# Supplementary material A. Guide to semi-structured interviews

Interview Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Interview Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The Wastewater Collection Scope of This Area: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

The Name of the Corresponding Wastewater Treatment Plant (WWTP): \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Work Model: □ Plant-pipeline network integration model (PPNIM)

□ Plant-pipeline network separation model (PPNSM)

Management Mode: □ State-owned Enterprises □ Entrusted Private Enterprises

|  |  |  |
| --- | --- | --- |
| No. | Question | Answer |
| I. Overview of Wastewater Treatment Work in This Area | | |
| 1 | What is the name of the administrative region where the wastewater treatment system is located? |  |
| 2 | What is the resident population scale in this area? |  |
| 3 | Details of the wastewater treatment plant: construction year, scale, treatment process, number of employees in the plant, etc. |  |
| 4 | In which year was the local drainage plan formulated? Has it been updated currently? |  |
| 5 | What are the proportions of combined sewer and separate sewer drainage pipe networks respectively? |  |
| 6 | What is the number of overflow ponds in the pipe network system of this area? |  |
| 7 | What is the number of overflow outlets in the pipe network system of this area? |  |
| 8 | What is the number of pumping stations in the pipe network operation and maintenance of this area? |  |
| 9 | What aspects of data are monitored in the wastewater collection and treatment work in this area? |  |
| 10 | What specific monitoring technologies are used in the wastewater collection and treatment work in this area? When did each start? |  |
| II. Description of the Interviewee's Experience | | |
| 1 | Is there anything special about the wastewater collection and treatment work in this area? For example, the presence of lakes, industrial wastewater, or rugged terrain. |  |
| 2 | Are you satisfied with the current wastewater collection and treatment work in this area? Why? |  |
| 3 | Are there any organizational adjustment activities currently? For example, the merger of wastewater treatment plants, the reform of integrated plant and network management, etc. |  |
| 4 | Are there any plant and network construction plans or plant and network renewal and maintenance plans in this area? |  |
| 5 | What successes have been achieved in the wastewater collection and treatment work in this area in the past decade? |  |
| 6 | What challenges still exist in the wastewater collection and treatment work in this area at present? |  |
| III. Questions Related to Stakeholders | | |
| 1 | What is your role in the wastewater collection and treatment work in this area? |  |
| 2 | Which units have participated in the drainage planning, design, and construction work in this area? What are the staff sizes of each unit? |  |
| 3 | Do you know which units are involved in the wastewater management work in this area? What are the staff sizes of each unit? |  |
| 4 | Do you know which units are involved in the wastewater collection work in this area? What are the staff sizes of each unit? |  |
| 5 | Do you know which units are involved in the wastewater treatment work in this area? What are the staff sizes of each unit? |  |
| 6 | Is there a relevant industry association for wastewater treatment in this region? |  |
| 7 | Who is the contact person for wastewater management work in this region? |  |
| 8 | What are the drainage-related private companies in this region and what businesses are they each responsible for? |  |
| 9 | What other important stakeholders are there in this region? Is there any overlap with water supply work? |  |
| 10 | With which stakeholders do you have frequent exchanges (at least once a month)? What are the contents of the exchanges? |  |
| IV. Socio-technical Related Questions | | |
| 1 | Have you participated in the technical work of wastewater collection and treatment in this region? |  |
| 2 | Do you have the right to access the monitoring data during the wastewater collection and treatment process? |  |

# Supplementary material B. Survey questionnaire on WWTN relationships

Dear Sir/Madam,

Hello! Thank you very much for participating in this questionnaire survey. This survey is aim to understand the actual situation of urban wastewater collection and treatment work. Please fill in the questionnaire truthfully. There are no right or wrong, good or bad answers. The questionnaire is filled out anonymously, and all information is strictly confidential and only used for academic research. Thank you for your support!

Thank you again for your support and cooperation!

Research Group on Digital Intelligence Urban Environmental Infrastructure

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**I. Basic Information**

**1.The work mode of wastewater collection and treatment in your drainage area is:**

□ Plant-pipeline network integration model

□ Plant-pipeline network separation model

**2. Your working department is:**

□ Government Agency (□ Environmental Protection Department □ Water Affairs Department □ Housing and Urban-Rural Development Department □ Finance Department □ Others: \_\_\_\_\_)

□ Water Company (□ Leadership and Management □ Pipe Network Operation and Maintenance Department □ Wastewater Treatment Department □ Water Supply Department

□ Engineering Equipment Department □ Administrative Office Department □ Human Resources Department □ Others: \_\_\_\_\_\_)

□ Pipe Network Operation and Maintenance Company (□ Leadership and Management □ Pipe Network Operation and Maintenance Department □ Water Quality Monitoring Department □ Dispatch Center □ Human Resources Department □ Engineering Technology Department □ Administrative Management Department □ Others: \_\_\_\_)

□ Wastewater Treatment Company (□ Leadership and Management □ Production and Operation Department □ Water Quality Monitoring Department □ Master Control Center

□ Sludge Dewatering Department □ Equipment Maintenance Department □ Administrative Management Department □ Others: \_\_\_\_)

□ Municipal Design Institute

□ Equipment Supplier

□ Industry Association

□ Water Quality Monitoring Institution

□ Others: \_\_\_\_\_\_\_\_\_\_\_

**3. Your age is:**

□ 18-35 years old □ 36-50 years old □ 51-60 years old □ 61 years old and above

**4. Your gender is:**

□ Male □ Female

**5. Your educational background is:**

□ Junior High School or Below □ High School □ Technical Secondary School/College □ Bachelor's Degree □ Master's Degree or Above

**6. Your years of experience in drainage work is:**

□ Less than 5 years □ 5-10 years □ 10-20 years □ 20 years and above

**7. Your average annual salary is:**

□ Less than 80,000 yuan □ 80,000-120,000 yuan □ 120,000-150,000 yuan □ 150,000-200,000 yuan □ More than 200,000 yuan

**8. Please summarize your job responsibilities in one sentence:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**II. Instrument and Equipment Operation**

**1.Have you participated in the technical work of wastewater collection and treatment?**

Such as operating influent pumps/sludge scrapers, repairing instruments and equipment, monitoring water quality and quantity, etc.

**2. What instruments and equipment have you operated? Can they respond quickly to your instructions?**

Such as pumping stations, pipe networks, storage tanks, blowers, dosing pumps, etc.

