PARANA STATE SANITATION COMPANY (SANEPAR)
BRAZIL

PROJECT
FOR
IMPROVEMENT OF OPERATION AND MAINTENANCE OF WATER SUPPLY AND SEWERAGE SYSTEMS
IN
PARANA STATE, BRAZIL

PROJECT COMPLETION REPORT

VOLUME II

-- ANNEXES --

September 2015

Japan International Cooperation Agency (JICA)

Nihon Suido Consultants Co., Ltd.

GE
JR
15-140

PROJECT
FOR
IMPROVEMENT OF OPERATION AND MAINTENANCE OF WATER SUPPLY AND SEWERAGE SYSTEMS
IN
PARANA STATE, BRAZIL

PROJECT COMPLETION REPORT

VOLUME II

-- ANNEXES --

A2-1 Letter Issued by C/P on Reciept of Equipment Provided by JICA

SANEPAR

PARANÁ
GOVERNO DO ESTADO

DP 114/2013
Curitiba, 25 de fevereiro de 2013.

Ilustríssimo Senhor
SATOSHI MUROSAWA
Agência de Cooperação do Japão – JICA Brasil

Senhor Representante Chefe

Temos a satisfação de enviar o "Termo de Recebimento" dos equipamentos adquiridos no âmbito do "Projeto de fortalecimento da capacidade de gerenciamento e manutenção do sistema de água e esgoto do Estado do Paraná", entregues pelos técnicos japoneses, conforme o Acordo firmado na Minuta de Entendimento assinado no dia 09 de maio de 2012.

Em anexo, como parte integrante do referido termo, a lista de todos os equipamentos doados ao Projeto, estamos providenciando a incorporação ao patrimônio da Empresa.

Sem mais para o momento, subscrevemo-nos, aproveitando o ensejo para reiterar a V.Sa. os nossos votos de estima e apreço.

Atenciosamente,

Antonio Hallage
Diretor-Presidente

Rua: Engenheiros Rebouças, 1376 - Rebouças
CEP: 80215-900 - Curitiba - PR
Fone: (41) 3330-3636
Fax: (41) 3330-3344

SANEPAR

PARANÁ
GOVERNO DO ESTADO

TERMO DE RECEBIMENTO

Declaramos para os devidos fins que a Companhia de Saneamento do Paraná – SANEPAR recebeu os equipamentos listados abaixo, provenientes do Termo de Doação datado de 8 de fevereiro de 2013, da Japan International Cooperation Agency – JICA no âmbito do "Projeto de fortalecimento da capacidade de gerenciamento e manutenção do sistema de água e esgoto do Estado do Paraná".

No	Equipamento	Modelo	Qtd.
1	Câmera de TV para inspeção primária	HANAREWAZA	1
2	Detector de gás portátil	GX-2003TYPE-B	1
3	Data Logger de condutividade	HOBO U24	3
4	Medidor portátil de qualidade de água multi-item	WQC-24	2
5	Medidor portátil de sedimento-líquido	Check Boy	2
6	Computador com monitor	Lenovo 57302491	1

Curitiba, 23 de fevereiro de 2013

Antonio Hallage
Diretor Presidente
Companhia de Saneamento do Paraná - SANEPAR

SANEPAR

PARANÁ
GOVERNO DO ESTADO

Curitiba, 27 de novembro de 2013
CA 3/2013 - USES

Ao Senhor

Satoshi Murosawa

Representante Chefe
Agência de Cooperação do Japão
JICA Brasil

Senhor Representante

Temos a satisfação de encaminhar a V.Sa. o "Termo de Recebimento" dos equipamentos doados conforme oficio JICA 460/13 de 13 de novembro de 2013 e anexos.

Estamos procedendo a incorporação dos mesmos ao patrimônio da empresa.

Sem mais para o momento, reiteramos os nossos votos de estima e consideração.

