waste Collection Companies (if outsourcing)	High

Advantages

- Helps reduce waste that is disposed
- Allows efficient use of resources if combined with recycling efforts
- Raises resident awareness about waste and resources issues

Disadvantages

- Requires all residents to understand and comply with waste separation rules
- Requires a more coordinated waste collection system

W5-2. Collaborate with Manufacturers

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Recurrent	\$	Low	All Residents	High

Advantages

- Helps reduce waste that is disposed
- Allows efficient use of resources
- Requires minimal investment for the city
- Increases collaboration and relationships between the city and its industries

Disadvantages

- Costly for both industries to invest in new processes, infrastructure, and R&D.
- Could increase cost of products to include the end-of-life or recycling costs

W5-3. Charge Fees for Waste Disposal

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Recurrent	\$	Mid	All Residents	High

Advantages

- Provides economic incentive to reduce waste
- Provides some income stream to the city to offset some costs or to invest in other initiatives
- Raises resident awareness about waste and resources issues

Disadvantages

- Could result in increases in illegal waste disposal
- Could encourage residents to dispose waste in adjacent cities or communities where waste disposal is cheaper

Performance Indicators

- Amount of waste produced or collected per person per day
- Amount of waste incinerated or disposed
- Frequency or extent of resident difficulty with waste separation

Alternative Actions

Composting is an alternative way to treat and reuse organic waste. Proper management is necessary to ensure composting does not produce odors or vectors and that it produces high quality fertilizer that is marketable if done at a large scale. Composting at the household scale is also effective as long as sanitary conditions are maintained. Refer to the sector model “Waste Management” of the Kitakyushu Model for more in depth discussion of recycling and other processes after waste separation

W5-1. Separate Waste

Description

Waste separation allows each type of waste to be handled in a way that is best suited for that type of waste. Some waste, such as metals for example, may be better recycled and reused, and even if incinerated, will not become ash. Creating different waste reuse, recycle, or waste disposal streams ultimately reduces waste that is disposed in landfills. Having residents participate in the initial separation process also creates an opportunity for residents to learn and reexamine products or items they use and are disposing.

Necessary Existing Conditions

- Residents and waste collection services capable and willing to separate trash and appropriately collect and handle each type.
- Organization of explanatory meetings, receiving resident feedback, and providing informative material (E2-1, E4-1)
- Cooperation from or availability of any necessary recycling plants or manufacturers to make use of each waste category (W5-2)



Important Considerations

- Clearly decide how each type of waste should be put out for collection. Using transparent plastic bags or open crates can be an easy way for residents and waste collection crew to ensure that the correct waste is being put out for collection. Inform residents of the chosen method.
- Waste collection services will need rearranging to accommodate different waste streams. Waste categories for recycling, for example, need to be transported to different locations than incineration plants or landfills. Raw food waste may require collection a few times a week for sanitary reasons, while collection for metals could be once or twice a month.
- Some waste could be collected outside of city waste collection services. For example, electronics could be collected by the manufacturer or electronic stores. Collaboration with these entities is critical.
- If the city had been relying on private businesses to collect and transport waste, changes in waste collection systems will possibly decrease work for these companies. Provide sufficient notice to these businesses and alter contracts if needed.
- Complete cooperation by residents is necessary. Organize resident meetings, reach out to CBOs for support, develop informational materials and reference materials for residents.

Financing and Resources

- Staff and budget to potentially cover increases in waste collection cost, due to increase in collection rounds. Consider outsourcing to private businesses if applicable.
- Staff and budget to cover public outreach

Operation and Maintenance

- Refer to operation of W2-1 and W2-2 for O&M of waste collection systems
- Maintain clean and hygienic environment at the waste collection station or location

The Kitakyushu Experience

Kitakyushu began asking residents to separate waste in 1993 starting with cans and glass bottles. The intent was to decrease waste the city generated and to promote recycling. When residents were asked about what they thought about this new idea, residents replied that more efficiently using or reusing resources and becoming a more environmentally friendly city fit with their values.

Separate collection of plastic bottles started in 1997, paper containers and white Styrofoam trays in 2000, fluorescent lights and colored Styrofoam trays in 2002, and various plastics in 2006.

Today, Kitakyushu residents separate waste into the following types for the given collection frequency.

- Aluminum and steel cans and glass bottles –once a week
- Plastic products – once a week
- Paper (cardboard boxes, magazines, newspapers) –once a month
- Clothes and cloth –anytime at collection boxes in markets
- Batteries – anytime at collection boxes in markets
- Metals –anytime at collection boxes in markets
- Electronics/household appliances – anytime by manufacturers
- Remaining household waste (organic waste, scraps of papers, unrecyclable plastics) – twice a week

Because Kitakyushu incinerates its waste, even if waste is not perfectly separated, the plant and landfill usually handle it without causing pollution issues.

W5-2. Collaborate with Manufacturers	
<p>Description</p> <p>Waste separation (W5-1) is meaningless without first securing an alternate waste processing stream for each category of waste. Collaboration with manufacturers also presents opportunity to minimize resources use, improving the product so that it uses less resources and produces less waste.</p> <p>Necessary Existing Conditions</p> <ul style="list-style-type: none"> Existing communication means and relationships with industries and manufacturers (E1-1). Intent on both the city and industries sides to together work towards waste reduction (E1-2). <p>Important Considerations</p> <ul style="list-style-type: none"> Discuss with manufacturers or industries what kind of product improvements and recycling will be possible and what cooperation from the city would be necessary to implement it. Realize that recycling plastics or paper, for example, requires development of such technology and construction of a recycling plant to create new products. This takes tremendous money and time investment for a private company. Realize that recollecting electronics, for example, and re-extracting useful parts or heavy metals also require industries to invest in research and development and reorganizing the manufacturing process. This takes tremendous money and time investment for a private company. Discuss the best way to collect each waste category. Plastics may make sense for the city to collect if it is frequently discarded, while a toaster made by Company A may make the most sense for Company A to decide how to recollect its own products. <p>Financing and Resources</p> <ul style="list-style-type: none"> Staff to collaborate with industries to develop a waste reduction plan or process Staff and budget to cover any public outreach taken on by the city Reach out to national or provincial governments, as applicable, to see if any financial help is available to industries. <p>Operation and Maintenance</p> <ul style="list-style-type: none"> Periodic communication with industries and making any necessary adjustments 	<p>The Kitakyushu Experience</p> <p>Home to numerous industries, Kitakyushu had the benefit of having local manufacturers who were very cooperative with the city’s waste reduction initiatives. Below are some example partnerships.</p> <ul style="list-style-type: none"> Mitsubishi Corporation and other partner companies agreed to invest in construction of plastic bottle recycling plants. After several years, the global market demand for recyclable plastic bottles increased. The national trend was to export this waste instead of processing it in-country to reduce cost. However, Kitakyushu kept its side of the bargain and did not choose the cheaper option. The history of cooperation and valuing the relationship with local companies was decided to be more important. Further, reliance on foreign markets to dispose recyclables outside Kitakyushu would increase the city’s susceptibility to global market trends and increase the risk of not being able to properly treat and dispose of city waste, which was deemed unacceptable. Under Kitakyushu’s request, Toshiba Corporation agreed to collaborate and invest in recycling plants for household appliances that met the national Home Appliance Recycling Law. Toshiba further promised to invest in other manufacturers recycling plants and R&D of recycling processes. Their efforts led to the redevelopment of product designs that allowed for easier recycling without increasing product cost to the consumer. Yoshikawa Kyogo, a steel manufacturing-related company in Kitakyushu, also developed a new car recycling process so that a car could be recycled almost entirely. With collaboration with Mitsubishi Corporation and Nippon Steel and Sumitomo Metal Corporation, Yoshikawa Kyogo constructed a recycling plant, which saw numerous visitors, including from car manufacturers. The national Japanese government incorporated this car recycling process in the End-of-life Vehicle Recycling Law.

W5-3. Charge Fees for Waste Disposal**Description**

Charging fees aims to encourage residents to:

- Reduce waste
- Dispose of recyclables separately

Necessary Existing Conditions

- Organization of resident informational meetings and receiving resident feedback (see **E2-1**)
- Resident understanding and agreement with the new process
- Similar initiatives and collaboration with surrounding cities and communities to prevent residents from disposing waste in adjacent cities because it is significantly cheaper.

Important Considerations

- Consider resident's capacity and willingness to pay as well as any additional costs to the city when setting fees. Compare fees also to neighboring areas to ensure they are not significantly different.
- Fees should be according to disposed weight or volume to encourage waste reduction, instead of it being a flat fee. Decide how to best charge fees. It could be requiring residents to purchase plastic trash bags of certain volumes or another creative method that works for residents, is simple, and is efficient.
- If requiring residents to purchase plastic trash bags or any other material, determine how to sell them. This may involve paying distributors and local markets to stock these city bags throughout the community.
- Develop informational materials to guide residents on the new process and system (**E4-1**).
- Invest in extra patrols and surveillance if increases in waste dumping is a concern (**W6-1**). If waste disposal costs to the resident are significantly different, it could lead to an increase in waste inflow from neighboring cities.

Financing and Resources

- Budget to cover production and distribution cost of the city plastic trash bags
- Staff to plan and organize the new fee system
- Staff for public outreach

Operation and Maintenance

- Conduct studies to determine effectiveness of charging fees to reduce waste. Revise prices accordingly.

Performance Indicator for Option:

- Waste volumes entering incineration plants or landfills

The Kitakyushu Experience

Kitakyushu charges residents for city plastic waste bags and requires their use for waste disposal. Current prices are as below.

- 45L bag - 0.50 U.S. Dollar (USD)
- 30L bag - 0.30USD
- 20L bag - 0.20USD
- 10L bag - 0.10USD

The Kitakyushu Experience

Kitakyushu experienced resident reluctance when first beginning to charge fees in 1998 for designated plastic waste bags, something the city had been providing for free. Residents finally agreed when the city government agreed to price the bag at about the unit cost of production, which was 0.10 USD for a 45 L bag.

The city provided the first 10 bags for free so that residents could get accustomed to using these new bags. The city also patrolled and supervised waste collection, paying about 10 USD daily for volunteers to help with this task. The city also sent out extra patrols to look for illegal waste disposal or dumping, but that did not become an issue.

However, the price was too cheap. Neighboring areas were charging more for their standard plastic trash bags, so non-city residents had begun purchasing city trash bags and disposing of the waste within city boundaries on their way to work.

The city then adjusted the price so that it matched those of neighboring areas. Kitakyushu also started charging for plastic recycling bags, although at a price lower than that for general waste.

Any fees collected over the production cost are used to purchase cleaning supplies and tools to support local waste-pick up or cleaning efforts.

W6. Maintaining a Waste-Free City Environment				
<p>Purpose/Introduction</p> <p>Litter brings more litter, meaning when there is already waste on the ground, people tend to litter and add to it, while it is much more difficult to be the one who initially litters the otherwise clean environment. Accumulation of litter leads to informal waste dump sites. Reducing waste dumping is not simple. A solution requires a raising resident awareness and sense of responsibility as well as enforcement of city ordinances.</p> 				
W6-1. Identify Waste Accumulation/Dump Sites				
<u>Timeframe</u> Recurrent	<u>Affordability</u> \$\$	<u>Technical Level</u> Low	<u>Partners</u> Residents, Private Companies (if outsourcing)	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Allows the city to clean identified sites to discourage future dumping Improves aesthetics and hygiene of the area 		<p>Disadvantages</p> <ul style="list-style-type: none"> Require human resources to patrol and to clean 		
W6-2. Collect Bulk Waste Periodically				
<u>Timeframe</u> Recurrent	<u>Affordability</u> \$\$	<u>Technical Level</u> Low	<u>Partners</u> Residents, Private Companies (if outsourcing)	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Helps reduce waste dumping Improves aesthetics and hygiene of the area 		<p>Disadvantages</p> <ul style="list-style-type: none"> May require extra budget to offer bulk collection services 		
W6-3. Install Waste Bins in Public Areas				
<u>Timeframe</u> Recurrent	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Private Companies or Organizations Managing Public Areas	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Helps reduce waste dumping and littering Improves aesthetics and hygiene of the area 		<p>Disadvantages</p> <ul style="list-style-type: none"> Risk of waste bins being stolen Increases city waste collection points Residents may dispose their household waste in public bins, which may cause issues if, for example, the city it charging for services May cause littering in the immediate vicinity of the waste bins 		
W6-4. Encourage Residents to Maintain a Clean City Environment				
<u>Timeframe</u> Recurrent	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Residents, Industries, Businesses, NPOs/NGOs	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Can be an opportunity to learn of best practices Help support other communities Encourage residents to take initiative 		<p>Disadvantages</p> <ul style="list-style-type: none"> None 		
Performance Indicators				
<ul style="list-style-type: none"> Frequency and distribution of waste dumping Participation level of residents and community groups 				

W6-1. Identify Waste Accumulation/Dump Sites**Description**

Once effective waste collection services are established and residents understand the correct ways to dispose of waste, people who intentionally dump waste will do so in easy to dump areas or areas that are less visible. Prevention of waste dumping includes patrolling areas prone to waste dumping, identifying sites, and quickly removing them if found. Patrols and identification of waste accumulation can include the following activities.