**3. In your work scope, what instruments and equipment can automatically send instructions based on monitoring data?**

Such as automatic dosing equipment, automatic disinfection equipment, automatic control equipment, etc.

**4. What do you think of the operating performance of automatic equipment? What is the room for improvement?**

**5. What monitoring data can you access and view? Including aspects such as instruments and equipment, environmental status, water quality and quantity.**

At the same time, through what media are these data displayed? For example, mobile phone terminals (mini-programs, wastewater management and control systems, etc.), video surveillance systems, historical data query systems, computer operation consoles, control room monitoring large screens, etc.

|  |  |  |  |
| --- | --- | --- | --- |
| No. | Category | Data Content | Data Display Media |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
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| 12 |  |  |  |
| 13 |  |  |  |
| 14 |  |  |  |

**II. Information Exchange and Interaction**

**1. Approximately what percentage of your weekly work tasks are related to wastewater collection or treatment? (0%-100%)**

**2. Are there any meetings related to the local wastewater treatment work plan? Do you attend them?**

**3. Do you think the local wastewater treatment work can achieve comprehensive management of personnel and technology?**

Comprehensive management refers to the joint coordinated management of personnel and technology in wastewater treatment work, considering the matching, load, and coordination of personnel and technology, and implementing hierarchical management and cross-level collaboration measures.

**4. What do you think of the digital intelligence level of the local wastewater treatment work? What is the room for improvement?**

Digital intelligence refers to the use of digital and intelligent means to achieve real-time perception and intelligent decision-making of water quality detection, equipment status, energy consumption prediction, and maintenance needs.

**5. In the past year, with whom have you exchanged data or information related to wastewater collection or treatment? What is the frequency of communication?**

Forms such as work exchanges, reports, and casual conversations are all acceptable (list all names here)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Name | Working Unit | Exchange Content | Exchange Frequency |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
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| 11 |  |  |  |  |
| 12 |  |  |  |  |

# Supplementary material C. Introduction of case WWTNs from Nanjing

**I. Plant Network Integration Project (Case A)**

Area served: 24.14 km2

Population served: 180,000

Design scale: 50,000 m3/d

WWTP’s footprint: 57,668 m2

Effluent standard: Grade A standard in “Pollutant Discharge Standard of Urban Wastewater Plant GB 18918-2002”

(<https://www.mee.gov.cn/ywgz/fgbz/bz/bzwb/shjbh/swrwpfbz/200307/t20030701_66529.shtml>)

Pipeline network operation mode: Given the relatively flat terrain of the location, the collection and conveyance of wastewater primarily rely on gravity flow. In densely populated areas, pumping stations are installed to handle peak wastewater flow volumes.

Treatment process: Modified A2/O process, representing an enhancement over the conventional A2/O process. Specifically, it mitigates the adverse impact of returned activated sludge on the anaerobic zone and augments its nitrogen removal efficiency. A reflux sludge pre-denitrification zone and internal reflux are incorporated, ensuring that the returned sludge first enters the pre-denitrification zone for phosphorus removal. Additionally, staged influent is employed to regulate and adapt to the carbon source utilization in the anaerobic and anoxic zones. The operational principle is illustrated in Fig. C1.



**Fig. C1 Flow of modified A2/O process**

**II. Plant Network Separation Project (Case B)**

Area served: 25.13 km2

Population served: 270,000

Design scale: 60,000 m3/d

WWTP’s footprint: 62,693m2

Effluent standard: Grade A standard in “Pollutant Discharge Standard of Urban Wastewater Plant GB 18918-2002”, which is the same as case A.

Pipeline network operation mode: The pipeline network is mainly maintained through gravity flow, supplemented by wastewater lift pumping stations. This approach aligns with that of Case A.

Treatment process: Modified A2/O process, same as case A.

# Supplementary material D. Node composition and attribute setting of case WWTN

Tables D1 and D2 systematically present the node compositions and attribute settings of Case PPNIM and Case PPNSM. The “Cost” column represents the node operation cost coefficient, which are standardized to enable unified measurement. The “Year” column pertains to social nodes and indicates the number of years that social actors have been engaged in wastewater treatment work. The “Organization” column refers to the organizational affiliation of social or technical nodes, which is specified in the notes below the table.