Atenciosamente,

Engº Gil Alceu Mochida
GPDO/USES

GPDO/DO – GERÊNCIA DE PLANEJAMENTO E DESENVOLVIMENTO OPERACIONAL
Rua Engenheiro Antonio Batista Ribas, 151 CEP 82.800-130- Tarumã - Curitiba Paraná
Fones (041)3330 7109 Fax (041)3330 -7162

TERMO DE RECEBIMENTO

Declaramos para os devidos fins que a Companhia de Saneamento do Paraná - SANEPAR recebeu os equipamentos listados abaixo, provenientes do Termo de Doação datado de 13 de novembro de 2013, da Japan International Cooperation Agency - JICA, no âmbito do "Projeto de fortalecimento da capacidade de gerenciamento e manutenção do sistema de água e esgoto do Estado do Paraná".

No	Equipamento	Qtd.
1	Câmera de TV para inspeção primária	2
2	Medidor de vazão ultrassônico (p/ coletor saturado)	2
3	Medidor de sulfeto de hidrogênio na atmosfera	2
4	Equipamento ultrassônico controlador de algas	1
5	Câmera auto propulsora para inspeção visual remota ROVVER	1
6	Medidor de Vazão Ultrassônico (método área-velocidade) FL900 HACH	15

Curitiba, _____ de novembro de 2013.

SANEPAR
Fernando E. Ghignone
Diretor Presidente
SANEPAR

SANEPAR

PARANÁ
GOVERNO DO ESTADO

Curitiba, 31 de janeiro de 2014
CA 1/2013 - USES

Senhora
Christiane Hiroko Hatano
Agência de Cooperação do Japão
JICA Brasil

Encaminhamos a V.Sa. o "Termo de Recebimento" do veículo Furgão Fiat Ducatto Cargo, datado de 30 de janeiro de 2014, da Japan International Cooporation Agency – JICA, devidamente assinado pelo Diretor Presidente da Sanepar, Senhor Fernando E. Ghignone.

Estamos procedendo a incorporação dos mesmos ao patrimônio da empresa.

Á disposição para esclarecimentos que se fizerem necessários.

Atenciosamente,

Engº Gil Alceu Mochida
Unidade de Serviço Processo Esgoto

GPDO/DO –GERÊNCIA DE PLANEJAMENTO E DESENVOLVIMENTO OPERACIONAL
Rua Engenheiro Antonio Batista Ribas, 151 CEP 82.800-130- Tarumã - Curitiba Paraná
Fones (041)3330 7109 Fax (041)3330 -7162

TERMO DE RECEBIMENTO

Declaramos para os devidos fins que a Companhia de Saneamento do Paraná - SANEPAR recebeu o veículo listado abaixo, provenientes do Termo de Doação datado de 23 de janeiro de 2014, da Japan International Cooperation Agency - JICA, no âmbito do "Projeto de fortalecimento da capacidade de gerenciamento e manutenção do sistema de água e esgoto do Estado do Paraná".

No	Equipamento	Qtd.
1	Furgão Fiat Ducatto Cargo 2012/2013, Diesel, branco Cód. Renavam: 00589680358 Placa: OVM7663	1

Curitiba, 30 de janeiro de 2014.

SANEPAR
Fernando E. Ghignone
Diretor Presidente
SANEPAR

SANEPAR

PARANÁ
GOVERNO DO ESTADO

DP 114/2013
Curitiba, 25 de fevereiro de 2013.

Ilustríssimo Senhor
SATOSHI MUROSAWA
Agência de Cooperação do Japão – JICA Brasil

Senhor Representante Chefe

Temos a satisfação de enviar o "Termo de Recebimento" dos equipamentos adquiridos no âmbito do "Projeto de fortalecimento da capacidade de gerenciamento e manutenção do sistema de água e esgoto do Estado do Paraná", entregues pelos técnicos japoneses, conforme o Acordo firmado na Minuta de Entendimento assinado no dia 09 de maio de 2012.

Em anexo, como parte integrante do referido termo, a lista de todos os equipamentos doados ao Projeto, estamos providenciando a incorporação ao patrimônio da Empresa.