- Install surveillance cameras
- Patrol by city government staff
- Install notice boards informing residents about monitoring and patrolling activities

**Necessary Existing Conditions**

- An accessible alternative to waste dumping, such as reliable city waste management services that reaches all parts of the city (**W1, W2, W4**). Patrolling and identifying waste accumulation and dump sites are meaningless if such a condition is the norm.
- Equipment and staff for patrol and monitoring activities

Important Considerations

- The same dump sites tend to be used repeatedly, and if so, fake cameras, real cameras, and notice boards can be effective in those locations. If installing real operating cameras, realize that someone needs to be checking the video/images periodically.
- If waste naturally accumulates or collects in certain locations, determine their sources and invest in public outreach and cleaning activities specific to those areas.
- Establish a hot line, so that residents can inform the government of any waste accumulation issues (**E1-1, D2-4**)
- Once a dump site is identified, it must be removed. Consider who should be held responsible for cleaning. If the city is going to be responsible, consider vehicles and equipment necessary to access the site and to transport the waste to appropriate locations
- Identify those responsible for dumping waste. This could be through surveillance cameras or if strong relationships are developed between the city government and communities, residents may know those that are responsible. Devise non-confrontational ways to request proper waste disposal. This could be holding an extra informational meeting in that area, delivering brochures in that area, and asking CBOs or community leaders to be extra vigilant.
- If waste dumping is a widespread issue, it may be necessary to clearly issue a city ordinance that establishes penalties and fines for waste dumping and/or littering.

**The Kitakyushu Experience**

Kitakyushu generally requires people responsible for the waste dumping to return, collect, and re-dispose of the waste correctly. Hence, Kitakyushu invests in searching for the responsible party by, for example, examining the disposed waste to determine its original owner.

Financing and Resources

- Budget to purchase, use, and maintain vehicles, cameras, and other necessary equipment
- Staff for monitoring and patrol or budget and contract to hire private companies for the task

Operation and Maintenance

- Keep records of waste accumulation and dump site locations, the volume of waste found, and the frequency at which those sites are identified and cleaned.
- Periodically check and maintain equipment, such as surveillance cameras.

W6-2. Collect Bulk Waste Periodically**Description**

Household bulk waste includes large items, such as furniture, bedding, rugs, and appliances, that cannot be recycled (if that is a waste disposal option) and too large to handle within the regular waste collection system. Most households may not have access to vehicles, such as trucks, to transport these items to designated locations, which may lead to unwanted dumping in nearby areas. Hence, the city government can provide bulk waste collection services periodically.

**Necessary Existing Conditions**

- Space to accommodate bulk waste collection
- Capacity within city waste management services or partnering industries to recycle, treat, or dispose of the collected waste

Important Considerations

- Consider how often bulk waste collection should take place. It could be designated days within the year when there is high demand, and/or the city could provide the service once requested from residents. Inform residents of the chosen service (**E4-1**).
- Decide whether to provide the service for free of charge or if the city will require a fee. A fee may make more sense if the city is on-call to provide these services. If collecting money, consider its affordability to residents, since the city would like residents to use this service than to dump waste in a nearby field or river.
- Designate pickup location and time. See important considerations outlined in **W1-4**.
- Ensure the city has the appropriate vehicles to collect bulk waste (see **W2-1**).
- Consider if it makes more sense for the city to outsource collection to a private business.

Financing and Resources

- Budget and staff to collect transport, and dispose of bulk waste
- Fees collected from requested services (if applicable)
- Staff to perform necessary public outreach

Operation and Maintenance

- Consider performing quick resident satisfaction surveys to determine if any adjustments to the service are needed

The Kitakyushu Experience

Kitakyushu used to collect bulk waste free of charge, two to three times a year from designated locations. In 1994, however, the city began charging for this service, because increasing proportions of bulk waste consisted of commercial, manufacturing, or industrial waste, the disposal for which is not the city's responsibility. As a result, annual bulk waste collected by Kitakyushu reduced from 29,000 tons in 1993 to 4,000 tons in 1994, and this bulk waste collection rate has since been consistent.

W6-3. Install Waste Bins in Public Areas**Description**

Waste bins in public areas, such as city centers, tourist areas, bus stations, train stations, and parks, can provide residents and users an alternative to littering.

Necessary Existing Conditions

- Cooperation from any organizations, businesses, or agencies managing the public area, such as parks departments or bus/train companies.
- Resident understanding or lack of incentive to steal installed waste bins
- Established city waste management services (**W1, W2, W4**)

Important Considerations

- Waste bin design: the bins should be durable to weather and frequent public use. Consider securing the bins on the ground to prevent theft. A consistent color and design would allow for easy recognition of waste bins as well as improve city aesthetics.
- Determine location and distribution of waste bin installation. Consider the volume of waste potentially generated and waste type. If this action is to address littering, clean the litter and set waste bins in those locations to provide an alternative way to dispose of the waste. Consider setting multiple waste bins to allow for waste separation.
- Consider the possibility that nearby residents may dispose of regular household waste in public waste bins. This may not be effective, for example, if the city is trying to charge fees for waste disposed by the household.
- Coordination with any organizations, businesses, or agencies managing the public area. Clarify which party is responsible for waste collection, waste bin maintenance, and cleaning.
- Determine necessary waste collection from waste bins set in public areas. These could simply be additions to waste collection stations planned and managed in **W1-4**.

Financing and Resources

- Budget and staff for waste collection, transport, and disposal
- Public outreach or education to teach residents to use available waste bins instead of littering

Operation and Maintenance

- Periodic cleaning and replacing of public waste bins as necessary

**The Kitakyushu Experience**

Kitakyushu had installed public waste bins to prevent littering. Initially, the public bins helped decrease littering in Kitakyushu, but this became less and less of an issue as resident awareness of proper waste management increased over the years.

Eventually, issues associated with public waste bins became more evident, which included disposal of regular household waste in public bins and overflowing and scattered waste from the bins. After deliberating, the city decided to remove all public waste bins in 1993, the same year the city began charging residents fees for waste disposal.

At the same time, the city invested more in education of its residents to prevent littering and asking each to be responsible for taking their waste home for proper disposal.

W6-4. Encourage Residents to Maintain a Clean City Environment**Description**

Resident driven, local, grassroots efforts to clean, pick-up litter, and maintain a clean, livable living environment is integral to maintaining a clean city overall. A small amount of effort from each resident can manage feats that a city government could never do on its own. Specific activities the government could engage in to encourage grassroots efforts include the following (also refer to **E1** and **E2**).

- Helping residents organize themselves into working groups that hold waste pick-up days or cleaning days to maintain their immediate environment.
- Supporting activities by providing tools, such as plastic waste bags or gloves
- Supporting activities by sending government staff to participate
- Selecting model areas to recognize the community's hard work and contributions.

**Necessary Existing Conditions**

- Established city waste management services (**W1**, **W2**, **W4**)
- Community level organizations or associations and people with time and resources to participate in local activities
- Shared values among residents that maintaining a clean living environment is important and worthwhile

Important Considerations

- Coordinate with local community groups and determine if there are needs that the city can help address.
- Recognize that in addition to residents, the city also consists of private businesses, industries, schools, NGOs/NPOs, and many potential informal networks. Be creative as to how each group can contribute.
- Consider recognizing "model areas" and/or specific resident groups. If so, decided how often to recognize an area. Ensure the selection is fair and does not always recognize areas that are more affluent or of a certain ethnic group or class. Remember the purpose is to encourage resident, grassroots initiatives around the city.
- Disseminate the information effectively, including model areas and best practices (**E2-2**, **E4-1**)
- Take advantage of the local environment. For example, children playing in public parks or inner city rivers tend to discourage people from intentionally polluting or littering these areas.

Financing and Resources

- Budget and staff to support resident activities (if applicable)

Operation and Maintenance

- Publicize and disseminate information about best practices and lessons learned from successful areas to other neighborhoods (also see **E4-1**)

Performance Indicators

- Number of active resident groups, and their type of activities, and frequency of those activities
- Number and distribution of "model areas" and other groups or areas that have received recognition.

The Kitakyushu Experience:

In 1994, Kitakyushu passed "the Kitakyushu City ordinance to prevent littering." As a part of this ordinance, the city government began designating "beautiful city areas" or "model areas" and assigning each at least one "beautiful city promoter." The promoter organizes clean-up events and increases awareness by distributing flyers and promotional materials. Up until a few years ago, promoters also spoke with people who litter the area. The objective of these actions is to promote and increase visibility of "clean areas" and thereby encourage more people to partake in such activities. Hence, "model areas" were usually set in publically visible areas, such as by the main train station or in areas where residents or communities were especially active.

In collaboration with residents and industry, the city additionally organizes events to increase awareness of the importance of maintaining a clean living environment. Example events include:

- Organizing a biannual "Make our City Beautiful and Clean Campaign"
- Recognizing a "Clean Community Building Week"
- Designating the first Sunday of every October as the "Make Our City Beautiful Together Day" and encouraging many local groups to clean roads, parks, rivers, and beaches during the early fall season.

Kitakyushu provides volunteer groups that clean city roads, parks, rivers, and other public areas with "Make Our City Beautiful" plastic trash bags for free. Cleaning of multi-residential buildings is excluded from this service.

4.5 Urban Drainage

Urban drainage infrastructure collects and conveys rainwater from urban areas into waterbodies to prevent urban flooding. This infrastructure is particularly important in urban settings because:

- Impervious areas increase surface runoff and prevent natural drainage
- Higher population, waste, and asset densities increase flood risk, health risk, and potential damages

River basinwide flood risk management (e.g. landuse planning within the floodplain, levee construction, multipurpose dam construction, large scale retention basin construction) and urban flood risk management (e.g. managing rainfall that falls and flows through the city) together secure a safe urban living environment. These are fundamental in a city's growth.

Basic discussion of basinwide flood risk as well as planning, design, and construction of drainage infrastructure to manage urban flood risk are not the focus of this subsector model. This introduction on urban drainage is limited to a brief overview of drainage infrastructure components, using a combined sewer system (CSS) as a schematic. Rather, this subsector model focuses primarily on adaptation, improvement, and maintenance of existing urban drainage infrastructure to maintain urban drainage capacity. Numerous free resources and extensive textbooks discuss the field of urban drainage more extensively, including the World Bank's *Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century* (2012) as well as Kitakyushu Model sector "Water Management."

Figure 4-8 presents a schematic of urban runoff and drainage infrastructure assuming a CSS. CSS is a system where both stormwater runoff and domestic wastewater are conveyed, treated, and discharged as one system. In comparison, separate sewer systems (SSS) provide separate networks for the two discharge streams. In Figure 4-8, blue arrows indicate stormwater flow while brown arrows indicate wastewater flow. Some runoff always infiltrates underground, percolating to groundwater basins (Circle 1 in Figure 4-8). Impervious areas, however, significantly reduce infiltration and increase surface runoff, which collects in gutters and drainage channels as stormwater (Circle 2) or in ponds or detention basins (Circle 3). Detention basins provide storage of runoff and an opportunity for infiltration, helping to decrease flows within the urban drainage system and receiving natural waterbodies. Runoff from both Circle 2 and Circle 3 enter underground pipes that carry domestic wastewater, which requires treatment before being discharged into a nearby water body (Circle 5). There can be underground storage (Circle 4) to control flow throughout the system, accommodate times of high flow, and to reduce combined sewer overflows (CSOs). CSOs are untreated discharges from CSS, necessary to prevent upstream flooding, but detrimental to the water quality and environment of the receiving water body.