**Table D1.** **Node composition and attribute setting of case PPNIM**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Node name | Node code | Cost | Year | Organi-zation | Intelligent |
| 1 | Government Environmental Department | GOV-E | 0.84 | 25 | 1 | / |
| 2 | Government Water Department | GOV-W | 1.05 | 27 | 1 | / |
| 3 | Government Finance Department | GOV-F | 0.94 | 21 | 1 | / |
| 4 | Environmental Group Leadership | EG-LL | 0.94 | 34 | 2 | / |
| 5 | Environmental Group Administrative Office | EG-AO | 1.15 | 25 | 2 | / |
| 6 | Environmental Group Finance Department | EG-FD | 0.94 | 21 | 2 | / |
| 7 | Environmental Group Enterprise Management Department | EG-EMD | 0.94 | 24 | 2 | / |
| 8 | Environmental Group Water Environment Department | EG-WED | 0.99 | 20 | 2 | / |
| 9 | Environmental Group Engineering Construction Department | EG-ECD | 0.99 | 23 | 2 | / |
| 10 | Wastewater Treatment Company General Manager | WWTC-GM | 0.00 | 32 | 3 | / |
| 11 | Wastewater Treatment Company Deputy General Manager | WWTC-DGM | 0.00 | 25 | 3 | / |
| 12 | Wastewater Treatment Company Equipment Department | WWTC-ED | 0.00 | 17 | 3 | / |
| 13 | Wastewater Treatment Company Finance Department | WWTC-FD | 0.00 | 15 | 3 | / |
| 14 | Wastewater Treatment Company Administrative Office | WWTC-AO | 0.00 | 8 | 3 | / |
| 15 | Wastewater Treatment Company Atmospheric Environment Department | WWTC-AED | 0.00 | 13 | 3 | / |
| 16 | Wastewater Treatment Company Operation Maintenance Leader | WWTC-OML | 0.00 | 21 | 3 | / |
| 17 | Wastewater Treatment Company Operation Maintenance Member 1 | WWTC-OM-M1 | 0.10 | 11 | 3 | / |
| 18 | Wastewater Treatment Company Operation Maintenance Member 2 | WWTC-OM-M2 | 0.11 | 6 | 3 | / |
| 19 | Wastewater Treatment Company Pipeline Network Work Leader | WWTC-PNWL | 0.13 | 18 | 3 | / |
| 20 | Wastewater Treatment Company Pipeline Network Inspection and Maintenance Team Leader | WWTC-PNIMTL | 0.19 | 24 | 3 | / |
| 21 | Wastewater Treatment Company Pipeline Network Inspection and Maintenance Team 1 | WWTC-PNIMT1 | 0.22 | 18 | 3 | / |
| 22 | Wastewater Treatment Company Pipeline Network Inspection and Maintenance Team 2 | WWTC-PNIMT2 | 0.26 | 24 | 3 | / |
| 23 | Wastewater Treatment Company Pipeline Network Inspection and Maintenance Team 3 | WWTC-PNIMT3 | 0.29 | 20 | 3 | / |
| 24 | Wastewater Treatment Company Pipeline Network Operation Maintenance Dispatch Team Leader | WWTC-PNOMDTL | 0.32 | 17 | 3 | / |
| 25 | Wastewater Treatment Company Pipeline Network Operation Maintenance Dispatch Team Member 1 | WWTC-PNOMDTM1 | 0.35 | 9 | 3 | / |
| 26 | Wastewater Treatment Company Pipeline Network Operation Maintenance Dispatch Team Member 2 | WWTC-PNOMDTM2 | 0.39 | 4 | 3 | / |
| 27 | Wastewater Treatment Company Pipeline Network Water Quality Testing Team Member 1 | WWTC-PNWQTTM1 | 0.42 | 14 | 3 | / |
| 28 | Wastewater Treatment Company Pipeline Network Water Quality Testing Team Member 2 | WWTC-PNWQTTM2 | 0.45 | 8 | 3 | / |
| 29 | Wastewater Treatment Plant General Manager | WWTP-GM | 0.48 | 29 | 4 | / |
| 30 | Wastewater Treatment Plant Deputy General Manager (Production) | WWTP-DGM-P | 0.52 | 21 | 4 | / |
| 31 | Wastewater Treatment Plant Deputy General Manager (Safety) | WWTP-DGM-S | 0.55 | 23 | 4 | / |
| 32 | Wastewater Treatment Plant Operation Team Leader | WWTP-OT-L | 0.58 | 20 | 4 | / |
| 33 | Wastewater Treatment Plant Operation Team Member 1 | WWTP-OT-M1 | 0.61 | 16 | 4 | / |
| 34 | Wastewater Treatment Plant Operation Team Member 2 | WWTP-OT-M2 | 0.65 | 11 | 4 | / |
| 35 | Wastewater Treatment Plant Operation Team Member 3 | WWTP-OT-M3 | 0.16 | 6 | 4 | / |
| 36 | Wastewater Treatment Plant Administrative Team Leader | WWTP-AT-L | 0.18 | 16 | 4 | / |
| 37 | Wastewater Treatment Plant Administrative Team Member 1 | WWTP-AT-M1 | 0.19 | 13 | 4 | / |
| 38 | Wastewater Treatment Plant Administrative Team Member 2 | WWTP-AT-M2 | 0.22 | 3 | 4 | / |
| 39 | Wastewater Treatment Plant Finance Team Leader | WWTP-FT-L | 0.26 | 21 | 4 | / |
| 40 | Wastewater Treatment Plant Finance Team Member 1 | WWTP-FT-M1 | 0.29 | 14 | 4 | / |
| 41 | Wastewater Treatment Plant Finance Team Member 2 | WWTP-FT-M2 | 0.32 | 13 | 4 | / |
| 42 | Wastewater Treatment Plant Equipment Team Leader | WWTP-ET-L | 0.35 | 19 | 4 | / |
| 43 | Wastewater Treatment Plant Equipment Team Member 1 | WWTP-ET-M1 | 0.39 | 15 | 4 | / |