Sem mais para o momento, subscrevemo-nos, aproveitando o ensejo para reiterar a V.Sa. os nossos votos de estima e apreço.

Atenciosamente,

Antonio Hallage
Diretor-Presidente

Rua: Engenheiros Rebouças, 1376 - Rebouças
CEP: 80215-900 - Curitiba - PR
Fone: (41) 3330-3636
Fax: (41) 3330-3344

SANEPAR

PARANÁ
GOVERNO DO ESTADO

TERMO DE RECEBIMENTO

Declaramos para os devidos fins que a Companhia de Saneamento do Paraná – SANEPAR recebeu os equipamentos listados abaixo, provenientes do Termo de Doação datado de 8 de fevereiro de 2013, da Japan International Cooperation Agency – JICA no âmbito do "Projeto de fortalecimento da capacidade de gerenciamento e manutenção do sistema de água e esgoto do Estado do Paraná".

No	Equipamento	Modelo	Qtd.
1	Câmera de TV para inspeção primária	HANAREWAZA	1
2	Detector de gás portátil	GX-2003TYPE-B	1
3	Data Logger de condutividade	HOBO U24	3
4	Medidor portátil de qualidade de água multi-item	WQC-24	2
5	Medidor portátil de sedimento-líquido	Check Boy	2
6	Computador com monitor	Lenovo 57302491	1

Curitiba, 23 de fevereiro de 2013

Antonio Hallage
Diretor Presidente
Companhia de Saneamento do Paraná - SANEPAR

A3-1 Change History of PDM

PDM before and after the modification

PDM before the modification (PDM_0) is as shown in Table 1. PDMs after modification (PDM_1, PDM_2 and PDM_3) are as shown in Table 2, Table 3 and Table 4 respectively.

In the third fiscal year, PDM was modified in embodying of XX% and target STPs in Output-2. The modification from PDM_2 toPDM_3 is only 99.18% instead of 99.78% in the project target.

Project period: Three years

- Organization of C/P: Parana State Sanitation Company (SANEPAR)
- Target area: Parana State Curitiba Metropolitan Area (CMA) and the Coastal Area
- Target organization: Parana State Sanitation Company (SANEPAR) Operation Department

Table 1 PDM_0 (before modification)

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Water supply and sewerage service of SANEPAR is improved in the target area of the Project.	1. The coverage of sewerage system becomes 79% in CMA and 60% in coastal area by the end of 2018 (baseline: 72% in CMA, 49.4% in coastal area, 2011). 2. Rehabilitation/renewal plan developed by the Project is implemented by year 2020.	1. SANEPAR's report (annual report etc.) 2. SANEPAR's report	
Project Purpose Operation and maintenance (O&M) of water supply and sewerage systems in SANEPAR is improved in the target area of the Project	1. Performance indicators on O&M of sewage treatment plant (i.e. sewage treatment index, consumption of electric power and chemicals per m^3 treated water, % of conformity to the treated water quality standard in Brazil) is improved by xx%. 2. Performance indicators on O&M of water treatment plant (i.e. consumption of electric power and chemicals per m^3 produced water, % of conformity to the drinking water quality standard in Brazil) are improved by xx%.	1. Project report, monthly report of SANEPAR 2. Project report, monthly report of SANEPAR	No major changes occur in term of sewerage and water supply policy in central and state government. Budget of SANEPAR for implementation of rehabilitation/renewal plan is secured.
Outputs 1. Capacity of SANEPAR for operation and maintenance (O&M) of sewage pipe network is strengthened.	1-1 Number of incidents of blockage and/or overflow of sewage pipe networks in pilot areas decreases by xx%. 1-2 Quantity of infiltration in pilot areas decreases by xx%	1-1 Project report, SANEPAR Information System (SIS) 1-2 Project report	SANEPAR staffs who are trained in the Project remain in their respective duties.
2. Capacity of SANEPAR for operation and maintenance (O&M) of sewage treatment plant is strengthened.	2-1 Rehabilitation/renewal plan for sewage treatment plants developed by the project is approved by the management level of SANEPAR. 2-2 Annual budget plan is elaborated based on the rehabilitation/renewal plan.	2-1 Project report 2-2 Project report	