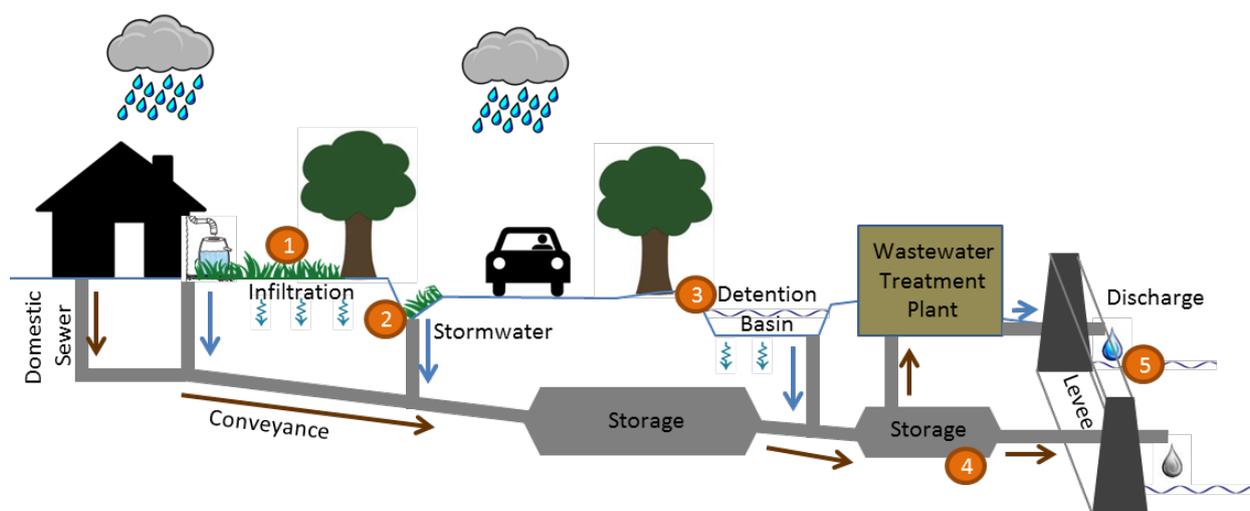


Figure 4-8. Schematic of a Combined Sewer System

The interplay of solid waste and urban flood risk occurs at points of open drainage, specifically, Circle 2 and Circle 3. Waste that accumulates in these structures can restrict runoff from entering the urban drainage system and cause inundation. Hence, half of the actions focus specifically on preventing waste

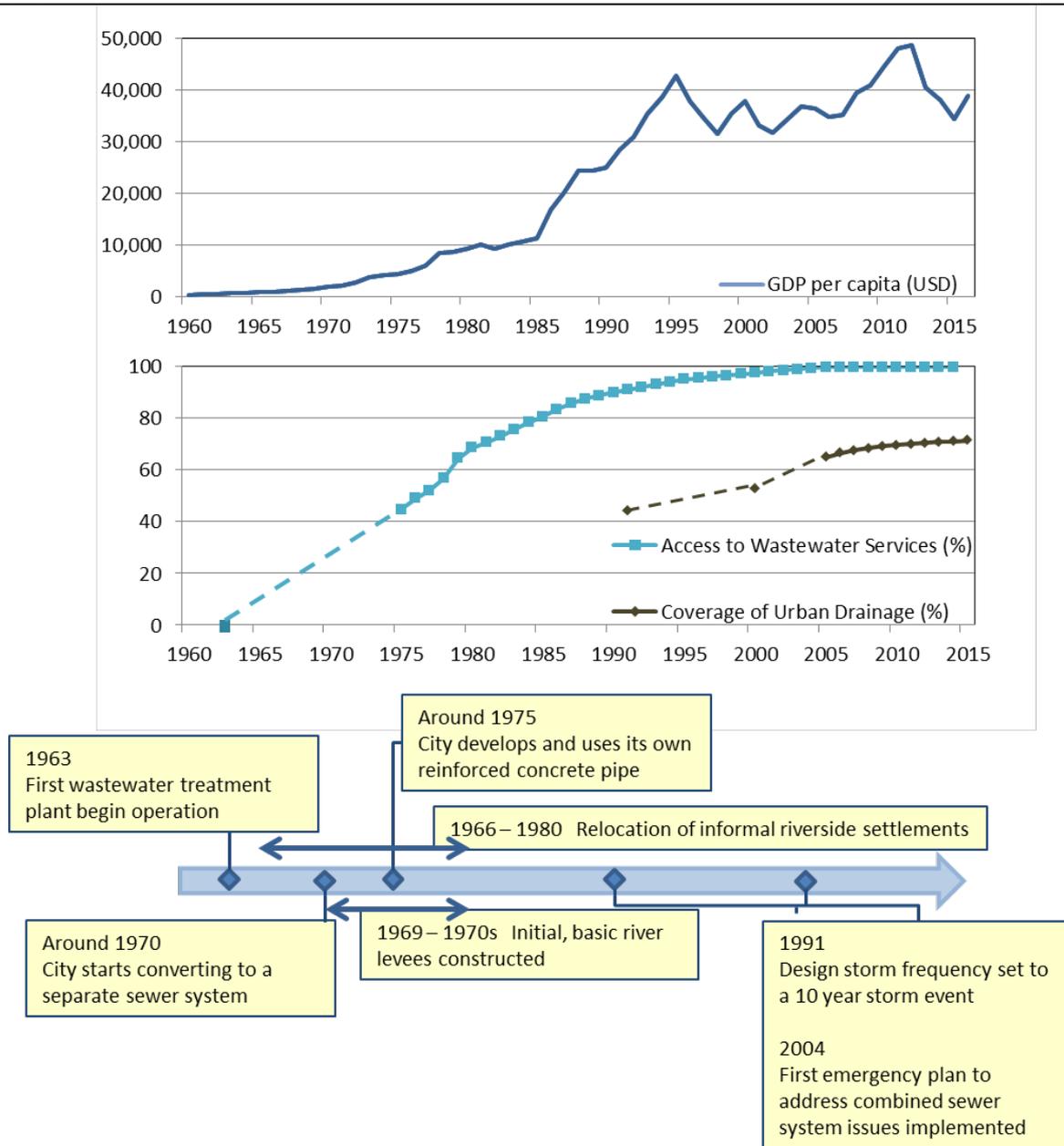
accumulation in this part of the system, using both infrastructural and maintenance methods. The model assumes some form of urban drainage infrastructure exists.

At the same time, in developing countries, urban drainage infrastructure capacity itself is usually inadequate to cope with runoff. Addressing systemwide urban drainage challenges require examining the entire system, Circles 1 through 5. This model does not present a holistic approach to urban drainage planning and design, but provides some suggested actions to a rapidly growing city, explaining important considerations when expanding or improving existing urban drainage systems. These considerations make up the second half of the urban drainage actions.

4.5.1 Urban Drainage and Kitakyushu Development

Kitakyushu officially became a municipality in 1963 with the merging of five former smaller “cities.” Construction of citywide wastewater and urban drainage systems began simultaneously, beginning with the construction of the first wastewater treatment plant, the Kougasaki Treatment Plant, that same year, as shown in Figure 4-9. Kitakyushu originally constructed a CSS, because one of the top city priorities in the 1960s and 1970s was to provide flushing toilets and wastewater services to its residents while also providing much needed urban drainage systems. Table 4-5 presents the advantages and disadvantages of CSOs.

The 1970s also was the period of river levee construction, as depicted on the timeline in Figure 4-9, which allowed Kitakyushu to then focus on planning and building urban drainage systems. It is around 1970 that the city additionally began constructing SSSs as feasible for new developments. Urban drainage infrastructure, thus, expanded rapidly in the 1970s, to the point that the city developed and used its own standard reinforced concrete pipes to lower costs. River, sewer/urban drainage, and road departments worked together to provide adequate services as quickly and comprehensively as possible. Again, as shown in Figure 4-9, early investments in infrastructure predated the rise in GDP. Demand for extensions and improvements to the urban drainage system, as well as demands to improve levees and river structures continues today. One major initiative today is to better manage CSOs and the water quality, environmental, and public health impacts they pose, so that residents can enjoy a cleaner, healthier living environment.



Data Sources:

GDP per Capita: Economic and Social Research Institute, 2015 and International Monetary Fund, 2017

Access to Wastewater Services and Coverage of Urban Drainage: Kitakyushu City, 2017

Notes:

- Access to wastewater services is the proportion of the city population that has access to wastewater services, where the wastewater receives treatment before final discharge into natural waterbodies.
- Coverage of urban drainage refers to the proportion of the designated area that receives sufficient flood risk protection from a 5-year storm event. National policy dictates the area that requires urban drainage systems to accommodate a defined size design storm.

Figure 4-9. Urban Drainage and Kitakyushu Development

Table 4-5. Advantages and Disadvantages of a Combined Sewer System

Advantages	Disadvantages
<ul style="list-style-type: none"> • Quicker implementation, lower overall construction and maintenance costs (one system) • Stronger against accidental pollution (including industrial wastewater), because is water is usually treated before discharge • Designed to handle grit and other solids, as well as large volumes of flow • More advantageous in areas with less fluctuations in precipitation 	<ul style="list-style-type: none"> • Higher health risk should inundation of sewage occur • Require larger pipes, more storage, and extensive O&M to accommodate highly fluctuating flows • Require larger wastewater treatment plant with higher operational costs • Environmental concerns in the receiving water body (combined sewer overflows)

4.5.2 Actions for Urban Drainage

Table 4-6 lists actions included in this subsection. This subsection first presents actions D1 and D2 that prevent and remove waste from accumulating in drainage canals, which would restrict conveyance of stormwater. The second half of the actions, D3 and D4 is broader, describing important considerations when expanding or improving drainage infrastructure. The orange numbers in Figure 4-8 are used in the action descriptions as a way to orient users as to where in the drainage system the action is the most relevant.

Table 4-6. Overview of Urban Drainage Actions

Urban Drainage	
<i>Actions to Maintain Drainage Capacity</i>	
D1. Local Adaptations to Capture Debris	<ul style="list-style-type: none"> D1-1. Cover Open Drains (wood or any other locally available material) D1-2. Cover Open Drains (concrete/metal grating) D1-3. Install Intermediary Screens within Drainage Channels
D2. Waste Clean-Up, Drain Cleaning, and Maintenance	<ul style="list-style-type: none"> D2-1. Perform Scheduled System Cleaning and Maintenance D2-2. Perform Ad Hoc Local Drain Cleanings D2-3. Inspect the System Prior to Rain Events D2-4. Establish a Hotline and Respond to Resident Reports D2-5. Hold Clean-Up Events
<i>Actions to Expand/Improve the Drainage System</i>	
D3. Systemwide Drainage Planning Considerations	<ul style="list-style-type: none"> D3-1. Plan Using Sustainable Urban Drainage System/Low Impact Development Principles D3-2. Convert to Partial Separate Sewer Systems D3-3. Utilize Open Spaces, Ponds, and Detention Basins D3-4. Relocate Informal Settlements around Waterbodies
D4. Design Level Considerations	<ul style="list-style-type: none"> D4-1. Secure Discharge Points/Points of Interest D4-2. Create or Revisit Design Storms and Runoff Assumptions D4-3. Redevelop or Manufacture New Materials and Designs D4-4. Expand Drainage System in Coordination with Other Construction

Figure 4-10 presents the above actions relative to their ease of implementation. Actions that are more complex to implement may require more technical expertise or resources or higher financial investment. Actions that are presented towards the left side are relatively simpler to implement. Figure 4-10 shows that D1 and D2, actions that more directly relate to the interplay of solid waste management and urban flood risk are overall, easier to implement. Figure 4-10 is strictly conceptual and what is appropriate and feasible in each country or city differs depending on realities and conditions on the ground.

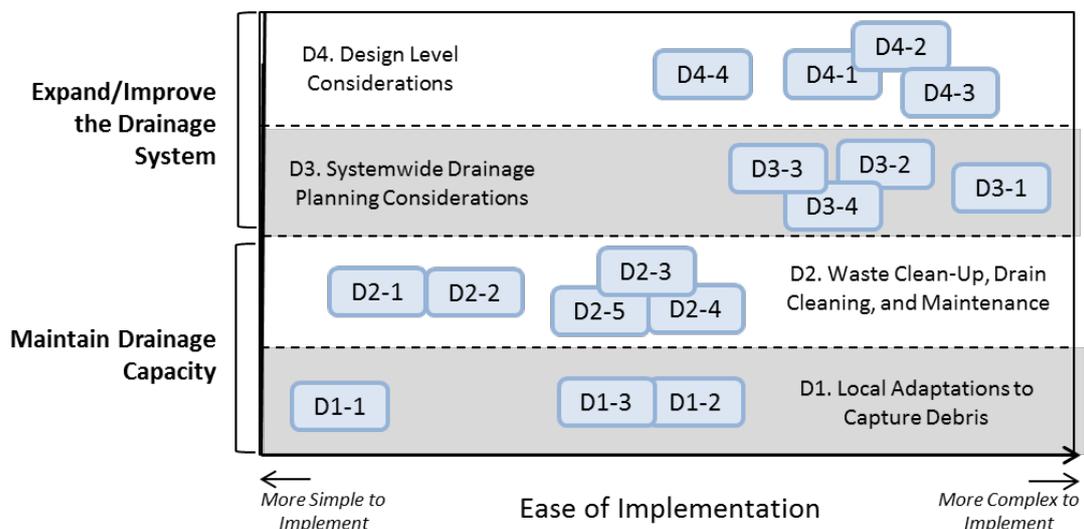
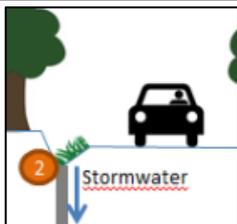