| 44 | Wastewater Treatment Plant Equipment Team Member 2 | WWTP-ET-M2 | 0.42 | 11 | 4 | / |
| 45 | Wastewater Treatment Plant Water Quality Monitor 1 | WWTP-WQM1 | 0.45 | 12 | 4 | / |
| 46 | Wastewater Treatment Plant Water Quality Monitor 2 | WWTP-WQM2 | 0.48 | 10 | 4 | / |
| 47 | Sensing Equipment Supplier | SES | 0.52 | 21 | 5 | / |
| 48 | Analytical Equipment Supplier | AES | 0.55 | 13 | 5 | / |
| 49 | Decision Equipment Supplier | DES | 0.58 | 18 | 5 | / |
| 50 | Execution Equipment Supplier | EES | 0.61 | 15 | 5 | / |
| 51 | Residents in Wastewater Treatment Area | Residents | 0.65 | 20 | 6 | / |
| 52 | Media | Media | 0.95 | 20 | 6 | / |
| 53 | Netizens | Netizens | 1.02 | 20 | 6 | / |
| 54 | Pipeline Network Water Level Meter 1 (Confluence of Main and Branch Pipes) | PN-WLM1-CMBP | 1.08 | / | 3 | 0 |
| 55 | Pipeline Network Water Level Meter 2 (Flood-prone Areas) | PN-WLM2-FPA | 1.14 | / | 3 | 0 |
| 56 | Pipeline Network Water Level Meter 3 (River) | PN-WLM3-R | 1.20 | / | 3 | 0 |
| 57 | Pipeline Network Flow Velocity Meter 1 (Confluence of Main and Branch Pipes) | PN-FVM1-CMBP | 1.26 | / | 3 | 0 |
| 58 | Pipeline Network Flow Velocity Meter 2 (Pumping Station) | PN-FVM2-PS | 1.32 | / | 3 | 0 |
| 59 | Pipeline Network Flow Velocity Meter 3 (Main Inlet Pipe) | PN-FVM3-MIP | 1.38 | / | 3 | 0 |
| 60 | Pipeline Network Flow Meter 1 (Confluence of Main and Branch Pipes) | PN-FM1-CMBP | 1.44 | / | 3 | 0 |
| 61 | Pipeline Network Flow Meter 2 (Pumping Station) | PN-FM2-PS | 1.50 | / | 3 | 0 |
| 62 | Pipeline Network Flow Meter 3 (Key Drainage Household) | PN-FM3-KDH | 1.56 | / | 3 | 0 |
| 63 | Pipeline Network Flow Meter 4 (Main Inlet Pipe) | PN-FM4-MIP | 1.61 | / | 3 | 0 |
| 64 | Pipeline Network Water Quality Tester 1 (Key Drainage Household) | PN-WQT1-KDH | 1.67 | / | 3 | 0 |
| 65 | Pipeline Network Water Quality Tester 2 (Main Inlet Pipe) | PN-WQT2-MIP | 1.73 | / | 3 | 0 |
| 66 | Pipeline Network Water Quality Tester 3 (Confluence of Main and Branch Pipes) | PN-WQT3-CMBP | 1.79 | / | 3 | 0 |
| 67 | Pipeline Network Video Surveillance 1 (Flood-prone Areas) | PN-VS1-FPA | 1.85 | / | 3 | 0 |
| 68 | Pipeline Network Video Surveillance 2 (Main Inlet Pipe) | PN-VS2-MIP | 1.91 | / | 3 | 0 |
| 69 | Wastewater Treatment Plant Water Quality Tester 1 (Inlet Pump House) | WWTP-WQT1-IPH | 1.97 | / | 4 | 0 |
| 70 | Wastewater Treatment Plant Water Quality Tester 2 (Biochemical Reactor) | WWTP-WQT2-BR | 2.03 | / | 4 | 0 |
| 71 | Wastewater Treatment Plant Water Quality Tester 3 (Outlet Pump House) | WWTP-WQT3-OPH | 2.09 | / | 4 | 0 |
| 72 | Wastewater Treatment Plant Water Level Meter 1 (Inlet Pump House) | WWTP-WLM1-IPH | 2.15 | / | 4 | 0 |
| 73 | Wastewater Treatment Plant Water Level Meter 2 (Recirculation Pump House) | WWTP-WLM2-RPH | 2.21 | / | 4 | 0 |
| 74 | Wastewater Treatment Plant Water Level Meter 3 (Chemical Addition Room) | WWTP-WLM3-CAR | 2.27 | / | 4 | 0 |
| 75 | Wastewater Treatment Plant Turbidity Meter 1 (High-density Sedimentation Tank) | WWTP-TM1-HST | 0.95 | / | 4 | 0 |
| 76 | Wastewater Treatment Plant Turbidity Meter 2 (UV Disinfection Channel) | WWTP-TM2-UVC | 1.47 | / | 4 | 0 |
| 77 | Wastewater Treatment Plant Sludge Level Meter (Secondary Sedimentation Tank) | WWTP-SLM-SST | 1.17 | / | 4 | 0 |
| 78 | Wastewater Treatment Plant Flow Meter 1 (Inlet Pump House) | WWTP-FM1-IPH | 0.64 | / | 4 | 0 |
| 79 | Wastewater Treatment Plant Flow Meter 2 (Biochemical Reactor) | WWTP-FM2-BR | 0.87 | / | 4 | 0 |
| 80 | Wastewater Treatment Plant Flow Meter 3 (Denitrification Filter) | WWTP-FM3-DF | 1.09 | / | 4 | 0 |
| 81 | Wastewater Treatment Plant Flow Meter 4 (Chemical Addition Room) | WWTP-FM4-CAR | 1.14 | / | 4 | 0 |
| 82 | Wastewater Treatment Plant Flow Meter 5 (Outlet Pump House) | WWTP-FM5-OPH | 1.25 | / | 4 | 0 |
| 83 | Wastewater Treatment Plant Water Temperature Meter (Outlet Pump House) | WWTP-WTM-OPH | 0.82 | / | 4 | 0 |
| 84 | Wastewater Treatment Plant Air Flow Meter (Blower Room) | WWTP-AFM-BR | 1.69 | / | 4 | 0 |
| 85 | Wastewater Treatment Plant Meteorological Sensor | WWTP-MS | 2.01 | / | 4 | 0 |
| 86 | Water Quality Analyzer 1 (Analyzing Network Wastewater) | WQA1-NW | 2.17 | / | 3 | 1 |
| 87 | Water Quality Analyzer 2 (Analyzing Inlet Wastewater) | WQA2-IW | 2.72 | / | 4 | 1 |