3. Capacity of SANEPAR operation and maintenance (O&M) of water treatment plant is strengthened.	3-1 Rehabilitation/renewal plan for water treatment plants developed by the Project is approved by the management level of SANEPAR. 3-2 Annual budget plan, including sludge treatment, is elaborated based on the rehabilitation/renewal plan.	3-1 Project report 3-2 Project report	
Activities of the Project 1-1 Conduct training courses on O&M and diagnosis of sewage pipe network 1-2 Organize diagnosis team(s) for sewage pipe network 1-3 Select pilot areas for sewage pipe network diagnosis 1-4 Prepare sewage ledger (GIS database) and clean up sewage pipe network on the pilot area 1-5 Conduct on-the-job training (OJT) on sewage pipe network diagnosis using TV camera 1-6 Analyze results of diagnosis and study on appropriate non-open trench method for rehabilitation and renewal of sewer pipe 1-7 Input results of diagnosis on the sewage ledger (GIS database) and formulate a plan for rehabilitation and renewal of sewage pipe network in pilot areas 1-8 Implement rehabilitation and renewal of sewage pipe network in the pilot areas 1-9 Formulate a diagnosis implementation plan for whole sewage pipe network in CMA and	**Inputs** Japanese Side: (1) JICA Experts - Chief advisor/O&M of sewage treatment plant - O&M of sewage pipe network - Sewage pipe diagnosis technology - O&M of water treatment plant - Sewage treatment technology - Water treatment technology - Electric/mechanical engineering (2) Training - Training in Japan (three to five persons/year) (3) Local cost - Cost for workshop/seminar - Cost for training materials (4) Equipment - TV cameras for sewage pipe diagnosis - Ultrasonic flow meters	Brazilian Side: (1) Counterpart personnel - Project director - Project manager - Staff for sewage pipe network diagnosis team - Staff for Standard Operation Procedure (SOP) team for sewage treatment plants - Staff for Standard Operation Procedure (SOP) team for water treatment plants (2) Office space, meeting room - Office space for JICA experts - Office facilities - Internet connections - Rooms for training/workshops (3) Local cost - Cost for diagnosis and rehabilitation/renewal of sewage pipe network - Cost for installation of equipment provided by the Project - Activity cost for the pilot project of advanced water supply and sewage treatment (including equipment, construction, running cost) - Other costs such as customs, value-added tax (VAT), custom clearance, storage, domestic transportation fee of the equipment provided by the Project etc.	

coastal area 1-10 Review existing specification for material and installation of sewage pipe based on the analysis of diagnosis result 1-11 Conduct workshop/seminar to disseminate the results of pilot project and the diagnosis implementation plan 2-1 Conduct a baseline survey on the sewage treatment plants and relay pumping stations in CMA and coastal area 2-2 Establish measurement system for monitoring sewage quantity flowing into sewage treatment plants 2-3 Organize a Standard Operation Procedure (SOP) Team for sewage treatment plants 2-4 Conduct training courses on O&M of sewage treatment plants 2-5 Review/develop manual(s) for O&M of sewage treatment plants 2-6 Formulate a plan for rehabilitation and renewal of sewage treatment plants and pumping stations 2-7 Study on introduction of advanced treatment facility for reuse of treated sewage 2-8 (Tentative) Implement a pilot project for advanced treatment based on the result of the study conducted in activity 2-7 2-9 Conduct monitoring of performance		

indicators (actual results) on O&M of sewage treatment plants 2-10 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of sewage treatment plants 3-1 Conduct a baseline survey on the water treatment plants in CMA and coastal area 3-2 Organize a Standard Operation Procedure (SOP) Team for water treatment plants 3-3 Conduct training courses on O&M of water treatment plant 3-4 Review/develop manual(s) for O&M of water treatment plants 3-5 Formulate a plan for rehabilitation and renewal of water treatment plants 3-6 Study on introduction of advanced treatment facility for removal of algae 3-7 (Tentative) Implement a pilot project for advanced treatment based on the result of the study conducted in activity 3-6 3-8 Conduct monitoring of performance indicators (actual results) on O&M of water treatment plants 3-9 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of water treatment plants		

