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Integrated Management and Technology of Urban Sewer System under Wet-Weather in South Korea

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Abstract

Technical solution to limit the impacts of the urban wet-weather discharges are traditionally based on end-of-pipe approach (called centralized system). However, nowadays, this type of approach is no longer effective with regulations, managements and technologies in South Korea. Also, there is no enforced with control for CSOs (Combined Sewer Overflow) and stormwater in South Korea before 2007. Thus, new integrated management and innovative technology with new guidelines which take into account the climate variability and the management of CSOs pollution are proposed. In this presentation, we would like to introduce two projects that currently underway in South Korea; the first project is the integrated management of urban sewer system under wet weather through the field operation case and the second project is the stochastic model with the uncertainties with integrated in a probabilistic approach. Such projects are able to respond to drastic uncertainty and variability and be commonly used in urban wet weather management.

Keywords: CSOs; climate variability; integrated management; urban sewer system; stochastic model; probabilistic approach.

1. Introduction

Combined sewer overflows, or CSOs, are a problem for many communities across the South Korea, the Ministry of Environment (MOE) announced the first enforced policy for controlling CSOs in order to help communities meet the requirements of the Korean water quality guideline on Sept, 2007. This enforced regulation for controlling CSOs was the first time in South Korea comparing to other countries (i.e., U.S. and Japan). According to the first CSO control policy, large communities that have combined sewer overflow problems should be implement certain minimum monitoring and controls about the characteristic of CSO loads as soon as possible. The first enforced policy for CSO control had somewhat flexibility. On Oct 2007, the MOE announced the second enforced policy for CSO control. Under this policy, the communities should be strongly encouraged to work with the governmental officials when trying to address CSO issues. Also, many solutions were addressed for the reducing CSO, i.e., source and runoff control, land-management, improvement of pipe and storage systems, and CSO treatment systems.

Recently, the MOE announced the manual for the performance improvement of combined sewer system in 2010 through an effective operation of WWTP. This manual can take full advantage of the benefits for effective CSO controls; 1) proper operation and regular maintenance programs for the sewer system and the CSOs in WWTP, 2) maximum use of the collection system for storage; 3) review and modification of pretreatment requirements to assure CSO impacts are minimized; 4) prohibition of CSOs during dry weather; 5) control of solid and floatable materials in CSOs; 6) pollution prevention; 7) public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts; and 8) monitoring to effectively characterized CSO impacts and the efficacy of CSO control.

In this paper, we would like to introduce and focus on how to operate WWTP under wet weather through field operation result through the field case (Gangju City, Geonggi Province). Also, the stochastic model with a probabilistic approach is applied to the situation of hydrological characteristics of uncertainty in the field case.