Figure 4-10. Ease of Implementation of Urban Drainage Actions

Actions to Maintain Drainage Capacity

D1. Local Adaptations to Capture Debris				
<p>Purpose/Introduction</p> <p>Local structural improvements of where runoff flows into the drainage system, combined with adequate maintenance, can help minimize inflow of waste and waste accumulation within the drainage system. These actions focus on relatively quick adaptations to sections of open drainage and conveyance that can help maintain urban drainage capacity.</p>				
D1-1. Cover Open Drains (wood or any other locally available material)				
<u>Timeframe</u> Short	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Residents	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Any material works as long as the drains are partially covered Quick and affordable Implementable anywhere 		<p>Disadvantages</p> <ul style="list-style-type: none"> Requires frequent replacement Predominantly depends on local resident ownership to maintain, clean, and replace Need to ensure the cover does not become debris and add to the drain blockage issue 		
D1-2. Cover Open Drains (concrete/metal grating)				
<u>Timeframe</u> Short	<u>Affordability</u> \$\$	<u>Technical Level</u> Mid	<u>Partners</u> City Engineers, Industry	<u>Involvement Level</u> Mid
<p>Advantages</p> <ul style="list-style-type: none"> Secure and designed cover that fits over existing drains Quick and affordable 		<p>Disadvantages</p> <ul style="list-style-type: none"> Depending on the cover, residents may need official help to access the drain for cleaning Require decentralized maintenance 		
D1-3. Install Intermediary Screens within Drainage Channels				
<u>Timeframe</u> Short	<u>Affordability</u> \$	<u>Technical Level</u> Mid	<u>Partners</u> Industry	<u>Involvement Level</u> Mid
<p>Advantages</p> <ul style="list-style-type: none"> Catches debris within stormwater drain before it collects and clogs a main artery or a pump station Quick and affordable 		<p>Disadvantages</p> <ul style="list-style-type: none"> Require decentralized maintenance 		
Operation and Maintenance				
<ul style="list-style-type: none"> Covers and screens will need to be maintained and replaced by either local residents or the City depending on the material and ease of purchase or installation. A more decentralized debris catchment system requires a decentralized cleaning system. (See D2) If the city is involved in initial community organization/development, it needs to continue at least a peripheral involvement and continue any necessary support 				
Performance Indicators				
<ul style="list-style-type: none"> Percent of open drainage covered Number of times annually or seasonally that each discharge point becomes a drainage bottleneck, although the system downstream still had capacity. <ul style="list-style-type: none"> Depth, extent, and duration of inundation. Time until residents responded to the blocked drain and the type of response taken. Time until the city learned of the issue, and the response taken 				
Alternative Actions				
<p>An alternative to decentralized collection of debris is to size the infrastructure and allow debris collection in a more central location. Assuming the city would be performing the cleaning, it may be more cost-effective to have larger amounts to clean but in less number of locations. However, this assumes that the debris load remains manageable. On the other hand, even with sufficient drainage covers, the city may still need to organize frequent cleanings at collection points throughout the drainage system.</p>				

D1-1. Cover Open Drains (wood or any other locally available material)**Description**

Cover existing drainage channels with planks of wood or any other locally available material to catch debris in the runoff before it enters the drainage system.

Necessary Existing Conditions

- Local drainage infrastructure exists, whether it be drainage channels or gutters around homes and local roads
- A feasible method to periodically clean debris that will collect around the covers and screens

Important Considerations

- If local drainage channels or ditches are not yet officially constructed, determine where runoff tends to currently collect by examining erosion patterns or existing gulleys. Structure these into a more uniform channel for easier runoff control and maintenance.
- Continued local maintenance and involvement is fundamental to this action. Use of informal covers also means the covers themselves will eventually disintegrate and possibly become sources of debris.

Financing and Resources

- Action relies primarily on local resident/industry ownership and agency to implement and maintain.
- The city can and should have a role in teaching communities to engage in this activity and to offer appropriate support.

D1-2. Cover Open Drains (concrete/metal grating)**Description**

Design and installation of simple concrete covers on open drainage channels or entirely covering the channel and installing metal grates or gutters as inlets for runoff is a more permanent way to remove debris from the drainage system.

**Necessary Existing Conditions**

- Local drainage infrastructure exists, whether it be drainage channels, gutters, or underground pipes around homes and local roads
- A feasible method to periodically clean debris that will collect around the covers and screens (see D2)

Important Considerations

- Consider the ease of removing these covers or grates for cleaning the channel or pipe underneath.
- Designs and installation will occur in mass. Consider mass production and installation costs and make initial adjustments that would make that work simpler and hence cheaper.

Financing and Resources

- City funded, if it is to be an official, more permanent system
- City engineers should be involved in designing appropriate covers or grates.

The Kitakyushu Experience

To better handle green waste from blocking grates, Kitakyushu designed a unique metal grate that collects leaves in one portion of the grate and leaves the remaining surface area clear to accommodate runoff.

Although this particular example only addresses green waste and cannot be directly applied in situations of high debris load, the example shows that preemptive design alterations and adjustments have the potential to significantly decrease necessary maintenance and cleaning after installation.

D1-3. Install Intermediary Screens within Drainage Channels**Description**

Install screens at intermediary locations throughout the stormwater drainage system, such as at system low points, underpasses, and before pump stations. Screens allow collection of debris that enters the system before it clogs a main detention basin, artery, or pump station.

Necessary Existing Conditions

- Local drainage infrastructure exists, whether it be drainage channels/pipes or gutters around homes and local roads
- A feasible method to periodically clean debris that will collect around the screens

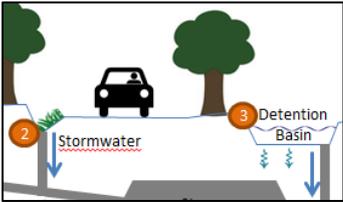
Important Considerations

- Continued local maintenance and involvement is fundamental to this action.
- Its location can be determined from experience, (where would it make structural and debris collections sense to install a screen?) or from a systemwide perspective on which screen locations may be the most effective.

Financing and Resources

- Screens can be installed by the city and maintained by the city or its residents.
- If residents are to be involved, the roles and responsibilities of the city versus the residents need to be delineated. A means for the residents to communicate with the city would also be necessary.



D2. Waste Clean-Up, Drain Cleaning, and Maintenance				
<p>Purpose/Introduction Debris inherently builds up and creates clogs throughout drainage infrastructure over time. Periodic cleaning and maintenance is crucial for effective and efficient urban drainage management. Cleaning activities are even more important in systems with high amounts of debris load. Trash pick-up, cleaning, and maintenance work can be performed by a combination of the following: the city, outsourced to private companies, and local residents.</p>				
D2-1. Perform Scheduled System Cleaning and Maintenance				
<u>Timeframe</u> Recurring	<u>Affordability</u> \$	<u>Technical Level</u> Mid	<u>Partners</u> Cleaning Crew, Private Cleaning Companies	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Ensures the system receives periodic care and maintenance. Strategically timing the cleaning and maintenance before rainy seasons allow for increased effectiveness Scheduled cleanings allow for easy financial planning 		<p>Disadvantages</p> <ul style="list-style-type: none"> Reliance solely on city cleaning activities may result in prohibitively high costs The city is usually not the first to recognize localized issues nor the one most suited to addressing it 		
D2-2. Perform Ad Hoc Local Drain Cleanings				
<u>Timeframe</u> Recurring	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Cleaning Crew, Private cleaning companies	<u>Involvement Level</u> High
<p>Advantages</p> <ul style="list-style-type: none"> Local residents are the most aware of changes, needs, and issues of their surroundings The City can minimize maintenance costs with resident involvement Create a sense of agency and pride among the residents in maintaining a livable environment 		<p>Disadvantages</p> <ul style="list-style-type: none"> Resident initiative implies dependence on resident responsibility Depending on the debris load and the commitment level of residents, the city may need alternative backup plans 		
D2-3. Inspect the System Prior to Rain Events				
<u>Timeframe</u> Recurring	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Cleaning Crew, Private Cleaning Companies	<u>Involvement Level</u> Mid
<p>Advantages</p> <ul style="list-style-type: none"> Ensures the drainage system is working at highest possible capacity during rain events 		<p>Disadvantages</p> <ul style="list-style-type: none"> Can only address minor, last minute issues, such as clearing a few drains 		
D2-4. Establish a Hotline and Respond to Resident Reports				
<u>Timeframe</u> Short	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Residents	<u>Involvement Level</u> Mid
<p>Advantages</p> <ul style="list-style-type: none"> Allows the city to use cleaning resources timely and effectively Builds on existing relationships between residents and the city 		<p>Disadvantages</p> <ul style="list-style-type: none"> Relies on responsive residents and a responsive city system 		

D2-5: Hold Clean-up Events				
<u>Timeframe</u> Short and Recurring	<u>Affordability</u> \$	<u>Technical Level</u> Low	<u>Partners</u> Cleaning Crew, Private Cleaning Companies	<u>Involvement Level</u> High
Advantages <ul style="list-style-type: none"> Mobilizes local resources to care for larger debris load than possible on an ad hoc basis Increases resident ownership over care for their surrounding environment. 		Disadvantages <ul style="list-style-type: none"> Requires organization and materials to support a larger-scale clean-up If the events are scheduled on an ad hoc basis, the city may not be able to rely on their activities for cleaning and maintenance 		
Important Considerations				
<ul style="list-style-type: none"> It is important to distinguish whether resident involvement is integral and necessary for maintenance of drainage infrastructure, or whether their involvement plays more of an educational and relationship building role between the city and its residents. Cleaning should be prioritized generally from downstream to upstream. Maintaining drainage capacity of discharge points and main arteries is necessary to allow more localized drainage. Cleaning larger capacity channels/pipes also require larger resources, which is suited to be centrally managed. Of the city cleaning and maintenance work, consider if any or all parts of the work can or should be outsourced to capable private companies. 			The Kitakyushu Experience Kitakyushu has annual contracts with a local private company who is responsible for responding to ad hoc maintenance needs. For example, the city would receive a call from a resident on the hotline, informing the city of a clogged drainage channel that is causing local inundation. The city would then call the private company to ask them to clean out the clog. The city pays the company for the task as agreed upon in the contract.	
Performance Indicators				
<ul style="list-style-type: none"> Number of hotline calls received. The proportion responded to and the time between the report and the response. Number of students or residents involved in clean-up events The number and extent of urban flooding caused by high debris load Locations of critical clogs and floods, so that the city can better focus maintenance on these areas before the next rain event. 				

D2-1. Perform Scheduled System Cleaning and Maintenance

Description

The city performs scheduled cleaning and maintenance needed throughout the system.



Necessary Existing Conditions

- A municipal trash collection and disposal system that sufficiently removes debris from the city, so that drainage infrastructure cleaning and maintenance are manageable.
- Understanding of locations within the drainage infrastructure that experience debris blockage.

Important Considerations

- Cleaning should be scheduled on a recurring basis, meaning the city should have the capacity to plan for its finances, human resources, and material needs.

Financing and Resources

- Annual funding and labor
- The city plans and finances system cleaning and maintenance, but can outsource the physical cleaning work to a private company.
- Any tools, trash bags, and vehicles necessary to perform needed cleaning

The Kitakyushu Experience

Kitakyushu performs annual system cleaning and maintenance, scheduled to be completed prior to Japan’s rainy month, which is also followed by a typhoon season. Since scheduled cleaning takes place once a year, the financial burden of this O&M is minimal.

D2-2. Perform Ad Hoc Local Drain Cleanings

Description

Residents maintain and play a continuous role in the upkeep of their local environment, including drainage systems. If residents cannot address the issue, they contact the appropriate city personnel, and either the city or a hired company responds in the field.

Necessary Existing Conditions

- A municipal trash collection and disposal system that sufficiently removes debris from the city, so that drainage infrastructure cleaning and maintenance are manageable.
- Self-reliant and responsible city residents

Important Considerations

- While it may be easy and ideal to rely on residents for local cleaning, maintaining a livable city is the city’s responsibility.
- Consider outreach and educational activities the City or local NGOs/NPOs can provide to encourage resident involvement.

Financing and Resources

- Local residents can be involved out of personal agency to maintain their living environment
- Any tools, trash bags, and vehicles necessary to perform needed cleaning

The Kitakyushu Experience

Kitakyushu built and still operates many open drainage channels and canals for runoff management. Contaminants in the runoff, such as litter, domestic solid waste, and historically, organic kitchen waste, contributed to unpleasant smells. During these times, it was in the residents’ interests to take initiative and clean out nearby drains periodically to ensure the channels were not blocked.

D2-3. Inspect the System Prior to Rain Events	
<p>Description</p> <p>The city sends out a crew to check the drainage system prior to a large storm event or a rainy season. Last minute cleaning or maintenance is performed if necessary.</p> <p>Necessary Existing Conditions</p> <ul style="list-style-type: none"> • A municipal trash collection and disposal system that sufficiently removes debris from the city, so that drainage infrastructure cleaning and maintenance are manageable. • Reliable weather forecasting that provides sufficient time for cleaning activities • A plan for inspection locations <p>Important Considerations</p> <ul style="list-style-type: none"> • Generally prioritize inspection of downstream locations before inspecting upstream system locations. • Inspection of low points within the drainage system, such as underpasses or locations of pumping stations, is especially important. • <p>Financing and Resources</p> <ul style="list-style-type: none"> • The city plans and finances system cleaning and maintenance, but can outsource the physical cleaning work to a private company. • Any tools, trash bags, and vehicles necessary to perform needed cleaning 	
D2-4. Establish a Hotline and Respond to Resident Reports	
<p>Description</p> <p>Establish a hotline that allows residents to contact the city’s drainage/stormwater department with issues. The city then responds to both the call and the issue.</p> <p>Necessary Existing Conditions</p> <ul style="list-style-type: none"> • A municipal trash collection and disposal system that sufficiently removes debris from the city, so that drainage infrastructure cleaning and maintenance are manageable. • The communication tool chosen must be convenient and accessible for the majority of the public. This may include phones, emails, and social applications. <p>Important Considerations</p> <ul style="list-style-type: none"> • Responding to hotline calls, both to the caller and to the issue at hand, is critical to develop and maintain trust as well as to address the reported issue. • Different city departments may need their own internal communication system to appropriately respond to the variety of calls the city may receive. <p>Financing and Resources</p> <ul style="list-style-type: none"> • Funding necessary to maintain the communication system, both the technical tool and human resources • Residents as reporter of issues, communicating observations and needs to the city 	<p>The Kitakyushu Experience</p> <p>The Kitakyushu city government’s rule to ensure that all calls are responded to in a week, even if the response is to provide an update or to request more time to address the raised issue.</p>

D2-5. Hold Clean-Up Events**Description**

Clean-up events consist of schools, community groups, volunteer groups, and other organizations that organize a local trash pick-up event.