Table 2 PDM$_1$ (after modification)

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Water supply and sewerage service of SANEPAR is improved in the target area of the Project.	1. The coverage of sewerage system becomes 79% in CMA and 60% in coastal area by the end of 2018 (baseline: 72% in CMA, 49.4% in coastal area, 2011). 2. Rehabilitation/renewal plan developed by the Project is implemented by year 2020.	1. SANEPAR's report (annual report etc.) 2. SANEPAR's report	
Project Purpose Operation and maintenance (O&M) of water supply and sewerage systems in SANEPAR is improved in the target area of the Project	1. Performance indicators on O&M of sewage treatment plant (i.e. sewage treatment index, consumption of electric power and chemicals per m^3 treated water, % of conformity to the treated water quality standard in Brazil) are improved by xx%. 2. Performance indicators on O&M of water treatment plant (i.e. consumption of electric power and chemicals per m^3 produced water, % of conformity to the drinking water quality standard in Brazil) are improved by xx%.	1. Project report, monthly report of SANEPAR 2. Project report, monthly report of SANEPAR	No major changes occur in terms of sewerage and water supply policy in central and state government. Budget of SANEPAR for implementation of rehabilitation/renewal plan is secured.
Outputs 1. Capacity of SANEPAR for operation and maintenance (O&M) of sewage pipe network is strengthened.	1-1 Number of incidents of blockage and/or overflow of sewage pipe networks in pilot areas decreases by xx%. 1-2 Quantity of infiltration in pilot areas decreases by xx%	1-1 Project report, SANEPAR Information System (SIS) 1-2 Project report	SANEPAR staffs who are trained in the Project remain in their respective duties.
2. Capacity of SANEPAR for operation and maintenance (O&M) of sewage treatment plant is strengthened.	2-1 Rehabilitation/renewal plan for sewage treatment plants developed by the project is approved by the management level of SANEPAR. 2-2 Annual budget plan is elaborated based on the rehabilitation/renewal plan.	2-1 Project report 2-2 Project report	
3. Capacity of SANEPAR operation and maintenance (O&M) of water treatment plant is strengthened.	3-1 Rehabilitation/renewal plan for water treatment plants developed by the Project is approved by the management level of SANEPAR. 3-2 Annual budget plan, including sludge	3-1 Project report	

	treatment, is elaborated based on the rehabilitation/renewal plan.	3-2 Project report	
Activities of the Project 1-1 Organize diagnosis team for sewage pipe diagnosis team 1-2 Implement baseline survey of O&M of sewage pipe network and identify the issues 1-3 Conduct training courses on O&M and diagnosis of sewage pipe network 1-4 Select pilot areas for sewage pipe diagnosis 1-5 Conduct OJT on sewage pipe network diagnosis using TV camera 1-6 Conduct OJT on monitoring sewage quantity using flowmeter 1-7 Grasp flow volume of sewerage system 1-8 Establish the policy of improvement plan of sewage pipe system 1-9 Analyze results of diagnosis, study rehabilitation or renewal of sewer pipe in pilot areas including non-open trench method, and establish rehabilitation or renewal plan of it 1-10 Implement rehabilitation, renewal and improvement of sewage pipe network in the pilot areas	**Inputs** Japanese Side: (1) JICA Experts - Chief advisor/O&M of sewage treatment plant - O&M of sewage pipe network - Sewage pipe diagnosis technology - O&M of water treatment plant - Sewage treatment technology - Water treatment technology - Electric/mechanical engineering (2) Training - Training in Japan (three to five persons/year) (3) Local cost - Cost for workshop/seminar - Cost for training materials (4) Equipment - TV cameras for sewage pipe diagnosis - Ultrasonic flow meters	Brazilian Side: (1) Counterpart personnel - Project director - Project manager - Staff for sewage pipe network diagnosis team - Staff for Standard Operation Procedure (SOP) team for sewage treatment plants - Staff for Standard Operation Procedure (SOP) team for water treatment plants (2) Office space, meeting room - Office space for JICA experts - Office facilities - Internet connections - Rooms for training/workshops (3) Local cost - Cost for diagnosis and rehabilitation/renewal of sewage pipe network - Cost for installation of equipment provided by the Project - Activity cost for the pilot project of advanced water supply and sewage treatment (including equipment, construction, running cost) - Other costs such as customs, value-added tax (VAT), custom clearance, storage,	

