

P1

Project Category: Scientific Research Project of Shanghai City
----------------------------------------------------------------

Project No.: Hu Huan Ke [213-43]
----------------------------------

**Final Report on Research of Envis Sentinel Pit Technology in Pollution Control and  
Regeneration of Rainfall Runoff**

Shanghai Academy of Environmental Sciences (SAES)

Date of preparation: December 2015

## Contents

<b>Contents</b> .....	i
<b>1. Considerations on Scientific Research</b> .....	<b>4</b>
<b>1.1 General Idea</b> .....	4
<b>1.2 Research Objective</b> .....	4
<b>1.3 Research Contents</b> .....	5
<b>1.4 Implementation Plan</b> .....	6
1.4.1 Technical approach .....	6
1.4.2 Research methods .....	7
<b>1.5 Research Task and Scheduling of the Project</b> .....	7
<b>2. Current Status of Pollution Control and Regeneration of Urban Rainwater at Home and Abroad</b> .....	<b>9</b>
<b>2.1 Overview</b> .....	9
<b>2.2 Current Status of Overseas Research</b> .....	10
<b>2.3 Current Status of Domestic Research</b> .....	13
<b>2.4 Profile of Rainwater Pollution Control and Regeneration Technologies at Home and Abroad</b> .....	16
<b>2.5 Current Status of Pollution and Control of Rainwater Runoff in Shanghai</b> .....	21
2.5.1 Overview of rainfall in Shanghai city .....	21
2.5.2 Category and source of urban runoff pollutants.....	22
2.5.3 Road rainfall runoff pollution in Shanghai city .....	22
<b>2.6 New Building Model of Urban Rainfall Flood Management – Sponge City</b> .....	24
2.6.1 Overview .....	24
2.6.2 Essence of sponge city .....	26
2.6.3 Building method.....	26
2.6.4 Control objective .....	27
2.7 Conclusions and Recommendations.....	29
<b>3. Profile of Envis Sentinel Pit Technology</b> .....	<b>30</b>
<b>3.1 Basic Structure and Principles</b> .....	30
<b>3.2 Construction Mode</b> .....	32
<b>3.3 Case Studies</b> .....	33
3.3.1 Syndal South Primary School .....	33
3.3.2 CERES parking lot system.....	33
3.3.3 Wantirna mall.....	34
3.3.4 Langwarrin residential district .....	34
<b>4. Pilot Scale Test Project Parking Lot Rainwater Purification</b> .....	<b>35</b>
<b>4.1 Test Purpose</b> .....	35
<b>4.2 Process Flow</b> .....	35
<b>4.3 Test Site and System</b> .....	35
4.3.1 Test site.....	35
4.3.2 Test system.....	36
<b>4.4 Test Content and Method</b> .....	40

4.4.1 Water quality analysis content.....	40
4.4.2 Test method .....	40
4.4.3 Requirements of water sample storage.....	41
4.4.4 Summary of this chapter .....	41
<b>5. Operation Effect Analysis of the Pilot Scale Test Project of Parking Lot Rainwater Purification .....</b>	<b>42</b>
<b>5.1 Water Quality Determination Methods.....</b>	<b>42</b>
<b>5.2 Results and Discussion.....</b>	<b>43</b>
5.2.1 Observation results of rainfall features .....	43
5.2.2 Monitoring result of water quality .....	43
5.2.3 Water quality purification effects in the pilot scale test .....	48
5.2.4 Mode of operation and maintenance .....	49
5.3 Summary of This Chapter .....	49
<b>6. Conclusions and Recommendations .....</b>	<b>49</b>
6.1 Conclusions.....	49
6.2 Recommendations .....	50

P6-7

## 1.2 Research Objective

Pollution control and regeneration of rainwater runoff have become a hot topic of social concern.

Enviss sentinel pit technology is a new technology in Australia that effectively solves the problem of surface rainwater runoff pollution. Combining rainwater collection and pollutant removal, it offers such benefits as low investment, high efficiency, small space requirements, minimal maintenance, low operating costs, and long maintenance period, and enables drain water to be used directly as a resource. This technology is very appropriate for small, scattered rainwater systems.

By implementing a pilot project, this project intends to research and summarize the applicability, pollutant removal effect, investment, life cycle, mode of operation and maintenance, operating costs of this technology in pollution control and regeneration of rainwater runoff in Shanghai. This project will also optimize and adjust such technology so as to suit the characteristics and treatment requirements of urban rainwater runoff in Shanghai, and carry out research on equipment localization to provide a new technology and considerations for solving the problem of water resource shortages and serious pollution caused by first flush in Shanghai as well as cities nationwide.

## 1.3 Research Contents

- (1) Investigate the current situation, planning and policies in relation to outdoor rainwater runoff pollution control technologies in domestic cities;
- (2) Investigate the characteristics of rainwater runoff and related planning for the control of runoff pollution in Shanghai, understand the rainwater runoff volume, construction of rainwater collection system, source of rainwater runoff pollution, major pollutants and pollution characteristics there, and seek countermeasures and planning for rainwater runoff pollution control of this city.
- (3) Conduct research on the pilot application of Enviss sentinel pits in rainwater runoff pollution control.

By conducting research through the pilot project, this project will analyze and summarize the advantages and disadvantages, technical nature, economy, and extension of this technology, and improve and adjust it in line with the characteristics of and policies for Shanghai's rainwater runoff.