Necessary Existing Conditions

- A municipal trash collection and disposal system that sufficiently removes debris from the city, so that drainage infrastructure cleaning and maintenance are manageable.

Important Considerations

- A clean-up event is simultaneously an educational and promotional event. Reach out to schools and the community. Consider how to effectively use mass media for publicity (See **E4-1**)

Financing and Resources

- Residents as participants
- Community groups, schools, private companies as those responsible for the event
- Seek local private company involvement as a part of their volunteer or CSR contribution
- Any tools, organization, and logistics necessary to prepare and hold a clean-up event

The Kitakyushu Experience

The mayor in the late 1960s, known as the “toilet mayor” was known to personally participate in clean-up events to encourage citizen involvement.



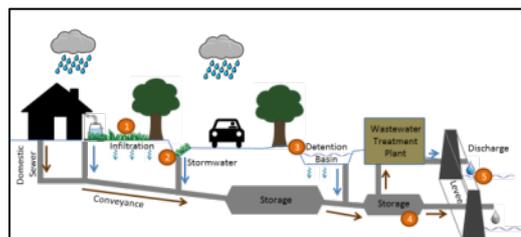
Today, there are resident-led groups throughout Kitakyushu, such as about 1,000 “road supporter” groups. Each of these groups organizes a clean-up event about once a month. The city government provides trash bags and tools to support these events, and government workers participate as well.

Actions to Expand/Improve the Drainage System

D3. System-wide Drainage Planning Considerations

Purpose/Introduction

Drainage infrastructure needs to adapt as the city grows, land-use patterns change, and resident needs shift. Urbanization increases impervious areas, runoff coefficients, and peak flows while decreasing water quality. Efforts to regain or maintain natural infiltration of rainwater will help decrease flooding, unintended environmental impacts, such as water pollution and erosion, and maintain groundwater resources. Basic considerations to plan updates to existing systems versus new systems are similar. This action presents system-wide planning options that Kitakyushu chose as its city expanded.



D3-1. Plan Using Sustainable Urban Drainage Systems (SUDS)/Low Impact Development (LID) Principles

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Long	\$\$\$	High	Construction Industry, R&D, Land Owners, Engineers	High

Advantages

- Enhances multiple beneficial uses of the same space, including aesthetics and recreation
- Can help conserve environmental habitat
- Improves discharge water quality
- Help maintain groundwater levels

Disadvantages

- Requires a large space for implementation compared to traditional drainage management
- Requires policy to encourage implementation of SUDS/LIDs in nonpublic spaces.

D3-2. Convert to Partial Separate Sewer Systems

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Long	\$\$\$	High	Construction Industry, R&D, Land Owners, Engineers	High

Advantages

- Limited or no risk of sewage overflow into public waterbodies
- Decreases demands on wastewater treatment plants
- Surface run-off and rainwater can be reused (e.g. for landscaping or agriculture) after simplified treatment
- Should there be flooding during rain events, floods will originate more often from greywater and not be contaminated with sewage

Disadvantages

- Difficult to construct in areas with narrow roads and minimal space
- More expensive to construct and maintain than combined sewer system
- Higher risk of water pollution by accidents (e.g. oil, chemicals) or unintended cross-connections

D3-3. Utilize Open Spaces, Ponds, and Detention Basins

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Long	\$\$	Mid	Residents, City Planners, Engineers	Mid

Advantages

- Increases city livability
- Increases operational flexibility for the drainage system
- Supports urban ecosystems
- Maintains groundwater levels

Disadvantages

- Requires long-term planning for land conservation
- Requires coordination with other uses for the space and water storage

D3-4. Relocate Informal Settlements around Waterbodies

<u>Timeframe</u>	<u>Affordability</u>	<u>Technical Level</u>	<u>Partners</u>	<u>Involvement Level</u>
Long	\$\$\$	Mid	Residents, Landowners, Community Leaders	High

Advantages

- Allows for an efficient drainage system
- Allows city governments to create public space by waterways

Disadvantages

- Relocation of people, industries, buildings, and services require significant outreach, consensus building, and appropriate compensation
- Time and resources intensive

D3-1. Plan Using Sustainable Urban Drainage Systems/Low Impact Development Principles**Description**

SUDS/LIDs refer to approaches that promote maintaining the same time of concentration at POIs pre- and post-development of the urban environment. The approach encourages higher infiltration, use of vegetative detention basins and channels, and strives to capture the first several centimeters of rain to address runoff water quality concerns. For specific descriptions of SUD/LID infrastructure, refer to the Kitakyushu Model, Water Management.

Necessary Existing Conditions

- Sufficient studies to design a location specific SUDS/LID infrastructure
- Capacity to accept, plan, and implement SUDS/LIDs principles
- Capacity to pass ordinances, taxes, and/or regulations on stormwater management so that there is systemwide implementation of SUDS/LIDs and not just on publically owned land.

Important Considerations

- Plant native plants for habitat restoration/preservation
- May require more maintenance to manage vegetation
- Consider the role of the specific structure (for example, water quality mitigation or temporary water storage)
- Consider involving the private market and incentivize landowners to convert or implement SUDS
- Development and installation of new infrastructure may require a need for new standards and regulations

Financing and Resources

- SUDS/LID structures can still be funded through traditional means, since it is an alternative to more traditional, utilitarian drainage systems
- City governments could possibly obtain funding from other sectors within and outside of the government, since this infrastructure usually provides multiple benefits
- R&D and technical personnel to install location-specific structures
- Consider creating a market by implementing regulations (such as a stormwater tax and rebate system) that leads to development of the private sector to meet this need

Operation and Maintenance

- Regular infrastructural maintenance and cleaning
- Additional maintenance to support vegetation

Performance Indicators

- Changes in time of concentration at POIs as SUDs/LIDs are implemented
- The amount or proportion of impervious areas
- Changes in water quality at points of discharge

The Kitakyushu Experience:

While a long-term vision for city and landuse planning is ideal, the reality of Kitakyushu City history shows that at the time, the clear priority was flood control and protection of the city and its resident's lives. Environmental, aesthetic, and other important roles an urban river should play only gradually came to be considered in the 1990s.

The Tarabaru Basin, a detention basin, is an example of SUDS/LID. This basin was specifically renovated and designed to provide recreational, educational, and environmental benefits along with flood management uses. Unlike many detention basins in Kitakyushu, the bottom of the Tarabaru Basin is undeveloped, allowing vegetation to grow and an ecosystem to flourish. The detention basin and its surroundings are used for festivals and school field trips when it is not fully inundated.



D3-2. Convert to Partial Separate Sewer Systems**Description**

Many cities initially operate combined sewer systems, but find it beneficial to convert to separate sewers as the city expands and drainage infrastructure is updated and replaced.

Necessary Existing Conditions

- Sufficient human and financial resources to implement a dual system
- Planning for the entire drainage area as to how and where to discharge stormwater and how and where to connect wastewater pipes to existing systems
- A longterm plan and strategy

Important Considerations

- Consider the benefit of managing wastewater inflow into treatment plants and how much separate sewers can contribute to continued use of existing infrastructure
- Consider the frequency of combined sewer overflows, its environmental impact on receiving water bodies, and societal impact of any overflows
- Drainage infrastructure can be updated and/or replaced in sections if strategically planned. Time drainage infrastructure update works with other ongoing construction that requires breaking ground.
- Prioritize areas to install separate sewer systems. Important criteria can include:
 - Severity of overflows or inundation events
 - Proximity or impact on important public services, such as hospitals and schools
 - Proximity or impact on economically important city sections

Financing and Resources

- In addition to traditional funding sources,
 - Consider if/whether separate systems, and hence lower flows, will allow elongated use and operation of existing wastewater treatment plants, and possibly reduce the need for additional treatment capacity
 - Consider the environmental/water quality benefit separate sewers will have.
- Hire necessary staff or private companies to support planning, engineering design, and construction work
- Maintenance of separate sewer systems may be more costly than a combined sewer system. Plan accordingly.

Operation and Maintenance

- Regular infrastructural maintenance for pipes, pump stations, and detention basins
- Gutter cleanings discussed in Action **D2**
- Pipe replacement needs depend on material and wear and tear

Performance Indicators

- Change in frequency of CSOs
- Improvement in water quality of receiving water bodies, especially during and immediately after rain events.
- Reduction in sewer backups resulting from flows exceeding design flows into treatment plants

The Kitakyushu Experience

Kitakyushu's drainage infrastructure that was built before approximately 1970 was designed to be a CSS. At the time, installing a CSS was faster, cheaper, and more efficient, since only one pipe network was necessary. Managing urban runoff to improve public health was one of Kitakyushu's priorities.

Today, 21% or 3,422 ha of the City's sewer/drainage network area is CSS. Areas built and renovated after 1970s generally have SSSs. This change in approach signifies extensive urbanization and increased impervious areas, which led to severer inundation and CSO issues during rain events. In mid to late 1970s Japanese cities nationally experienced serious urban flooding due to inadequate drainage capacity relative to the landuse changes that had occurred. Drainage infrastructure was then redesigned and updated to accommodate the high runoff coefficient, while nonstructural measures to decrease runoff started to be examined.

In 2005, the City prepared its first "Emergency Plan to Improve the City's CSS," and this plan and its goals have been updated twice since then.

Overall goals include:

- Reduce CSS pollution loads to those of SSS.
- Halve the number of CSOs
- Control the amount of debris in discharge waters

Specific actions include:

- Construct new stormwater pipes or canals, and refurbish existing CSS pipelines as wastewater pipelines.
- Construct stormwater detention basins to capture the initial runoff and majority of urban nonpoint source pollution. This water is treated at a wastewater treatment plant after the rain event.

D3-3. Utilize Open Spaces, Ponds, and Detention Basins**Description**

As the city expands and develops it is often beneficial to secure open spaces and utilize existing water bodies, such as small agricultural reservoirs. Many older structures can be adapted and converted for use as detention basins or ponds that encourage infiltration as well as provide temporary stormwater storage.

Necessary Existing Conditions

- An overall city development plan
- Plan or knowhow on annexing additional land into the city.

Important Considerations

- Agreement or consensus with landowners
- Determine if there are necessary legal processes issues with converting water and land uses from agriculture or rural based zoning to urban uses
- Consider multiple benefits of the space, including recreation, aesthetics, ecosystem, and water quality benefits

Financing and Resources

- Funding and human resources to plan, adapt, and remodel existing infrastructure.
- Social and institutional skills to navigate land acquisitions and zoning changes
- Consider getting funding from non-drainage specific sources, if the city can claim multiple benefits of the facility

Operation and Maintenance

- Regular infrastructural maintenance for intakes, outlets, and any pump stations
- Dredging if sediment/debris build-up is an issue
- General trash pickup cleaning (See **D2**)
- Pipe replacement needs depend on material and wear and tear

Performance Indicators

- Changes in infiltration rates/groundwater levels
- Use of the open space for the various beneficial uses
- Decrease in drainage system overflows
- Increase in discharge water quality

Alternative Actions

- Construct underground storage structures, such as storage tanks, to increase storage throughout the system. This will increase system operational flexibility and help decrease CSOs, but would not provide other multiple benefits.

The Kitakyushu Experience

Kitakyushu manages 10 detention basins within the city. Many of these basins were former agricultural reservoirs, and while no longer used for agriculture, these basins work to temporarily store runoff to decrease flow in downstream rivers

These structures reduce flood risk and have proven to successfully manage intense rainfall events.



D3-4. Relocate Informal Settlements around Waterbodies**Description**

People often settle near waterways and floodplains, creating informal settlements in many cities. These structures can impede needed flow capacities in the waterways, and people living in these settlements may directly dispose of domestic waste into the waterway. These residents are vulnerable to the smallest of floods and often have the least capacity to cope and recover from flood disasters. Simultaneously, lands along waterbodies are often public or government land, which could be used for not just flood risk management but other publically beneficial uses, such as recreation. Resettlement is a difficult process, but may be necessary to improve conditions city-wide.

Necessary Existing Conditions

- Identification of cooperative community leaders
- Clear need for relocation for the larger public good
- Compensation for those that are forcibly moved
- Capacity to follow through and develop as planned the land that was formerly informally settled.

Important Consideration

- Consider not just locations for resettlement but whether those people can make a living in their new locations. For example, if the resettlement involves an industry, such as fisheries, are there alternative work locations for the people or alternative sources of fish for consumers?
- Limit relocations of structures and people to those that are necessary.