1-11 Formulate a improvement plan for whole sewage pipe network in CMA and coastal area 1-12 Conduct workshop/seminar to disseminate of the results of pilot project and the improvement plan of sewage pipe network 2-1 Conduct a baseline survey on the sewage treatment plants and relay pumping stations in CMA and coastal area 2-2 Establish measurement system for monitoring sewage quantity flowing into sewage treatment plants 2-3 Conduct field survey and experiment for improving issues regarding operation and maintenance of sewage treatment plants 2-4 Conduct measure for improving issues on equipment in sewage treatment plants and pumping stations 2-5 Organize a Standard Operation Procedure (SOP) Team for sewage treatment plants 2-6 Conduct training courses on O&M of sewage treatment plants 2-7 Review/develop manual(s) for O&M of sewage treatment plants 2-8 Formulate a plan for rehabilitation and renewal of sewage treatment plants and pumping stations		domestic transportation fee of the equipment provided by the Project etc.	

2-9 Study on introduction of advanced treatment facility for reuse of treated sewage 2-10 (Tentative) Implement a pilot project for advanced treatment 2-11 Conduct monitoring of performance indicators (actual results) on O&M of sewage treatment plants 2-12 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of sewage treatment plants 3-1 Conduct a baseline survey on the WTPs in CMA and coastal area 3-2 Organize a Standard Operation Procedure (SOP) team for WTPs 3-3 Conduct training courses on O&M of WTP 3-4 Review/develop manual(s) for O&M of WTPs 3-5 Formulate a plan for rehabilitation and renewal of WTPs 3-6 Study on introduction of advanced treatment facility for removal of algae 3-7 (Tentative) Implement a pilot project for advanced treatment based on the result of the study conducted in Activity 3-6 3-8 Conduct monitoring of performance		

indicators (actual results) on O&M of WTPs 3-9 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of water treatment plants 3-10 Conduct a survey on the improvement of the existing DAF system, and conduct a pilot project for improving the existing DAF system		

Table 3 PDM_2 (after modification)

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Water supply and sewerage service of SANEPAR is improved in the target area of the Project.	1. The coverage of sewerage system becomes 79% in CMA and 60% in coastal area by the end of 2018 (baseline: 72% in CMA, 49.4% in coastal area, 2011). 2. Rehabilitation/renewal plan developed by the Project is implemented by year 2020.	1. SANEPAR's report (annual report etc.) 2. SANEPAR's report	
Project Purpose Operation and maintenance (O&M) of water supply and sewerage systems in SANEPAR is improved in the target area of the Project	1. Performance indicators on O&M of sewage treatment plant (i.e. volume of treated sewage divided by total inflow volume) is improved to 99.78% in CMA. In addition, % of water quality conformity to the treated water quality standard is improved to 37.3% in CMA and 97.6% in the Coastal Area respectively. 2. Performance indicator on O&M of water treatment plant (i.e., % of conformity to the drinking water quality standard of treated water (ICP-Produção: Indice de Conformidade ao Padrão de potabilidade na Producao)) is improved to 100%.	1. Project report, monthly report of SANEPAR 2. Project report, monthly report of SANEPAR	No major changes occur in terms of sewerage and water supply policy in central and state government. Budget of SANEPAR for implementation of rehabilitation/renewal plan is secured.
Outputs 1. Capacity of SANEPAR for operation and maintenance (O&M) of sewage pipe network is strengthened.	1-1 Number of complaints including incidents of blockage and/or overflow of sewage pipe networks in pilot areas decreases from the previous year. 1-2 Dissolved oxygen level of the rivers in pilot areas are maintained at least 5 mg/L.	1-1 Project report, SANEPAR Information System (SIS) 1-2 Project report	SANEPAR staffs who are trained in the Project remain in their respective duties.
2. Capacity of SANEPAR for operation and maintenance (O&M) of sewage treatment plant is strengthened.	2-1 Rehabilitation/renewal plan for sewage treatment plants developed by the project is approved by the management level of SANEPAR. 2-2 Annual budget plan is elaborated based on the	2-1 Project report	

