Large-scale LID design for urban expansion in South Korea

The city of Asan will be the first in South Korea to incorporate low impact development practices into a large-scale development. The Asan-Tangjeong project will demonstrate the effectiveness of these practices for protecting local waters, **Steven Trinkaus** of Trinkaus Engineering, LLC and **Kyung Hak Hyun** of the Land and Housing Institute report.

The city of Asan, South Korea, located approximately 100 kilometers south of Seoul, currently has a population of 250,000 people, and the Korea Land and Housing Corporation is expanding the city to provide additional housing, commercial development, and parks. The Asan-Tangjeong low impact development (LID) design demonstration district is the initial phase of the Asan-Tangjeong expansion project and will encompass 1.75 square kilometers (km^2). It also will be the first project in South Korea to incorporate LID concepts for a large-scale development.

A division of the Land and Housing Corporation, the Land and Housing Institute (LHI), has proposed various types of treatment systems in the demonstration area and will monitor and evaluate the LID systems installed there. A careful investigation of the new standards and approaches used in the Asan-Tangjeong project is imperative for successfully considering future LID concepts in South Korea.

Why LID?

Stormwater management in the city of Asan, as in most urban areas, relies on a structural collection and conveyance system. By incorporating LID, cities can manage and treat rainwater where it falls, controlling it at the source rather than at the end of a pipe. LID is intended to both treat pollutants and reduce runoff volume for small, frequent rainfall events.

LID strategies not only manage environment. By retrofitting existing stormwater management systems, LID can also help restore the natural hydrologic system and urban water cycle.

LID design considerations

The 1.75-km^2 LID design demonstration district will include three predominant land uses including residential, commercial, and public facilities. The residential district will encompass 0.54 km^2, or 30.7 percent of the district area; the commercial district will be 0.32 km^2, or 18.4 percent of the district area; and public facilities will be 0.86 km^2, or 48.8 percent of the district area. Notably, parks and green open spaces in the LID design district are expected to comprise 25 percent of the land area, mirroring Korea's new town regulations. In effect, approximately 0.44 km^2 will be dedicated park space or remain undeveloped.

Successful application of LID requires a thorough knowledge and investigation of the soils and groundwater depths in the project area. In the case of the Asan-Tangjeong project, three predominant soil types exist in the area's surface soil. The percentage of silty sand, sandy silt, and coarse sand in the soils vary throughout the site. A portion of the site also consists of weathered soft rock where LID treatment systems will not be installed.

Seasonal high groundwater levels vary between 3.8 meters (m) and 5.0 m below the existing ground surface, and the average depth is approximately 5.2 m. LID

BY INCORPORATING LID, CITIES CAN MANAGE AND TREAT RAINWATER WHERE IT FALLS, CONTROLLING IT AT THE SOURCE RATHER THAN AT THE END OF A PIPE.

Above: Grass Swale and LID

seasonal high groundwater level.

South Korea's Ministry of Environment has determined that the initial 5 millimeters (mm)of the total rainfall depth must be infiltrated into the soil or should not leave the site as a standard for nonpoint source pollution control. This standard is based on long-term rainfall records kept by the Korean Meteorological Administration, which show that 60 percent of total annual rainfall events are 5 mm or less within a 24-hour period. In addition to meeting this requirement, the Ministry of the Environment also dictates that LID systems must fully treat runoff by reducing pollutant loads to the maximum extent possible.

LID types to be implemented

A substantial amount of earthwork and land re-contouring will take place as part of the Asan-Tangjeong project, leaving most, if not all, LID systems located in a disturbed soil profile. Even if the underlying soils are sandy in nature, cutting and filling can modify the soil's natural infiltrative properties. These changes need to be accounted for in deciding which LID systems should be used. Because the Asan-Tangjeong project is the first large-scale application of LID concepts in South Korea, it is important that the selected LID systems function properly to demonstrate the benefits of LID. Systems to be implemented in the project's LID demonstration district include rainwater harvesting from building roofs,

embraces rainwater harvesting in areas with the greatest building density. Rainfall collected from building roofs will be directed to large storage tanks located in the basement of the buildings and will be provided for non-potable uses, including irrigating building landscapes and public parks and for street cleaning within the district.

Additionally, rainwater harvesting systems will be installed in five of the Asan-Tangjeong project parks. Storage will be provided in three rainwater harvesting tanks, each having a capacity of 545 cubic meters (m^3), and two additional tanks with a capacity of 1,090 m^3 and 3,815 m^3.

Infiltration swales will be installed along road edges in the district's highly urbanized areas along with infiltration "L" drains – a Korean variation on the standard US infiltration trench. In less dense areas of the Asan-Tangjeong project, vegetated swales will be installed adjacent to roads. Finally, constructed wetland systems will polish the runoff along road planting strips before discharging to an existing watercourse.

Grass swales and infiltration trenches are easier than other LID systems to design and install, making them appropriate for this first large-scale LID application. The Ministry of the Environment has endorsed both systems for controlling nonpoint source pollution onsite. Grass swales and infiltration trenches can receive runoff as overland flow or through a curb inlet located along the road edge. However, avoiding highly concentrated flows is important for reducing failure of the system by erosion and sedimentation.

In order to observe the effectiveness of the various systems involved, LHI created a monitoring facility for LID at the Asan-Tangjeong project. Kyung Hak Hyun, a research fellow within LHI's Department of Urban Environment Research, developed the guidelines, standards, and monitoring concept for the project and is the principal in charge of this study. The monitoring area includes LID systems such as grass swales, bioretention, and infiltration trenches. An artificial watershed area consisting of an oversized, sloped concrete slab that pitches from one side to the other was created to direct runoff to the monitored systems. Concrete curbs divide the slab into equal areas so that the amount of runoff to each system is equalized, normalizing both the flow rate and volume to each monitored LID system. Monitoring water quality and volume reduction results enables an equal, unbiased comparison of the various LID systems.

MONITORING WATER QUALITY AND VOLUME REDUCTION RESULTS ENABLES AN EQUAL, UNBIASED COMPARISON OF THE VARIOUS LID SYSTEMS.

The installation and monitoring of LID systems in the large-scale Asan-Tangjeong development project will help to improve water quality and control runoff volume from small storms. Additionally, it will inform future sustainable stormwater management in South Korea. Construction of the project began in 2013, and infrastructure work is expected to be complete in 2015. Full build-out of the project will likely be completed by 2025.

Authors' Note

Steven Trinkaus is the principal engineer for Trinkaus Engineering, LLC. Trinkaus has spent more than 28 years in the land development field and is a nationally recognized expert in the application of LID strategies. He has significant experience working in China and South Korea, and his specialty is in development of LID regulations for municipalities.

Kyung Hak Hyun has more than 20 years of experience in stormwater management and sanitary engineering. He is a nationally recognized expert in the development and application of greywater reuse, decentralized rainwater management, and LID. He presently holds the first research fellow within the Department of Urban Environment Research at LHI.