| 88 | Water Quality Analyzer 3 (Analyzing Outlet Wastewater) | WQA3-OW | 2.56 | / | 4 | 1 |
| 89 | Wastewater Treatment Plant SCADA | WWTP-SCADA | 2.88 | / | 4 | 1 |
| 90 | Pipeline Network SCADA | PN-SCADA | 0.68 | / | 3 | 1 |
| 91 | Wastewater Treatment Company Central Control Platform | WWTC-CCP | 0.76 | / | 3 | 1 |
| 92 | Wastewater Treatment Plant Decision System | WWTP-DS | 0.84 | / | 4 | 1 |
| 93 | Pipeline Network Decision System | PN-DS | 0.92 | / | 3 | 1 |
| 94 | Wastewater Treatment Plant Control Center | WWTP-CC | 1.26 | / | 4 | 0 |
| 95 | Pipeline Network Control Center | PN-CC | 1.32 | / | 3 | 0 |
| 96 | Wastewater Treatment Plant Pump 1 (Inlet Pump House) | WWTP-P1-IPH | 1.38 | / | 4 | 0 |
| 97 | Wastewater Treatment Plant Pump 2 (Denitrification Filter) | WWTP-P2-DF | 1.44 | / | 4 | 0 |
| 98 | Wastewater Treatment Plant Pump 3 (Aeration Sedimentation Tank) | WWTP-P3-AST | 1.50 | / | 4 | 0 |
| 99 | Wastewater Treatment Plant Pump 4 (Outlet Pump House) | WWTP-P4-OPH | 1.56 | / | 4 | 0 |
| 100 | Wastewater Treatment Plant Sludge Pump 1 (Recirculation Pump House) | WWTP-SP1-RPH | 1.61 | / | 4 | 0 |
| 101 | Wastewater Treatment Plant Sludge Pump 2 (High-density Sedimentation Tank) | WWTP-SP2-HST | 1.67 | / | 4 | 0 |
| 102 | Wastewater Treatment Plant Chemical Addition Pump (Chemical Addition Room) | WWTP-CAP-CAR | 1.73 | / | 4 | 0 |
| 103 | Wastewater Treatment Plant Chemical Unloading Pump (Chemical Addition Room) | WWTP-CUP-CAR | 1.79 | / | 4 | 0 |
| 104 | Wastewater Treatment Plant Odor Removal Device 1 (Biochemical Reactor) | WWTP-ORD1-BR | 1.85 | / | 4 | 0 |
| 105 | Wastewater Treatment Plant Odor Removal Device 2 (Sludge Removal Room) | WWTP-ORD2-SRR | 1.91 | / | 4 | 0 |
| 106 | Wastewater Treatment Plant Debris Cleaner 1 (Inlet Pump House) | WWTP-DC1-IPH | 1.97 | / | 4 | 0 |
| 107 | Wastewater Treatment Plant Debris Cleaner 2 (Aeration Sedimentation Tank) | WWTP-DC2-AST | 2.03 | / | 4 | 0 |
| 108 | Wastewater Treatment Plant Blower (Blower Room) | WWTP-BR-BR | 2.09 | / | 4 | 0 |
| 109 | Wastewater Treatment Plant Sand and Oil Skimmer (Aeration Sedimentation Tank) | WWTP-SOS-AST | 2.15 | / | 4 | 0 |
| 110 | Wastewater Treatment Plant Mixer 1 (Biochemical Reactor) | WWTP-M1-BR | 2.21 | / | 4 | 0 |
| 111 | Wastewater Treatment Plant Mixer 2 (High-density Sedimentation Tank) | WWTP-M2-HST | 2.27 | / | 4 | 0 |
| 112 | Wastewater Treatment Plant Mixer 3 (Chemical Addition Room) | WWTP-M3-CAR | 0.95 | / | 4 | 0 |
| 113 | Wastewater Treatment Plant Air Compressor (Denitrification Filter) | WWTP-AC-DF | 1.47 | / | 4 | 0 |
| 114 | Wastewater Treatment Plant Sand-Water Separator (Aeration Sedimentation Tank) | WWTP-SWS-AST | 1.17 | / | 4 | 0 |
| 115 | Wastewater Treatment Plant Conveyor (Inlet Pump House) | WWTP-CV-IPH | 0.64 | / | 4 | 0 |
| 116 | Wastewater Treatment Plant Propeller (Biochemical Reactor) | WWTP-PR-BR | 0.87 | / | 4 | 0 |
| 117 | Wastewater Treatment Plant Mud Scraper 1 (Secondary Sedimentation Tank) | WWTP-MS1-SST | 1.09 | / | 4 | 0 |
| 118 | Wastewater Treatment Plant Mud Scraper 2 (High-density Sedimentation Tank) | WWTP-MS2-HST | 1.14 | / | 4 | 0 |
| 119 | Wastewater Treatment Plant Press (Aeration Sedimentation Tank) | WWTP-PRESS-AST | 1.25 | / | 4 | 0 |
| 120 | Wastewater Treatment Plant Chemical Consumption Metering Pump (Chemical Addition Room) | WWTP-CCMP-CAR | 0.82 | / | 4 | 0 |
| 121 | Wastewater Treatment Plant UV Disinfection Device (UV Disinfection Channel) | WWTP-UVD-UVC | 1.69 | / | 4 | 0 |
| 122 | Wastewater Treatment Plant Sludge Dewatering Equipment | WWTP-SDE | 2.01 | / | 4 | 0 |
| 123 | Wastewater Treatment Plant Sludge Drying Equipment | WWTP-SDRY | 2.17 | / | 4 | 0 |
| 124 | Pipeline Network Pump Station 1 (Main Pipeline) | PN-P1-MP | 2.72 | / | 3 | 0 |
| 125 | Pipeline Network Pump Station 2 (Low-lying Area) | PN-P2-LLA | 2.56 | / | 3 | 0 |
| 126 | Pipeline Network Pump Station 3 (High-density Population Area) | PN-P3-HDPA | 2.88 | / | 3 | 0 |
| 127 | Pipeline Network Electric Valve 1 (Pipeline Intersection) | PN-EV1-PI | 0.68 | / | 3 | 0 |
| 128 | Pipeline Network Electric Valve 2 (Before and After Pump Station) | PN-EV2-PS | 0.76 | / | 3 | 0 |
| 129 | Pipeline Network Electric Valve 3 (Before Inlet Pipeline) | PN-EV3-BIP | 0.84 | / | 3 | 0 |
| 130 | Pipeline Network Electric Valve 4 (Key Drainage Household Pipeline) | PN-EV4-KDHP | 0.92 | / | 3 | 0 |