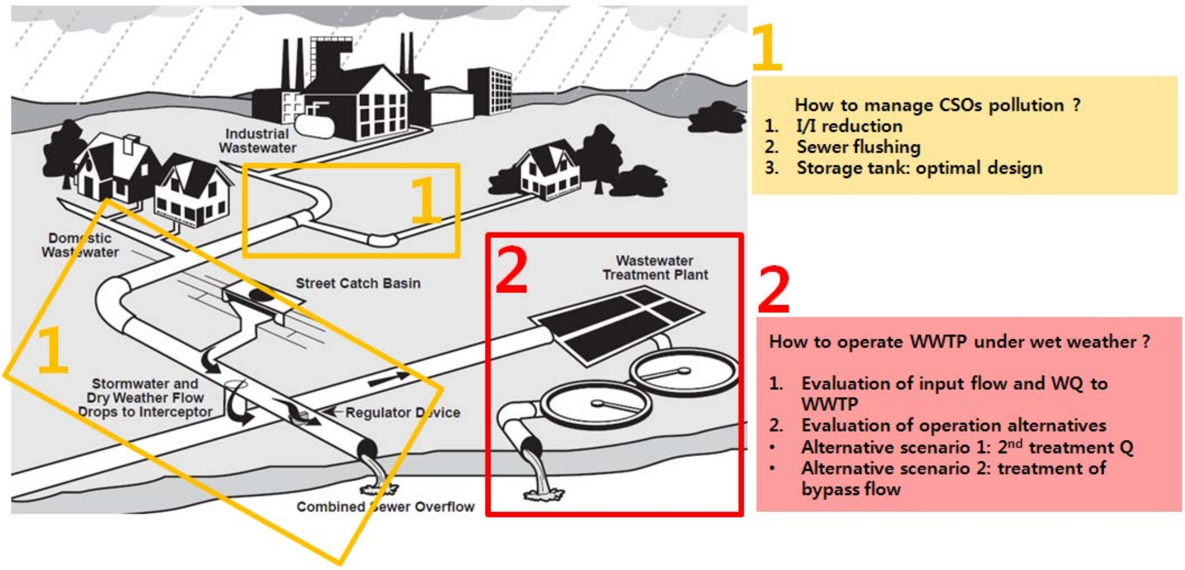

Figure 1: Strategies for the CSOs treatment

2. Integrated management; Alternatives for the Stable Operation of WWTP

The wastewater treatment plants (WWTP) in the Geonggi province, South Korea have been performing through alternatives for stable operation with a higher rate of inflows and a higher concentration of pollutants during wet weather to minimize the pollution loads being discharged into receiving waters. Table 1 and2 show the typical conditions and operation condition of wastewater treatment plant in WWTP, Geonggi province.

Table 1. Typical conditions of wastewater treatment plant in study area

Capacity (m^3/d)	Population (person)	Type of sewer system	Watershed area (ha)	Process
25,000	62,079	Combined sewer system	552	Activated Sludge process

Table 2. Operation condition of wastewater treatment plant in study area

Item	Value		
Capacity(m^3/d)	25,000		
Area(ha)	552.5		
1st clarifier		**1 line**	**2 line**
Surface area(m^2)	778	∅16m × H3m	∅15.5m × H3m
Total volume(m^3)	2,338	603.18m^3 × 2set	566.07m^3 × 2set
Retention time(h)	2.8	2.6	3.02
Aeration tank		**1 line**	**2 line**
Tatal volume(m^3)	5,220	W9m × L27m × H3m 729m^3 × 4set	W8m × L24m × H3m 576m^3 × 4set
Hydraulic Retention time(h)	6	6	6
Mixed liquid suspended solid(mg/L)	1,764		
Solid Retention Time(d)	13		
Dissolved Oxygen(mg/L)	1.2		
pH	6.8		
Temperature(°C)	12.8		
Air flow rate(m^3/h)	23,000		
2nd clarifier		**1 line**	**2 line**
Surface area(m^2)	988	∅18.5m × H3m	∅17m × H3m
Total volume(m^3)	2,974	806.4m^3 × 2set	680.94m^3 × 2set
Retention time(h)	3.5	3.5	3.6
Others			
Recyle MLSS(mg/L)	4,076		
Recycle ratio(%)	39.3		
Dewater sludge cake(m^3/d)	16.4		
T-COD in supernatant(mg/L)	21,000		
The ratio of contain water in sludge cake(%)	80		

Figure 2 shows the flow chart for the integrated management of urban sewer system under wet weather. In WWTP, we performed an evaluation of input flow and water quality in WWTP during dry and wet weather through field monitoring in order to reduce CSOs loading. The evaluation of CSOs loading was performed by SWMM and ASM tool.