	rehabilitation/renewal plan.	2-2 Project report	
3. Capacity of SANEPAR operation and maintenance (O&M) of water treatment plant is strengthened.	3-1 Rehabilitation/renewal plan for water treatment plants developed by the Project is approved by the management level of SANEPAR. 3-2 Annual budget plan, including sludge treatment, is elaborated based on the rehabilitation/renewal plan.	3-1 Project report 3-2 Project report	
Activities of the Project 1-1 Organize diagnosis team for sewage pipe diagnosis team 1-2 Implement baseline survey of O&M of sewage pipe network and identify the issues 1-3 Conduct training courses on O&M and diagnosis of sewage pipe network 1-4 Select pilot areas for sewage pipe diagnosis 1-5 Conduct OJT on sewage pipe network diagnosis using TV camera 1-6 Conduct OJT on monitoring sewage quantity using flowmeter 1-7 Grasp flow volume of sewerage system 1-8 Establish the policy of improvement plan of sewage pipe system 1-9 Analyze results of diagnosis, study rehabilitation or renewal of sewer pipe in pilot areas including non-open trench method, and establish rehabilitation/renewal and improvement plan of it 1-10 Implement rehabilitation, renewal and	**Inputs** Japanese Side: (1) JICA Experts - Chief advisor/O&M of sewage treatment plant - O&M of sewage pipe network - Sewage pipe diagnosis technology - O&M of water treatment plant - Sewage treatment technology - Water treatment technology - Electric/mechanical engineering (2) Training - Training in Japan (three to five persons/year) (3) Local cost - Cost for workshop/seminar - Cost for training materials (4) Equipment - TV cameras for sewage pipe diagnosis - Ultrasonic flow meters	Brazilian Side: (1) Counterpart personnel - Project director - Project manager - Staff for sewage pipe network diagnosis team - Staff for Standard Operation Procedure (SOP) team for sewage treatment plants - Staff for Standard Operation Procedure (SOP) team for water treatment plants (2) Office space, meeting room - Office space for JICA experts - Office facilities - Internet connections - Rooms for training/workshops (3) Local cost - Cost for diagnosis and rehabilitation/renewal of sewage pipe network - Cost for installation of equipment provided by the Project - Activity cost for the pilot project of advanced water supply and sewage treatment	

improvement of sewage pipe network in the pilot areas 1-11 Formulate a draft diagnosis plan for whole sewage pipe network in CMA and coastal area 1-12 Conduct workshop/seminar to disseminate of the results of pilot project and the improvement plan of sewage pipe network 2-1 Conduct a baseline survey on the sewage treatment plants and relay pumping stations in CMA and coastal area 2-2 Establish measurement system for monitoring sewage quantity flowing into sewage treatment plants 2-3 Conduct field survey and experiment for improving issues regarding operation and maintenance of sewage treatment plants 2-4 Conduct measure for improving issues on equipment in sewage treatment plants and pumping stations 2-5 Organize a Standard Operation Procedure (SOP) Team for sewage treatment plants 2-6 Conduct training courses on O&M of sewage treatment plants 2-7 Review/develop manual(s) for O&M of sewage treatment plants 2-8 Formulate a plan for rehabilitation and renewal of sewage treatment plants and		(including equipment, construction, running cost) - Other costs such as customs, value-added tax (VAT), custom clearance, storage, domestic transportation fee of the equipment provided by the Project etc.	