Financing and Resources

- Funding to pay for relocation compensation as well as development of new housing or complexes when necessary
- Labor to undergo a long consensus building process with landowners and residents
- Lawyers if the city faces legal and settlement issues

Operation and Maintenance

- NA

Performance Indicators

- Community surveys on living condition satisfaction
- Extent and demographics of informal settlements
- Change in lifestyles after relocation

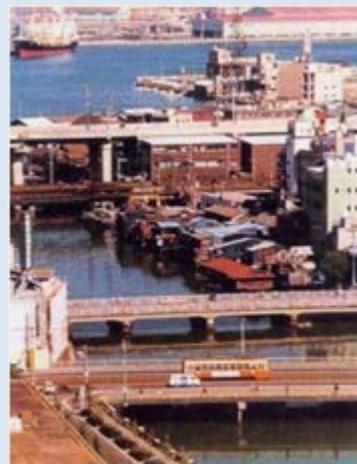
The Kitakyushu Experience

Kitakyushu City had illegal settlements along and within the city rivers, and these settlements were causing city-wide drainage water discharge issues, in an otherwise developed river. The City began relocation efforts starting around 1970 with close coordination between prefecture and city officials as well as community leaders. The City built public housing for resident relocation.



Near the Mouth of the Murasaki River in the late 1960s

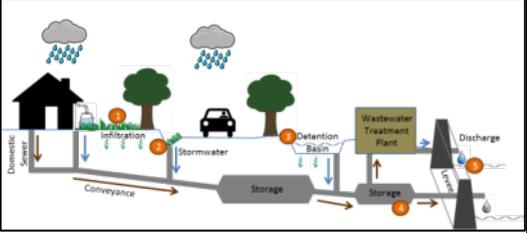
On the other hand, there are still sections of the city where buildings extrude even today. Located near the mouth of a tributary to the Murasaki River, it is an old and central community market that has been in operation since the early 1900s. This market, however, has important historic and cultural value, and plans to both protect this area and manage flood risks are underway.



Near the Mouth of the Murasaki River in the early 1970s

D4. Design Level Considerations

Purpose/Introduction
 Urbanization increases impervious areas, runoff coefficients, and peak flows while decreasing water quality. This means, urbanization increases the need for more robust infrastructure. These actions focus on design and construction level considerations necessary to expand and adjust the drainage system for an increasingly urban landscape.



D4-1. Secure Discharge Points/Points of Interest

<u>Timeframe</u> Short	<u>Affordability</u> \$\$	<u>Technical Level</u> High	<u>Partners</u> Engineers, Planners	<u>Involvement Level</u> High
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<p>Advantages</p> <ul style="list-style-type: none"> Allows for or promotes planning development of the entire drainage area Ensures sufficient drainage capacity for the entire area 	<p>Disadvantages</p> <ul style="list-style-type: none"> Takes a long time to secure final discharge points if coordinating with levee construction/river development
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D4-2. Create or Revisit Design Storms and Runoff Assumptions

<u>Timeframe</u> Short	<u>Affordability</u> \$	<u>Technical Level</u> High	<u>Partners</u> Engineers	<u>Involvement Level</u> High
---------------------------	----------------------------	--------------------------------	------------------------------	----------------------------------

<p>Advantages</p> <ul style="list-style-type: none"> Provides a common design criteria to size drainage infrastructure Ensures design criteria is up-to-date 	<p>Disadvantages</p> <ul style="list-style-type: none"> Requires long-term data collection, management, and analysis
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D4-3: Redevelop or Manufacture New Materials and Designs

<u>Timeframe</u> Mid	<u>Affordability</u> \$\$	<u>Technical Level</u> High	<u>Partners</u> Engineers	<u>Involvement Level</u> High
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<p>Advantages</p> <ul style="list-style-type: none"> Can reduce design and construction costs Encourage city specific R&D fit for the environment or situation Makes retrofitting or future adaptation easier if infrastructure is standardized Encourage development of private sector manufacturing 	<p>Disadvantages</p> <ul style="list-style-type: none"> Standardization also devalues non-standard designs or methods Poor standards can have city-wide impact
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D4-4. Expand Drainage System in Coordination with Other Construction

<u>Timeframe</u> Long	<u>Affordability</u> \$\$\$	<u>Technical Level</u> High	<u>Partners</u> Engineers, Contractors	<u>Involvement Level</u> High
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<p>Advantages</p> <ul style="list-style-type: none"> Decreases overall costs Ensures drainage is considered as the city expands or is reconstructed 	<p>Disadvantages</p> <ul style="list-style-type: none"> May complicate each engineering and construction project Separate planning and projects are required to ensure overall drainage infrastructure needs are addressed Requires coordination with other departments
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D4-1. Secure Discharge Points/Points of Interest**Description**

Drainage infrastructure is built downstream up. Plan drainage systems using drainage “areas.” Determine the downstream “point of interest” (POI), calculate needed capacity at the POI (See **D4-2**), stabilize the point of discharge, and build upstream from this point. Securing the most downstream points of discharge require collaboration with land-use planning and river flood management planning and integration with existing or planned levee or other flood management structures. It may be necessary to relocate existing structures to locate discharge points where most technically sound (**D3-4**).

Necessary Existing Conditions

- Topographic map or elevations to determine drainage areas, POIs, and slope
- Design storm hyetographs, runoff coefficients, and runoff hydrographs (**D4-2**)
- Schematic and understanding of the entire drainage infrastructure system

Important Considerations

- For points of discharge, the lowest POI, it may be necessary to coordinate with levee construction or any structural needs of the receiving water body. POIs are generally set where the system would enter public waterbodies.
- Selection of POI is the start of planning for a new drainage area. Prioritize construction according to:
 - Localized urban flood risk
 - Location of important public services, such as hospitals, water treatment plants, power distribution centers, public schools, evacuation zones, police and fire stations
 - Economic value
 - Ease of post-flood reconstruction

The Kitakyushu Experience

Kitakyushu’s drainage regions are about 16,000 ha each and usually corresponds to “urbanization areas” as defined under Japan’s City Planning Act. Hence, the area is a unit convenient for planning purposes. New regions were added to the network as the city expanded upstream.

The lowest point of discharge is at the Murasaki River, and these points were determined and secured simultaneously as levees were built for city flood protection. Fukuoka prefecture performed flood planning while the city was responsible for levee construction within its jurisdiction. Flood control construction projects on the downstream end of Murasaki River took place in the 1970s.

Financing and Resources

- Funding for planning, design, and construction of new infrastructure
- R&D and other technical personnel to perform drainage infrastructure planning
- Contractors to install structures

Operation and Maintenance

- Maintain discharge capacity at POIs and final discharge points. (See **D2** for trash/debris removal options).
- Maintenance of final discharge capacity may also involve river cleaning and, if necessary, river dredging to remove river-basin wide sediment buildup.

Performance Indicators

- Frequency and extent of drainage backup due to undersized downstream capacity (e.g., at POIs)

D4-2. Create or Revisit Design Storms and Runoff Assumptions**Description**

The stormwater component of drainage infrastructure design often uses design storms and other criteria to determine appropriate sizing of drainage infrastructure, such as pipe sizes. Key criteria or assumptions include:

- Design storm event hyetographs (including what frequency storm to design for)
- Runoff coefficients and slopes

These determine runoff hydrographs and associated time of concentration and flow at time of concentration, for which the system needs to be designed.

Since these assumptions and criteria are foundational to all designs that follow, these should be revisited as:

- Rainfall patterns change
- Increase in data allows for updates to design storms
- Changes in land use, especially changes in impervious areas and ground elevations

Necessary Existing Conditions

- Adequate precipitation monitoring data and analysis capacity
- Topographic/landuse/vegetation/elevation data
- Decision on what frequency storm to use
- POI location and associated drainage area (**D4-1**)

Important Considerations

- Consider national or regional plans or regulations that usually dictate the level of flood/inundation protection drainage infrastructure should provide
- Consider if neighboring cities or regions have updated design storms that can be also applied.
- Coordinate this option with other cities, regional, and national governments as, ideally, a part of a larger program
- Determine runoff coefficients, and hence runoff, considering city development 30 to 50 years into the future
- Designing for a design storm implies that flooding needs to be expected should a larger or more intense storm comes. The city should separately plan for such inundation events.

Financing and Resources

- Continual funding is needed to support installation and operation of rain gauge stations, data collection, and data cleaning and management. This need not be at the city government level.
- Required human resources could include data managers, meteorologists, hydrologists, hydrologic engineers, city planners
- Rain gauge station technology with remote or manual systems to collect the data

Operation and Maintenance

- Regular O&M of rain gauge stations, and other equipment needed for analysis, such as computers/servers
- Data management

Performance Indicators

- Extended records of inundation to determine if assumptions need to be revisited. (For example, the system was in theory design for a 10-year rain event, but statistically, it floods much more often)

The Kitakyushu Experience

In 1995, the national urban planning committee set the national policy to plan for 10 year events in urban areas and to provide this level of protection by the beginning of the 21st century.

Historically, Kitakyushu City had designed its drainage infrastructure for a 5 year storm event, but since 1991, the City has designed for a 10 year storm. The 10 year storm is currently determined to have the intensity of 53.1mm/hour.

Further, studies within Kitakyushu have shown that urbanization has increased total runoff by a factor 2.5 within a set drainage area. Urban drainage infrastructure needs to accommodate for such changes in runoff characteristics.

D4-3. Redevelop or Manufacture New Materials and Designs**Description**

Standards sizes and designs for drainage canals, gutters, screens, grating, and pipelines can be useful to streamline engineering, procurement, and construction, while also giving the city its own “look.” Any cost savings incorporated into these standard designs will have a compounding impact, when considering the total length of pipes and number of manholes necessary to develop an entire drainage system. Having consistent designs and sizes throughout the city also will allow for easier systemwide retrofits and adaptations when necessary.

Necessary Existing Conditions

- Technically capable city officials and/or residents
- Cooperation with manufacturing companies
- Need that is of a large enough scale that manufacturing, designing, or creating for a set standard has extensive impact on future systemwide planning and construction.

Important Considerations

- Look into readily available materials and sizes. Do they meet standards? Are they affordable? It may be as simple as choosing the most readily available materials, such as pipes and manhole covers, to become the city standard.
- Determine national or other available and relevant standards such as required material quality, strength, safety characteristics, and manufacturing processes. New materials/designs must at least meet these standards.
- What specific needs do the city standard need to address? This could include costs or smart design adaptations, such as the example in Option D1-2, where a unique metal grating was designed to collect green waste in such a way that it does not completely restrict water flow.
- Consider tradeoffs for different designs and sizes. For example, a smaller pipe may be cheaper to manufacture, but may put strains on construction workers who have to fit inside smaller tunnels to lay the pipes. Weaker pipe material may be cheaper to procure, but may require that it be buried deeper into the ground.
- Consider contributing new developments to existing standards

Financing and Resources

- Experience, technical knowledge, and physical resources to manufacture/design new materials
- Longterm and reliable investment such that would support development of new standards or designs

Operation and Maintenance

- Regular O&M of manufacturing or construction of particular materials or system segments
- Continual economic and human investment in R&D

Performance Indicators

- Relevant indicators depend on the need new designs/standards were intended to meet. It may include:
 - Comparative monitoring of cost savings
 - Prevalence or replacement rate of the new design/standard throughout the system
 - Effectiveness at achieving what the new design/standard was intended to accomplish

The Kitakyushu Experience

Historically, Kitakyushu City collaborated closely with manufacturing companies and created its own standard materials to cut costs and to construct a drainage system as quickly as possible. Some adaptive materials included the following:

- Manhole covers made with concrete and metal



- Stronger reinforced concrete pipe so that it did not need to be buried as deep and could withstand a wider range of environments.



Kitakyushu's industrial background meant that human resources and technical resources were locally available to attempt such R&D. Kitakyushu's experience is nonetheless remarkable and shows how local ingenuity can go a long way in solving a local problem.

D4-4. Expand Drainage System in Coordination with Other Construction

Description

The drainage infrastructure network is best expanded along with other planned construction or reconstruction. Urban development construction, whether it be commercial buildings, homes, or roads all alter existing land use and runoff patterns. Roads in particular are essentially lines of raised berms, meaning artificial drainage for the surrounding areas must be installed. Coordinating construction not only makes technical sense, but it often allows the city to cut total costs.

Necessary Existing Conditions

- A drainage area plan, including a schematic for where to construct drainage pipes or canals of what capacity.
- Coordination of drainage infrastructure planning with city development and/or roads department

Important Considerations

- Build drains as roads and new developments are built.
 - Reduces excavation costs by decreasing the number of excavations necessary
 - Eliminates need for re-patching or resurfacing road concrete/asphalt.
 - Simplifies construction management by interacting with both road and drainage contractors together
 - Reduce impacts to and complaints from residents
- Determine where exactly to lay drainage pipelines. Urban areas generally have crowded underground utility systems, so coordination is important.
- As a general rule, should different pipelines come in close proximity, drinking water pipes should be above stormwater drainage pipes, which should be above wastewater pipes.
- When replacing roads and if the drainage pipes lie underneath the roads, consider upgrading pipe material to increase strength. Steel pipes, for example can withstand higher stress than clay pipes, and may be necessary depending on traffic load conditions.