Note: The “Organization” column functions as an identifier for node affiliations. In this context, “1” symbolizes the government. “2” refers to environmental groups. “3” indicates wastewater treatment companies responsible for the operation of WWTPs. “4” represents WWTPs. “5” stands for equipment suppliers. And “6” is the public.

**Table D2. Node composition and attribute setting of case PPNSM**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Node name | Node code | Cost | Year | Organization | Intelligent |
| 1 | Government Environmental Department | GOV-E | 1.47 | 10 | 1 | / |
| 2 | Government Water Department | GOV-W | 1.60 | 12 | 1 | / |
| 3 | Government Finance Department | GOV-F | 1.71 | 15 | 1 | / |
| 4 | Water Company Leadership | WC-L | 2.45 | 20 | 2 | / |
| 5 | Water Company Administrative Office | WC-AO | 0.98 | 8 | 2 | / |
| 6 | Water Company Human Resources | WC-HR | 0.92 | 7 | 2 | / |
| 7 | Wastewater Company General Manager | SC-GM | 2.21 | 18 | 3 | / |
| 8 | Wastewater Company Deputy General Manager | SC-DGM | 1.96 | 15 | 3 | / |
| 9 | Wastewater Company Administrative Office | SC-AO | 0.73 | 6 | 3 | / |
| 10 | Wastewater Company Process Technology Department | SC-PTD | 1.10 | 10 | 3 | / |
| 11 | Wastewater Company Operation Management Department | SC-OMD | 1.17 | 12 | 3 | / |
| 12 | Wastewater Company Facilities and Equipment Department | SC-FED | 1.04 | 10 | 3 | / |
| 13 | Wastewater Company Safety Assurance Department | SC-SAD | 1.04 | 10 | 3 | / |
| 14 | Wastewater Treatment Plant General Manager | WWTP-GM | 1.84 | 15 | 4 | / |
| 15 | Wastewater Treatment Plant Deputy General Manager (Production) | WWTP-DGM-P | 1.72 | 14 | 4 | / |
| 16 | Wastewater Treatment Plant Deputy General Manager (Safety) | WWTP-DGM-S | 1.65 | 13 | 4 | / |
| 17 | Wastewater Treatment Plant Administrative Team Leader | WWTP-AT-L | 0.86 | 8 | 4 | / |
| 18 | Wastewater Treatment Plant Administrative Team Member 1 | WWTP-AT-M1 | 0.61 | 5 | 4 | / |
| 19 | Wastewater Treatment Plant Administrative Team Member 2 | WWTP-AT-M2 | 0.61 | 5 | 4 | / |
| 20 | Wastewater Treatment Plant Operation Team Leader | WWTP-OT-L | 0.86 | 8 | 4 | / |
| 21 | Wastewater Treatment Plant Operation Team Member 1 | WWTP-OT-M1 | 0.61 | 5 | 4 | / |
| 22 | Wastewater Treatment Plant Operation Team Member 2 | WWTP-OT-M2 | 0.61 | 5 | 4 | / |
| 23 | Wastewater Treatment Plant Operation Team Member 3 | WWTP-OT-M3 | 0.61 | 5 | 4 | / |
| 24 | Wastewater Treatment Plant Water Quality Testing Team Member 1 | WWTP-WQT-M1 | 0.61 | 5 | 4 | / |
| 25 | Wastewater Treatment Plant Water Quality Testing Team Member 2 | WWTP-WQT-M2 | 0.61 | 5 | 4 | / |
| 26 | Wastewater Treatment Plant Maintenance Team Member 1 | WWTP-MT-M1 | 0.74 | 7 | 4 | / |
| 27 | Wastewater Treatment Plant Maintenance Team Member 2 | WWTP-MT-M2 | 0.74 | 7 | 4 | / |
| 28 | Wastewater Treatment Plant Maintenance Team Member 3 | WWTP-MT-M3 | 0.74 | 7 | 4 | / |
| 29 | Wastewater Treatment Plant Canteen Manager | WWTP-CM | 0.61 | 5 | 4 | / |
| 30 | Wastewater Treatment Plant Environmental Manager | WWTP-EM | 0.61 | 5 | 4 | / |
| 31 | Wastewater Treatment Plant Security Manager | WWTP-SM | 0.61 | 5 | 4 | / |
| 32 | Pipeline Network Company General Manager | PNC-GM | 1.84 | 15 | 5 | / |
| 33 | Pipeline Network Company Administrative Team Leader | PNC-AT-L | 0.86 | 8 | 5 | / |
| 34 | Pipeline Network Company Administrative Team Member 1 (Documentation) | PNC-AT-M1 | 0.61 | 5 | 5 | / |
| 35 | Pipeline Network Company Administrative Team Member 2 (Operations) | PNC-AT-M2 | 0.61 | 5 | 5 | / |
| 36 | Pipeline Network Company Administrative Team Member 3 (Maintenance) | PNC-AT-M3 | 0.61 | 5 | 5 | / |
| 37 | Pipeline Network Company Inspection Work Leader | PNC-IT-L | 0.86 | 8 | 5 | / |
| 38 | Pipeline Network Company Inspection Team 1 | PNC-IT-M1 | 0.61 | 5 | 5 | / |
| 39 | Pipeline Network Company Inspection Team 2 | PNC-IT-M2 | 0.61 | 5 | 5 | / |
| 40 | Pipeline Network Company Inspection Team 3 | PNC-IT-M3 | 0.61 | 5 | 5 | / |
| 41 | Pipeline Network Company Operations Team Leader | PNC-OT-L | 0.86 | 8 | 5 | / |
| 42 | Pipeline Network Company Operations Team Member 1 | PNC-OT-M1 | 0.61 | 5 | 5 | / |
| 43 | Pipeline Network Company Operations Team Member 2 | PNC-OT-M2 | 0.61 | 5 | 5 | / |
| 44 | Pipeline Network Company Operations Team Member 3 | PNC-OT-M3 | 0.61 | 5 | 5 | / |
| 45 | Sludge Disposal Company General Manager | SDC-GM | 1.84 | 15 | 6 | / |
| 46 | Sludge Disposal Company Deputy General Manager (Project Coordination) | SDC-DGM | 1.65 | 13 | 6 | / |
| 47 | Sludge Disposal Company Administrative Staff | SDC-AS | 0.61 | 5 | 6 | / |
| 48 | Sludge Disposal Company Operation Team Leader | SDC-OT-L | 0.86 | 8 | 6 | / |