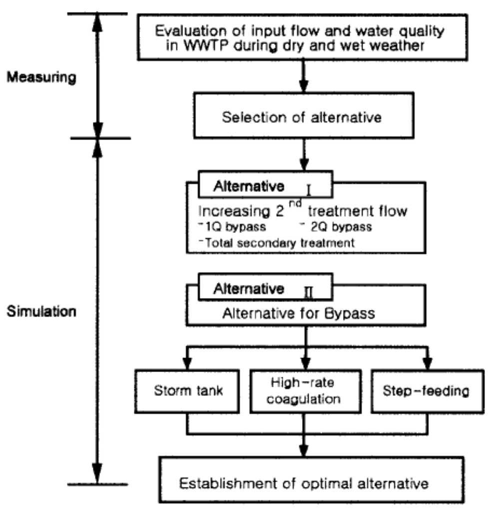

Figure 2: Scope and content of study

In South Korea, 3Q (Q: dry weather flow) of a base flow is normally intercepted and flows into WWTP as it was current practice. In this presentation, the WWTP have been operated according to two scenario plans; (1) increasing of 2nd treatment flow (2Q or 3Q treatment, normally 1Q treatment in South Korea) and (2) treatment of bypass flow that the bypass pollution loads were in the average range of 23.9 % - 38.5 % of the total loads flowing into the WWTP indicating that the bypassed flows need an extra treatment such as stormwater detention reservoir, high-rate coagulation with sedimentation, and step-feed. The high-rate coagulation with sedimentation was the most effective with respect to removal of the pollution loads. Figure 3 shows the process diagram how to operate WWTP.

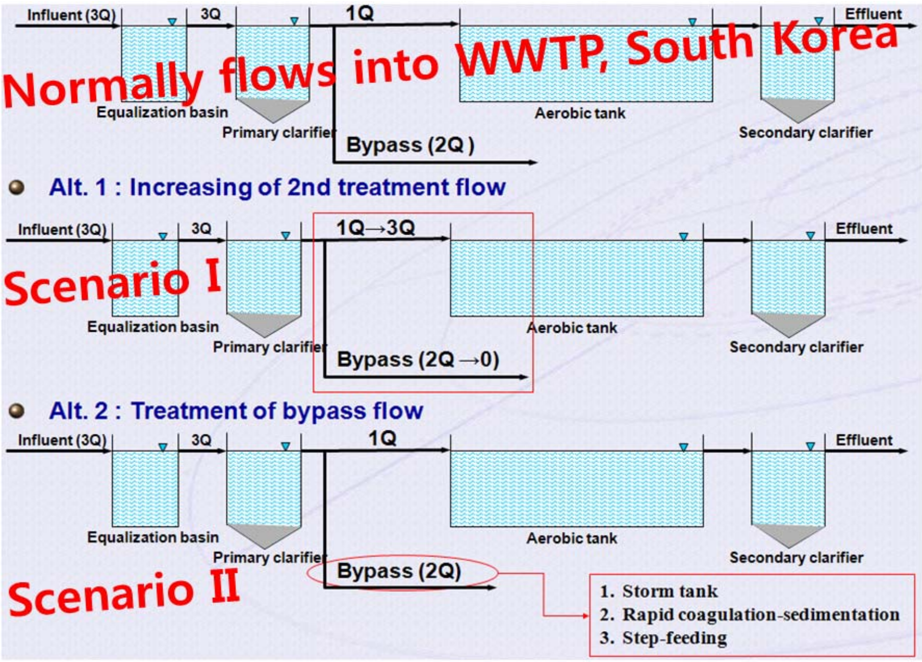

Figure 3: Operation of optimal alternatives

3. Stochastic Model with the Uncertainties

CSOs are much more likely to be a problem during climatic uncertainties, when the uncertainty of rainwater runoff can be enough to overload many combined sewer systems, causing untreated wastewater to overflow into the nearest body of water. These overflows occur either because the sewers do not have the capacity to carry the combined rainwater and wastewater, or because the treatment plant is itself not large enough to hold and threat all of the combined flow. Stochastic models can significantly impact the safe design of the CSO control system with considering climatic uncertainties. While these models are not yet available, Seoul National Universities (Moo Young Han’s research group) and Korea Institute of Science and Technology (KIST) supported by the central government are under performing. When available, the stochastic models are expected to be available by decision makers for CSOs control.