P9-10

### 1.5 Research Task and Scheduling of the Project

The research of this project will be carried out from June 2013 to November 2015 over a span of 29 months. Its specific scheduling and milestone objectives are:

(1) In July 2013, complete the investigation, collection and summarising of all information.

**Milestone objective:** Complete the investigation into the current status of pollution control and regeneration of rainwater runoff at home and abroad and the treatment of rainwater runoff in Shanghai, and collect relevant basic information. Based on the summary and analysis of early investigation, research and determine the technical planning of Enviss sentinel pits in line with the research objectives of this project. Write the research outline, and obtain the approval of Shanghai Environmental Protection Bureau.

(2) In December 2013, determine the technical planning and site for the demonstration project on the basis of the information from the investigation at the early stage.

**Milestone objective:** Conduct technical design of the demonstration project, optimize the design of the test unit, and determine the test site.

(3) In October 2015, complete the test of the demonstration project.

**Milestone objective:** Install and operate the test unit according to the determined project test scheme, sample and test initial rainwater in different rainfall events.

(4) In November 2015, summarize information and complete the scientific research report.

**Milestone objective:** According to the test and sample data, prepare the report, submit the test research results, and pass the inspection and obtain the acceptance of experts.

#### 5.2.4 Mode of operation and maintenance

The operation of Enviss sentinel pit technology for half a year shows that surface deposits mainly include leaves and soil. Under normal circumstances, it only requires removal of deposits from the surface about once every two weeks to clean a sentinel pit. If mud on the surface is hard to be removed, soaking the area with water is required before cleaning or wiping it out multiple times. Thus, this sentinel pit can continue to operate effectively.

### 6. Conclusions and Recommendations

#### 6.1 Conclusions

Non-point source pollution, also known as diffused pollution, has the characteristics of a wide area, very random and high uncertainty. Urbanization leads to a reduction in pavement water permeability, thus increasing rainfall runoff pollution, raising the runoff speed and magnifying the flush effect. As a result, it causes greater difficulty in the management of urban rainfall floods. Road rainwater is a major component of urban non-point source pollution, with its runoff flush pollution being affected by such factors as traffic flow, interval between dryness and wetness, and atmospheric sedimentation. The actual situation indicates that first flush from rainwater runoff on roads meets a larger load, and plays a greater role in influencing water bodies of the surrounding environment and the inflowing water load of urban sewage treatment plants. China has developed an approach of building a sponge city for managing urban rainfall floods. This idea aims to lower flood peaks, reduce pollution load and utilize rainwater by employing a comprehensive method.

Enviss sentinel pits provide an alternative to rainwater gardens and wetlands in the control of runoff pollution on urban roads. The pilot scale test, which has been conducted in the parking lot of Shanghai Academy of Environmental Sciences (SAES), shows:

- 1) The pollution concentrations expressed in chemical oxygen demand ( $COD_{cr}$ ), total nitrogen (TN) and total phosphorus (TP), caused by rainwater runoff on the characteristic road at the parking lot of SAES fluctuates greatly, however its average pollution load is lower than that of other similar sites;
- 2) Pollution from road rainwater runoff presents an obvious flush effect. That is, the pollution load is larger in the first few minutes, then begins to fall significantly, and tends to be stable and low in value about 20 minutes later.
- 3) Enviss sentinel pits are notably effective in purifying road runoff pollution. They are able to reduce  $COD_{cr}$ , TN and TP by up to 49.82%, 41.38%, and 38.49% respectively.
- 4) Enviss sentinel pits are able to retain suspended substances (SS) carried by road runoff. Similarly, such pits are able to better filter and adsorb small granular substances and soluble nutrient substances.
- 5) An observation of the pilot scale test for nearly half a year shows that the discharge capacity of a small Enviss sentinel pit is able to meet the needs of a rainfall catchment area at a rate of a 10 sq.m. preventing retention or overflow from occurring.
- 6) The modular design allows the Enviss sentinel pit system to feature compact structure, making transport, installation, regular cleanup and replacement easier and more suitable for use in

a limited urban space and area. Moreover, its concrete structure ensures that vehicles run normally over this pit.

7) Enviss sentinel pits can be used not only to control runoff pollution, but also be connected with other functions like impounding reservoirs to achieve storage and reuse of purified rainwater.

## 6.2 Recommendations

Enviss sentinel pits, a type of rainwater runoff control product produced by Australian Envirostream Solutions (Enviss) Pty Ltd, is suitable for urban places that have restricted installation conditions. This type of product has seen some successful applications in Australia. Unlike cities in Australia, cities on the Chinese mainland are large in size with vast populations, heavy vehicle traffic, significantly differences in urban rainfall, huge runoff pollution load, and high areas of urban impermeable ground. To ascertain whether Enviss sentinel pits are applicable to Chinese cities, we recommend that further research on the following respects be conducted:

- 1) Strengthen the research into the relationship between the maximum rainfall capacity of applicable cities, the maximum speed of their runoff flow and the maximum discharge capacity of Enviss sentinel pits to prevent the occurrence of flood disasters due to insufficient discharge capacity.
- 2) Reinforce the research on whether Enviss sentinel pits are appropriate for installation in urban road functional units (municipal transportation, parking lots, etc.), and on whether conditions permit on-site excavation, hoisting, regular cleaning, maintenance and change.
- 3) Intensify the research on the comprehensive benefits of Enviss sentinel pits, mainly including economic, social and environmental benefits, and on whether such regions can afford to produce Enviss sentinel pits financially.