| 49 | Sludge Disposal Company Operation Team Member 1 | SDC-OT-M1 | 0.61 | 5 | 6 | / |
| 50 | Sludge Disposal Company Operation Team Member 2 | SDC-OT-M2 | 0.61 | 5 | 6 | / |
| 51 | Sludge Disposal Company Operation Team Member 3 | SDC-OT-M3 | 0.61 | 5 | 6 | / |
| 52 | Sludge Disposal Company Equipment Maintenance Department | SDC-EMD | 0.74 | 7 | 6 | / |
| 53 | Sensing Equipment Supplier | SES | 1.23 | 10 | 7 | / |
| 54 | Analytical Equipment Supplier | AES | 1.23 | 10 | 7 | / |
| 55 | Decision Equipment Supplier | DES | 1.23 | 10 | 7 | / |
| 56 | Execution Equipment Supplier | EES | 1.23 | 10 | 7 | / |
| 57 | Residents in Wastewater Treatment Area | Residents | 0.00 | / | 8 | / |
| 58 | Media | Media | 0.00 | / | 8 | / |
| 59 | Netizens | Netizens | 0.00 | / | 8 | / |
| 60 | Pipeline Network Water Level Meter 1 (Confluence of Main and Branch Pipes) | PN-WLM1-CMBP | 0.25 | / | 5 | 0 |
| 61 | Pipeline Network Water Level Meter 2 (Flood-prone Areas) | PN-WLM2-FPA | 0.25 | / | 5 | 0 |
| 62 | Pipeline Network Water Level Meter 3 (River) | PN-WLM3-R | 0.25 | / | 5 | 0 |
| 63 | Pipeline Network Water Level Meter 4 (Main Inlet Pipe) | PN-WLM4-MIP | 0.25 | / | 5 | 0 |
| 64 | Pipeline Network Flow Velocity Meter 1 (Confluence of Main and Branch Pipes) | PN-FVM1-CMBP | 0.38 | / | 5 | 0 |
| 65 | Pipeline Network Flow Velocity Meter 2 (Pumping Station) | PN-FVM2-PS | 0.38 | / | 5 | 0 |
| 66 | Pipeline Network Flow Velocity Meter 3 (Key Drainage Household) | PN-FVM3-KDH | 0.38 | / | 5 | 0 |
| 67 | Pipeline Network Flow Velocity Meter 4 (Main Inlet Pipe) | PN-FVM4-MIP | 0.38 | / | 5 | 0 |
| 68 | Pipeline Network Flow Meter 1 (Confluence of Main and Branch Pipes) | PN-FM1-CMBP | 0.51 | / | 5 | 0 |
| 69 | Pipeline Network Flow Meter 2 (Pumping Station) | PN-FM2-PS | 0.51 | / | 5 | 0 |
| 70 | Pipeline Network Flow Meter 3 (Key Drainage Household) | PN-FM3-KDH | 0.51 | / | 5 | 0 |
| 71 | Pipeline Network Flow Meter 4 (Main Inlet Pipe) | PN-FM4-MIP | 0.51 | / | 5 | 0 |
| 72 | Pipeline Network Water Quality Tester 1 (Key Drainage Household) | PN-WQT1-KDH | 0.76 | / | 5 | 0 |
| 73 | Pipeline Network Water Quality Tester 2 (Main Inlet Pipe) | PN-WQT2-MIP | 0.76 | / | 5 | 0 |
| 74 | Pipeline Network Water Quality Tester 3 (Confluence of Main and Branch Pipes) | PN-WQT3-CMBP | 0.76 | / | 5 | 0 |
| 75 | Pipeline Network Video Surveillance 1 (Flood-prone Areas) | PN-VS1-FPA | 0.64 | / | 5 | 0 |
| 76 | Pipeline Network Video Surveillance 2 (Main Inlet Pipe) | PN-VS2-MIP | 0.64 | / | 5 | 0 |
| 77 | Pipeline Network Video Surveillance 3 (Key Drainage Household) | PN-VS3-KDH | 0.64 | / | 5 | 0 |
| 78 | Smart Manhole Cover Terminal 1 (High-density Population Area) | SMCT1-HDPA | 0.30 | / | 5 | 1 |
| 79 | Smart Manhole Cover Terminal 2 (Main Pipeline) | SMCT2-MP | 0.30 | / | 5 | 1 |
| 80 | Wastewater Treatment Plant Water Quality Tester 1 (Inlet Pump House) | WWTP-WQT1-IPH | 0.88 | / | 4 | 0 |
| 81 | Wastewater Treatment Plant Water Quality Tester 2 (Biochemical Reactor) | WWTP-WQT2-BR | 0.88 | / | 4 | 0 |
| 82 | Wastewater Treatment Plant Water Quality Tester 3 (Outlet Pump House) | WWTP-WQT3-OPH | 0.88 | / | 4 | 0 |
| 83 | Wastewater Treatment Plant Water Level Meter 1 (Inlet Pump House) | WWTP-WLM1-IPH | 0.30 | / | 4 | 0 |
| 84 | Wastewater Treatment Plant Water Level Meter 2 (Recirculation Pump House) | WWTP-WLM2-RPH | 0.30 | / | 4 | 0 |
| 85 | Wastewater Treatment Plant Water Level Meter 3 (Chemical Addition Room) | WWTP-WLM3-CAR | 0.30 | / | 4 | 0 |
| 86 | Wastewater Treatment Plant Turbidity Meter 1 (High-density Sedimentation Tank) | WWTP-TM1-HST | 0.50 | / | 4 | 0 |
| 87 | Wastewater Treatment Plant Turbidity Meter 2 (UV Disinfection Channel) | WWTP-TM2-UVC | 0.50 | / | 4 | 0 |
| 88 | Wastewater Treatment Plant Sludge Level Meter (Secondary Sedimentation Tank) | WWTP-SLM-SST | 0.38 | / | 4 | 0 |
| 89 | Wastewater Treatment Plant Flow Meter 1 (Inlet Pump House) | WWTP-FM1-IPH | 0.63 | / | 4 | 0 |
| 90 | Wastewater Treatment Plant Flow Meter 2 (Biochemical Reactor) | WWTP-FM2-BR | 0.63 | / | 4 | 0 |
| 91 | Wastewater Treatment Plant Flow Meter 3 (Denitrification Filter) | WWTP-FM3-DF | 0.63 | / | 4 | 0 |
| 92 | Wastewater Treatment Plant Flow Meter 4 (Chemical Addition Room) | WWTP-FM4-CAR | 0.63 | / | 4 | 0 |
| 93 | Wastewater Treatment Plant Flow Meter 5 (Outlet Pump House) | WWTP-FM5-OPH | 0.63 | / | 4 | 0 |
| 94 | Wastewater Treatment Plant Water Temperature Meter (Outlet Pump House) | WWTP-WTM-OPH | 0.25 | / | 4 | 0 |
| 95 | Wastewater Treatment Plant Air Flow Meter (Blower Room) | WWTP-AFM-BR | 0.50 | / | 4 | 0 |
| 96 | Wastewater Treatment Plant Meteorological Sensor | WWTP-MS | 0.38 | / | 4 | 0 |
| 97 | Water Quality Analyzer 1 (Analyzing Network Wastewater) | WQA1-NW | 1.00 | / | 5 | 0 |