The Kitakyushu Experience

Kitakyushu clearly delineated roles and responsibilities to coordinate road construction with urban drainage infrastructure construction.

The wastewater/urban drainage department was responsible for designing and constructing drainage pipes, pump stations, and detention basins. On the other hand, the roads department took responsibility for design and construction of gutters, drainage canals adjacent to roads, and underpasses. This coordination allowed Kitakyushu to quickly manage urban flood risks during its development.

Financing and Resources

- Investment is needed for city development. However, building roads/other infrastructure along and expanding drainage infrastructure along with the construction is in itself an economical method.
- Required human resources could include managers, planners, and engineers of both the main development and drainage departments.

Operation and Maintenance

- The relevant departments should coordinately sufficiently to ensure the larger drainage system is being adequately constructed, although in parts.

Performance Indicators

- Percentage of new development, including roads, that did not contribute to expansion of the drainage system

5 Financing Options

Financing is critical in providing government services. Initiating new services and investing in infrastructure requires high capital costs. In contrast, O&M of existing infrastructure and systems, public involvement, and education require less annual or one-time costs but rely on constant, reliable financing streams.



This subsector model includes both sector specific, infrastructural projects as well as cross-sector actions that involve residents and stakeholders on a recurring basis. The former may rely on specific grant schemes or loans, while the city government may have to fund the latter on their own. Hence, this financing section examines the overall financial sources for a city, based off of the Kitakyushu city government experience. The city government then allocates these sources internally, according to regulations, policies, and priorities.

Simultaneously, funds are always finite. City governments and their departments frequently reexamine their budget, prioritize projects, and identify ways to reduce project costs. Kitakyushu has a history of being creative to reduce costs of high investment projects, especially for their urban drainage systems. These examples are also presented in this section. In Kitakyushu's words, it is the city government's responsibility to overcome insufficient resources, including funds, people, and materials to provide public services. Shortages are ongoing issues, and are never sufficient excuses for not being able to serve residents.

This section consists of the following two subsections.

- Financial sources for a city
- Examples of costs reduction methods

This section does not include the following information, because they are infrastructure project centric and are covered in existing Kitakyushu Model sectors.

- Risk management during project cost estimation
- Procurement procedures and methods
- Contract and construction management methods and types

While Kitakyushu's experience may not be directly applicable globally, it can act as a reference for other city planners in their own attempts to secure adequate funding to implement projects and programs.

5.1 Financial Sources for a City

5.1.1 Financial Sources for the City Government

A country's system of government heavily influences sources of city budgets. Japan is a unitary state, in which the nation enforces a high level of organizational and policy standardization. Table 5-1 presents an overview of Kitakyushu's financial sources and how each source is used, how often they are available, and how reliable they are. The proportion of each financial source relative to the annual city budget is provided as reference. The combination of city taxes, revenue from user fees, and municipal bonds, which are financial sources raised solely by the city government, amounts to approximately 50 percent of the total budget.

Generally, ongoing city services and activities, such as public outreach, education, and recurring O&M work are funded by constant and reliable sources. On the other hand, infrastructural projects require a heavy, one time investment, for which the city can issue municipal bonds. Numerous national grants and assistance may be available, but these often require grant applications and evaluations before an award decision is made. To finance an infrastructural project, the city takes advantage of any available national grants first and then municipal bonds. If the project is still underfunded, the city government draws from city taxes and national government allocations as a last resort.

Table 5-1. Overview of Kitakyushu Financial Sources and Their Characteristics

	Funds Ongoing Activities	Funds Projects	Frequency Available	Reliability of Availability	Proportion of Total City Budget ¹
City Taxes	☑		Annually	Reliable	29%
National Government Allocations	☑		Annually	Reliable	9%
Revenue from Services and User Fees	☑		Annually	Reliable	3%
Municipal Bonds		☑	Almost Every Year ²	Reliable	18%
National/Regional Government Grants		☑	New Award Every Few Years ³	Depends on Grant Application Result	22%
Miscellaneous	☑		-	-	19%

Source: Kitakyushu City (2015)

Notes:

1. Proportion of city government budget is approximate, based on fiscal year 2014.
2. Kitakyushu City government issues municipal bonds almost every year.
3. A new grant award may be once every few years in a given sector. However, there can be multiple grants and each grant disbursement can span several years. Hence, there are funds from grants every year.

Additional details for each financial source identified in Table 5-1 are provided below. Although not used in Kitakyushu, international funds, such as loans and funds from bilateral and multilateral donor agencies, NGOs, and institutions can additionally assist city governments around the world. Descriptions of these sources are omitted in this subsection.

City Taxes and National Government Allocations

City taxes are mandatory fees the city collects from its residents. Feasible taxes depend on each city's jurisdiction and legal powers as well as the relationship and separation of powers between the city and the regional and national governments. Example city taxes include but are not limited to the following.

- Resident tax
- Property tax
- City planning and industry/business tax
- Tax on automobiles and motorcycles
- Tax on luxury items, such as tobacco
- Various taxes on tourism

In contrast, national government allocations are national budgets annually disbursed from the national government to help ensure cities provide basic services to city residents. Both taxes and national government allocations are reliable financial streams.

The Kitakyushu Experience

In Kitakyushu, these two sources fund ongoing city activities. City taxes also help fund infrastructural projects when national grants and municipal bonds are insufficient. For example, for an average waste management project, these sources account for approximately 10 percent of city borne costs.

Revenue from Services and User Fees

It is generally good practice to have users of a service directly pay for that service. Effective fee or rate setting is critical to balance affordability, equity, and legal constraints or requirements. User fees can help fund O&M and future system investments. Requiring payment can also encourage users to efficiently use services, which can decrease overall demands on the infrastructure or system. Fees that can be collected from services relevant to this model consist of the following.

- Wastewater service fees from users
- Stormwater fees from property owners
- Waste collection fees from users
- Revenue from visitors visiting city museums or from participants in programs/events

The Kitakyushu Experience

Kitakyushu charges households service fees for wastewater, and hence, partly for drainage services, relative to the amount of drinking water used. The water and wastewater bill is provided together as a set service, since water delivered to a household must be drained out. Kitakyushu does not charge for stormwater drainage services.

As dictated by national policy, Kitakyushu does not charge residents for waste management services. However, as described in **W5-3**, the city government began charging residents for city designated plastic trash bags in 1998 with the intent to encourage waste reduction at the household level. A fee of 0.50 USD per bag was deemed effective for waste reduction and was initiated in 2006. Kitakyushu uses collected revenue in excess of bag procurement costs to provide cleaning tools to residents and CBOs, supporting community waste cleaning activities. This example portrays that charging users for disposed waste could be a revenue stream to support financial sustainability of waste management services.

Further, some city services or projects can provide multiple benefits, which could become an additional revenue source. Examples relevant to this subsector model include the following.

- Revenue from selling heat and electricity generated by the incineration plant
- Revenue collected from users of recreational facilities located near public facilities or constructed as a part of public works projects

The Kitakyushu Experience

Kitakyushu's 24-hour incineration plant produces heat and electricity, which Kitakyushu uses to power the plant. Electricity produced in excess is sold to local power utilities and nearby industries as an additional income stream.

Municipal Bonds

A city government can borrow money from investors for a defined time and pay back the loan plus interest. These debt investments are called municipal bonds. Japanese cities issue bonds to help secure necessary cash flow to fund capital investment. Japan has the second largest municipal bond market in the world (Ministry of Internal Affairs and Communications, 2010).

The Kitakyushu Experience

In Kitakyushu, municipal bonds are a reliable source of funding for construction projects. A new bond is issued almost every year. Municipal bonds, for example, accounted for 90 percent of the local cost share when implementing waste management facility projects.

National/Regional Government Grants

National and/or regional governments often provide grant or funding schemes to promote local development in line with national policies. Cities must prepare a grant application and are awarded funding depending on national government evaluations and discretion. Below are several examples of Japan's funding schemes Kitakyushu has utilized. Many schemes are set to promote projects or systems that provide multiple benefits.

The Kitakyushu Experience

- Funds to Promote Resource-Cycling Societies
Provides one-third cost-share for waste treatment facilities that recover energy, material recycling resources centers, and final disposal sites. Provides one-half cost-share for advanced facilities, such as incineration plants that generate electricity.
The nation helps fund these recycling or energy-conscious waste management related facilities, because they often require high capital costs but have a life of about 30 years. The country promotes construction and use of more advanced, environmentally and financially sustainable facilities by supporting initial capital investment.
- Funds for Offshore Landfill Walls/Levees
Provides 50 percent cost-share to construct and maintain levees/walls of offshore municipal waste landfills. Provides 40 percent cost-share to construct and maintain levees/walls of offshore industrial or private-sector waste landfills.
The fund encourages development of offshore landfills that simultaneously improve the local environment; improve access, use, and working conditions in and around the harbor; provide public open spaces; and act as a public emergency evacuation site.
- Urban River Improvement Projects
- Comprehensive Funds for Public Infrastructure
Provides assistance to renovate or newly construct river bank protection infrastructure and detention or flood control basins. The fund supports system adaptation to increasing urban flood risk from intense rain events and

higher runoff flows.

Urban river improvement projects are an example use of this comprehensive fund. The fund provides assistance for high priority projects on relatively smaller rivers of nationally designated important rivers. Projects include river expansions, levee renovations, and river dredging, and are conducted in coordination with the prefectural government.

Kitakyushu has relied on these funds to construct levees. The prefectural government conducted a basin-wide flood protection plan, and the city, in coordination with the prefecture, performed construction work. Project cost share was one-third national, one-third prefecture, and one-third city government.

- Funds for Urban Drainage Services

Provides funding for expansion or extension of stormwater infrastructure and pipelines, if the capacity (e.g. pipe length, diameter) is large enough to meet minimum funding criteria.

5.1.2 Coordination with the National Government to Develop Necessary Funding Streams

City governments, as well as other local organizations and entities, can lobby and work with national governments to develop relationships, effective grant schemes, and other necessary support systems. Coordination can increase a city government's understanding of national goals/policies, including how to best apply for funding. In return, the national government can learn about local needs and challenges so that future policies and schemes can be formulated to better address those needs.

The Kitakyushu Experience

Kitakyushu has a long history of working with the national government, providing on-the-ground information and city needs and challenges to the national government so that effective funding streams could be developed. Kitakyushu also cooperates with other major Japanese cities so that their collective voices can be heard. Below are coordination and communication examples.

- Meeting and holding discussions with key national ministry staff in Tokyo before the annual budget is decided
- Cooperating with other cities and co-developing white papers and/or requests, which can then be presented to the national government. These initiatives are usually sector or content specific. For example, a report was prepared and submitted to the national government to request expansion of Funds to Promote Resource-Cycling Societies so that a wider variety of facilities would be applicable for funding. They also requested that funds be dispersed over a longer time-period.
- Building cooperative, respectful relationships through ongoing project grant management

5.1.3 External Financial Resources for City NGOs and CBOs

There are separate national subsidies as well as some private company funds that are available to NGOs/CBOs for their volunteer work. Private funds include corporate social responsibility (CSR) funds from large companies offered through competitive or noncompetitive means. TOTO, for instance, the ceramic company globally known for their toilets, is based in Kitakyushu City, and actively supports local NGO/CBO initiatives. NGO/CBO activities contribute to or supplement city services, such as by organizing clean-up events, promoting clean cities, and offering environmental education opportunities.

The Kitakyushu Experience

The community organization council of the Nakatani-District advocates for preservation and restoration of the aquatic environment of the Masubuchi Reservoir and the Muraski River, Kitakyushu's drinking water source and the river that flows through the city, respectively. The council focuses on increasing awareness of the need to restore these iconic natural systems, and has received private corporate funding to support their activities in Kitakyushu.

5.2 Examples of Cost Reduction Methods

Within an infrastructure project life cycle, starting from project planning to construction and ending with O&M, construction requires the highest cash flow. Figure 5-1 depicts project-based expenditures relative to when in the project cycle a project team may have the most opportunity to alter or influence project impacts and costs. Conceptual planning and feasibility studies are lower cost compared to construction, but decisions made at these stages can more extensively influence future costs. For example, overall plans for urban drainage or waste management systems, dictate the types of infrastructure that are needed. In comparison, engineering design phase allows for minor adaptations and alterations, but the project is already committed to, for instance, building a wastewater treatment plant or a sanitary landfill of a

designated capacity. Likewise, cost reductions for O&M is easier when planning or designing the facility but much more difficult once the infrastructure exists. Note that Figure 5-1 is strictly conceptual.

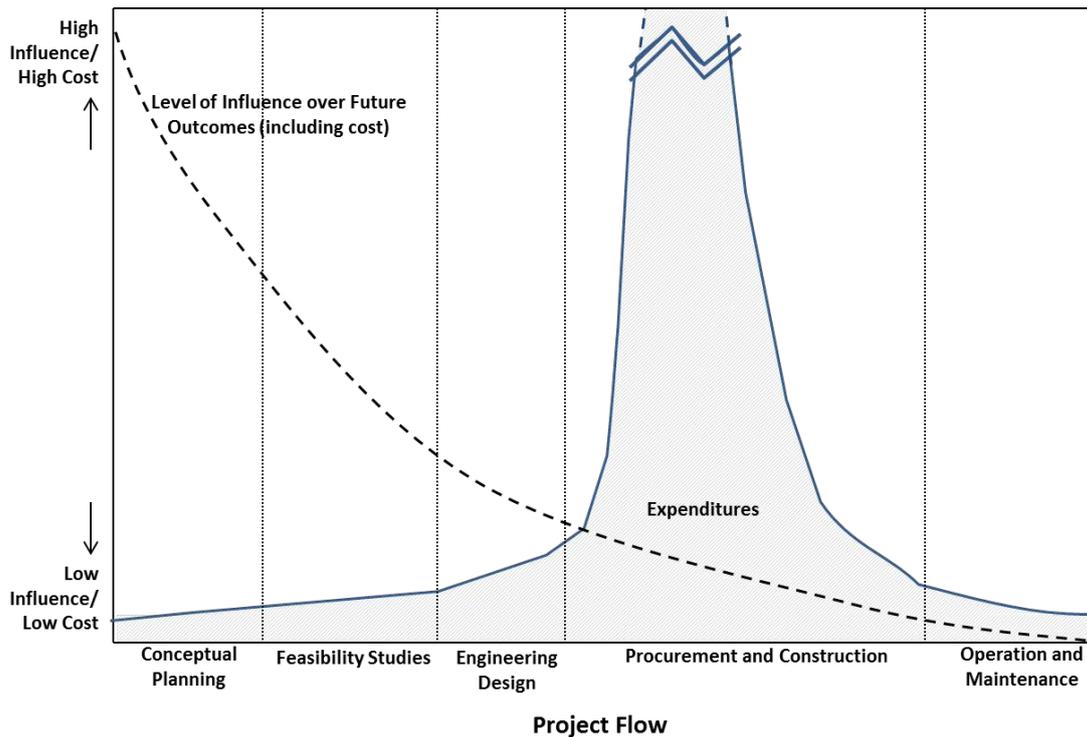


Figure 5-1. Project Phases, Level of Influence, and Cost

This subsection focuses on methods to reduce project costs at the engineering design and construction phases for actions that require such investment. Overall planning, while more influential over long-term project costs, is unique to each city’s situation and difficult to generalize. O&M, while also important, usually allows only for minor cost savings. Further, planning phase and O&M considerations have been covered, as applicable, under each action in Section 4.

Table 5-2 organizes cost reduction suggestions for design and construction phases presented in this subsection. Construction materials, labor, and time/processes are the main components of construction, dictating who, uses what, how, to build a facility. Cost reduction examples for planning and studies phases as well as the O&M phase are included in Table 5-2 as references. These closely resemble or are included in action descriptions presented in Section 4.

Table 5-2. Cost Reduction Suggestions for Design, Construction, and O&M Phases

	Planning and Studies	Design and Construction	Operation and Maintenance
Construction Materials	<ul style="list-style-type: none"> • NA 	<ul style="list-style-type: none"> • Redesigning materials • Manufacturing materials 	<ul style="list-style-type: none"> • NA
Labor	<ul style="list-style-type: none"> • NA 	<ul style="list-style-type: none"> • Hiring unemployed citizens 	<ul style="list-style-type: none"> • Involving the public and community organizations
Time and Processes	<ul style="list-style-type: none"> • Planning and structuring waste collection to allow for 24 hour operations of the incineration plant. 	<ul style="list-style-type: none"> • Procuring in bulk • Improving construction methods 	<ul style="list-style-type: none"> • Coordinating and aligning city departments • Improving efficiency and effectiveness of drain/waste cleanings or waste collection

Suggestions in Table 5-2 and this subsection are based off of the Kitakyushu experience. As seen in sections 4.2 Solid Waste Management and 4.3 Urban Drainage, Kitakyushu rapidly expanded city services during the 1960s and 1970s. City staff remembers being constantly short on funds and having to be creative to meet resident demands and their own expectations. Kitakyushu reduced project or program costs, beyond the typical competitive bidding process, so that residents could receive waste management or urban drainage services. While these cost reduction suggestions may not be universal, they provide case studies and ideas to other city government planners facing similar funding challenges today.

5.2.1 Construction Materials

Large-scale construction, such as installation of a drainage system, requires the same or similar materials, such as pipes, to be used repeatedly. Hence, minor cost reductions at the material level, can multiply to become significant cost savings over the entire construction. Further, improvements in materials may allow for quicker or simpler installation, decreasing necessary labor or time. Two Kitakyushu examples are presented below.

Redesigning Construction Materials

Description:

Kitakyushu redesigned construction materials, sometimes for the sole purpose of cutting costs. One example was developing concrete manhole covers in the 1970s (See **D4-3**), which was cheaper to install than covers that were made entirely of metal. Today, most of these concrete manhole covers have been replaced by entirely metal covers.

Another example of designing city materials, Kitakyushu ordered the development of precast reinforced concrete pipes that met a stricter stress resistance standard. The city government had decided that a stronger pipe would require less intensive pipe support structures, allowing for easier and hence, cheaper construction, making up for the initial R&D investments (See **D4-3**).

Tradeoffs:

- Investment in R&D to design materials required initial costs and accepting risk that a desired design may not be developed.
- Cheaper materials sometimes mean shorter life. Cheap materials could decrease construction costs but may increase costs over decades when system replacement and renovation is considered.

Manufacturing its Own Construction Materials

Description:

Prior to the incorporation of Kitakyushu City in 1963, the then Yahata City reduced construction costs by manufacturing its own drainage pipes (Figure 5-2). This decision came after extensive and yet unfruitful negotiations with local private manufacturing companies and asking them to decrease bulk prices. The city ordered cast-iron molds from iron factories and began casting its own concrete drainage pipes.

Today, these concrete pipes probably would not meet manufacturing and materials standards. However, some of these pipes have been inspected for regular O&M purposes and are still in use today.

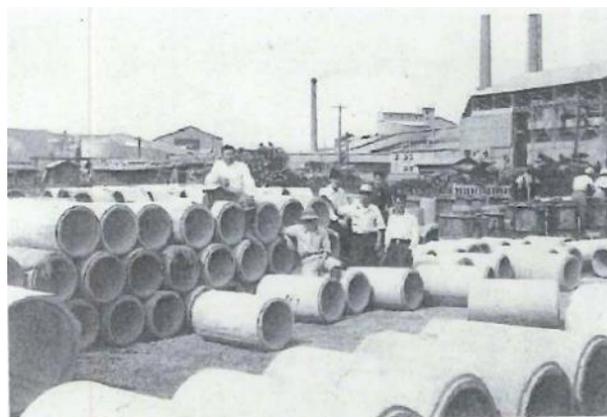


Figure 5-2. Yahata City and Its Self-Manufactured Pipes

Tradeoffs:

- City decision to self-manufacture materials hurt local manufacturers.
- Materials were constructed by nonprofessionals, which could have undermined reliability, quality, and safety of the material.

5.2.2 Labor

Physical labor is a major input during project construction. Some workers are required to be of a certain trade or have technical skills such as in surveying, concrete, foundations, carpentry, ironworks, welding, machinery, or electricity and instrumentation. Other work, such as digging trenches, simply requires physical human labor. Need for human labor may be more intense earlier in a city's development when less technological input, such as dexterous excavators, is available. Negotiating labor costs can be key in reducing construction costs. However, worker health and safety, minimum wage, and other social and legal requirements must simultaneously be considered.

Hiring Unemployed Local Residents

Description:

Yahata City constructed its own materials in the 1950s by hiring unemployed workers for 240 Japanese yen per day, the cost for a bag of cement at the time. Economic instability and high unemployment were issues during this post-Second World War era, and Yahata City hired residents for public works projects to simultaneously address unemployment and resident demand for a cleaner, healthier city.

Tradeoffs:

- Wages did not meet current minimum wage standards, even with adjusted prices. Yahata City provided what was deemed acceptable, fair, and feasible at that time.

5.2.3 Time and Processes

Finally, improvements in work efficiency can help reduce construction costs, because that translates into less labor costs, less fuel costs, and shorter rental costs of any borrowed equipment. Two Kitakyushu examples are provided below.

Procuring Necessary Materials in Bulk

Description:

For cheaper and smoother construction, Kitakyushu procured pipes in bulk in the 1970s. This means, instead of ordering pipes from manufacturers for every section of pipe installation, larger amounts of pipes were ordered together to reduce paperwork, processing time, and possibly, unit cost per pipe. In Kitakyushu, these pipes were stored at local wastewater treatment plants and shipped to construction sites as necessary. Bulk procurement can decrease costs for any materials needed in large quantities, such as concrete, pipe connectors, or plastic bags.

Tradeoffs:

- Private contractors opposed Kitakyushu's decision to procure materials by itself and in bulk, since it hurt their bottom line. There are examples of local companies that went under and were bought by others during this era.

Improving Construction Methods

Description:

In the early 1970s, Kitakyushu adopted tunneling shields as a part of its excavation work to lay underground pipelines. The Japanese standard at the time was to only use tunnel shields if installing pipes of a minimum 1.5m in diameter. However Kitakyushu set its own standard to allow for a minimum of 1.35m diameter pipes, effectively cutting excavation costs. The Japan Sewerage Works Association officially recognized the 1.35m as a standard size in 1996.

Tradeoffs:

- The Japanese 1.5m minimum diameter standard was set partly for worker safety reasons. Construction workers from this era's tunnel shielding remember how they endured back pain during this work.



Figure 5-3. Tunnel Shield Excavations for 1.35m Pipes

6 Conclusion

In many cities across the globe, accumulation of uncollected and unmanaged solid waste and its impacts on urban flood risk and sanitation are pressing challenges. This model aspired to persuade and encourage city planners to comprehensively involve residents and local businesses in actions that address these challenges, such as waste management and waste reduction efforts. Similarly, the model hopes to encourage greater collaboration within city departments so that planners will come to consider whether through their urban flood risk management plans, it is possible to also help address waste management challenges, or vice versa. Kitakyushu’s experience shows that not only is this collaboration possible but that it has the potential to reshape and improve the city holistically.

The three model sectors and their actions are reiterated and depicted in Figure 6-1. This model was organized according to two important concepts:

Concept 1 was “Independent City Government Sectors and Activities.” The role of city governments is to serve city residents and provide basic services, including public education, solid waste management, and urban flood risk management. This means, each department sector needs to invest in developing their unique foundational services and infrastructure. Only with basic city services can the cross-sector issues be adequately addressed. Actions presented in this model that generally pertain to solely each sector included E3, E4, W2, W3, W4, D3, and D4, as shown in Figure 6-1. These actions belong in each department’s strategy and action plan.

Concept 2 was “All Unite as City Residents.” Services provided under Concept 1 usually have gaps or leaves some unmet need, which tends to be larger earlier in a city’s development. An example of this is uncollected waste that ends up clogging urban drainage channels. This model presents specific actions that can help fill this gap, which rely heavily on resident, community, and industry involvement. Relevant actions were E1, E2, W1, W5, W6, D1, and D2, as shown in Figure 6-1. A supplemental action plan consisting of these actions can help bolster or enhance each sector’s action plans and their performance.

Active resident involvement, a sense of community and co-dependency, with each actor maintaining a



Note: The banner states “We are all connected by one ocean”

Figure 6-2. Beach Clean Up in Coordination with Cities in Korea and China

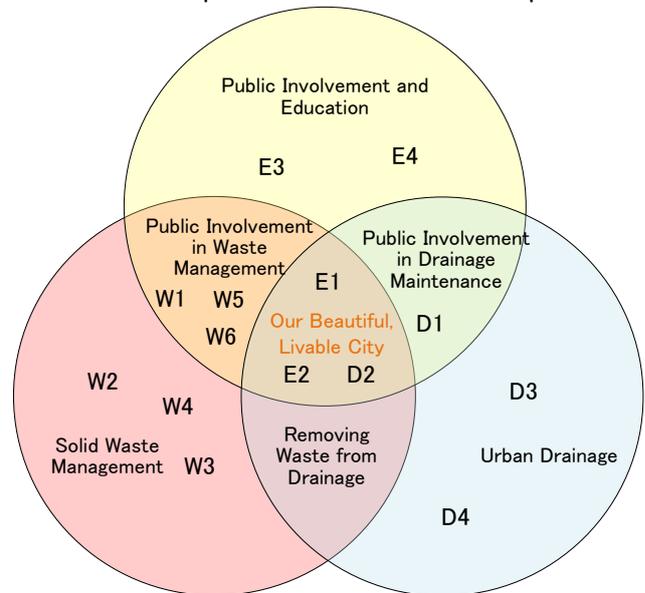


Figure 6-1. Model Sectors and Their Actions

practical dose and sense of personal responsibility is what makes Kitakyushu’s experience unique. After all, the city government is not the city. Residents are, and these residents form communities, NGOs/CBOs, industries, and the government. Not only is it reasonable to have these residents partake in maintaining their homes and public areas, resident initiative is essential in truly creating a beautiful, livable, vibrant city that everyone dreams of.

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