| 98 | Water Quality Analyzer 2 (Analyzing Inlet Wastewater) | WQA2-IW | 1.00 | / | 4 | 0 |
| 99 | Water Quality Analyzer 3 (Analyzing Outlet Wastewater) | WQA3-OW | 1.00 | / | 4 | 0 |
| 100 | Wastewater Treatment Plant SCADA | WWTP-SCADA | 3.75 | / | 4 | 0 |
| 101 | Pipeline Network SCADA | PN-SCADA | 3.00 | / | 5 | 0 |
| 102 | Sludge Disposal SCADA | SD-SCADA | 2.50 | / | 6 | 0 |
| 103 | Wastewater Treatment Plant Decision System | WWTP-DS | 3.00 | / | 4 | 1 |
| 104 | Pipeline Network Decision System | PN-DS | 2.50 | / | 5 | 1 |
| 105 | Sludge Disposal Decision System | SD-DS | 2.00 | / | 6 | 1 |
| 106 | Wastewater Treatment Plant Control Center | WWTP-CC | 2.50 | / | 4 | 1 |
| 107 | Pipeline Network Control Center | PN-CC | 2.00 | / | 5 | 1 |
| 108 | Wastewater Treatment Plant Pump 1 (Inlet Pump House) | WWTP-P1-IPH | 1.25 | / | 4 | 0 |
| 109 | Wastewater Treatment Plant Pump 2 (Denitrification Filter) | WWTP-P2-DF | 1.25 | / | 4 | 0 |
| 110 | Wastewater Treatment Plant Pump 3 (Aeration Sedimentation Tank) | WWTP-P3-AST | 1.25 | / | 4 | 0 |
| 111 | Wastewater Treatment Plant Pump 4 (Outlet Pump House) | WWTP-P4-OPH | 1.25 | / | 4 | 0 |
| 112 | Wastewater Treatment Plant Sludge Pump 1 (Recirculation Pump House) | WWTP-SP1-RPH | 1.00 | / | 4 | 0 |
| 113 | Wastewater Treatment Plant Sludge Pump 2 (High-density Sedimentation Tank) | WWTP-SP2-HST | 1.00 | / | 4 | 0 |
| 114 | Wastewater Treatment Plant Chemical Addition Pump (Chemical Addition Room) | WWTP-CAP-CAR | 0.75 | / | 4 | 0 |
| 115 | Wastewater Treatment Plant Chemical Unloading Pump (Chemical Addition Room) | WWTP-CUP-CAR | 0.75 | / | 4 | 0 |
| 116 | Wastewater Treatment Plant Odor Removal Device 1 (Biochemical Reactor) | WWTP-ORD1-BR | 0.63 | / | 4 | 0 |
| 117 | Wastewater Treatment Plant Odor Removal Device 2 (Sludge Removal Room) | WWTP-ORD2-SRR | 0.63 | / | 4 | 0 |
| 118 | Wastewater Treatment Plant Debris Cleaner 1 (Inlet Pump House) | WWTP-DC1-IPH | 0.75 | / | 4 | 0 |
| 119 | Wastewater Treatment Plant Debris Cleaner 2 (Aeration Sedimentation Tank) | WWTP-DC2-AST | 0.75 | / | 4 | 0 |
| 120 | Wastewater Treatment Plant Blower (Blower Room) | WWTP-BR-BR | 1.50 | / | 4 | 0 |
| 121 | Wastewater Treatment Plant Sand and Oil Skimmer (Aeration Sedimentation Tank) | WWTP-SOS-AST | 0.88 | / | 4 | 0 |
| 122 | Wastewater Treatment Plant Mixer 1 (Biochemical Reactor) | WWTP-M1-BR | 0.75 | / | 4 | 0 |
| 123 | Wastewater Treatment Plant Mixer 2 (High-density Sedimentation Tank) | WWTP-M2-HST | 0.75 | / | 4 | 0 |
| 124 | Wastewater Treatment Plant Mixer 3 (Chemical Addition Room) | WWTP-M3-CAR | 0.75 | / | 4 | 0 |
| 125 | Wastewater Treatment Plant Air Compressor (Denitrification Filter) | WWTP-AC-DF | 1.00 | / | 4 | 0 |
| 126 | Wastewater Treatment Plant Sand-Water Separator (Aeration Sedimentation Tank) | WWTP-SWS-AST | 0.88 | / | 4 | 0 |
| 127 | Wastewater Treatment Plant Conveyor (Inlet Pump House) | WWTP-CV-IPH | 0.75 | / | 4 | 0 |
| 128 | Wastewater Treatment Plant Propeller (Biochemical Reactor) | WWTP-PR-BR | 0.75 | / | 4 | 0 |
| 129 | Wastewater Treatment Plant Mud Scraper 1 (Secondary Sedimentation Tank) | WWTP-MS1-SST | 0.88 | / | 4 | 0 |
| 130 | Wastewater Treatment Plant Mud Scraper 2 (High-density Sedimentation Tank) | WWTP-MS2-HST | 0.88 | / | 4 | 0 |
| 131 | Wastewater Treatment Plant Press (Aeration Sedimentation Tank) | WWTP-PRESS-AST | 1.13 | / | 4 | 0 |
| 132 | Wastewater Treatment Plant Chemical Consumption Metering Pump (Chemical Addition Room) | WWTP-CCMP-CAR | 0.63 | / | 4 | 0 |
| 133 | Wastewater Treatment Plant UV Disinfection Device (UV Disinfection Channel) | WWTP-UVD-UVC | 1.25 | / | 4 | 0 |
| 134 | Sludge Dewatering Equipment | SDE | 3.75 | / | 6 | 0 |
| 135 | Sludge Drying Equipment | SDRY | 4.50 | / | 6 | 0 |
| 136 | Pipeline Network Pump Station 1 (Main Pipeline) | PN-P1-MP | 2.00 | / | 5 | 0 |
| 137 | Pipeline Network Pump Station 2 (Low-lying Area) | PN-P2-LLA | 2.00 | / | 5 | 0 |
| 138 | Pipeline Network Pump Station 3 (High-density Population Area) | PN-P3-HDPA | 2.00 | / | 5 | 0 |
| 139 | Pipeline Network Electric Valve 1 (Pipeline Intersection) | PN-EV1-PI | 0.50 | / | 5 | 0 |
| 140 | Pipeline Network Electric Valve 2 (Before and After Pump Station) | PN-EV2-PS | 0.50 | / | 5 | 0 |
| 141 | Pipeline Network Electric Valve 3 (Before Inlet Pipeline) | PN-EV3-BIP | 0.50 | / | 5 | 0 |
| 142 | Pipeline Network Electric Valve 4 (Key Drainage Household Pipeline) | PN-EV4-KDHP | 0.50 | / | 5 | 0 |

Note: The “Organization” column serves as an indicator of node affiliations. Here, “1” is the government. “2” is the water company. “3” is the drainage company. “4” is the WWTP. “5” is the pipeline network company. “6” is the sludge disposal company. “7” is the equipment supplier. And “8” is the public.