pumping stations 2-9 Study on introduction of advanced treatment facility for reuse of treated sewage 2-10 (Tentative) Implement a pilot project for advanced treatment 2-11 Conduct monitoring of performance indicators (actual results) on O&M of sewage treatment plants 2-12 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of sewage treatment plants 3-1 Conduct a baseline survey on the WTPs in CMA and coastal area 3-2 Organize a Standard Operation Procedure (SOP) team for WTPs 3-3 Conduct training courses on O&M of WTP 3-4 Review/develop manual(s) for O&M of WTPs 3-5 Formulate a plan for rehabilitation and renewal of WTPs 3-6 Study on introduction of advanced treatment facility for removal of algae 3-7 (Tentative) Implement a pilot project for advanced treatment based on the result of the study conducted in Activity 3-6		

3-8 Conduct monitoring of performance indicators (actual results) on O&M of WTPs 3-9 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of water treatment plants 3-10 Conduct a survey on the improvement of the existing DAF system, and conduct a pilot project for improving the existing DAF system		

Table 4 PDM_3 (after modification)

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Water supply and sewerage service of SANEPAR is improved in the target area of the Project.	1. The coverage of sewerage system becomes 79% in CMA and 60% in coastal area by the end of 2018 (baseline: 72% in CMA, 49.4% in coastal area, 2011). 2. Rehabilitation/renewal plan developed by the Project is implemented by year 2020.	1. SANEPAR's report (annual report etc.) 2. SANEPAR's report	
Project Purpose Operation and maintenance (O&M) of water supply and sewerage systems in SANEPAR is improved in the target area of the Project	1. Performance indicators on O&M of sewage treatment plant (i.e. volume of treated sewage divided by total inflow volume) is improved to 99.18% in CMA. In addition, % of water quality conformity to the treated water quality standard is improved to 37.3% in CMA and 97.6% in the Coastal Area respectively. 2. Performance indicator on O&M of water treatment plant (i.e., % of conformity to the drinking water quality standard of treated water (ICP-Produção: Indice de Conformidade ao Padrão de potabilidade na Producao)) is improved to 100%.	1. Project report, monthly report of SANEPAR 2. Project report, monthly report of SANEPAR	No major changes occur in terms of sewerage and water supply policy in central and state government. Budget of SANEPAR for implementation of rehabilitation/renewal plan is secured.
Outputs 1. Capacity of SANEPAR for operation and maintenance (O&M) of sewage pipe network is strengthened.	1-1 Number of complaints including incidents of blockage and/or overflow of sewage pipe networks in pilot areas decreases from the previous year. 1-2 Dissolved oxygen level of the rivers in pilot areas are maintained at least 5 mg/L.	1-1 Project report, SANEPAR Information System (SIS) 1-2 Project report	SANEPAR staffs who are trained in the Project remain in their respective duties.
2. Capacity of SANEPAR for operation and maintenance (O&M) of sewage treatment plant is strengthened.	2-1 Rehabilitation/renewal plan for sewage treatment plants developed by the project is approved by the management level of SANEPAR. 2-2 Annual budget plan is elaborated based on the	2-1 Project report	

	rehabilitation/renewal plan.	2-2 Project report	
3. Capacity of SANEPAR operation and maintenance (O&M) of water treatment plant is strengthened.	3-1 Rehabilitation/renewal plan for water treatment plants developed by the Project is approved by the management level of SANEPAR. 3-2 Annual budget plan, including sludge treatment, is elaborated based on the rehabilitation/renewal plan.	3-1 Project report 3-2 Project report	
Activities of the Project 1-1 Organize diagnosis team for sewage pipe diagnosis team 1-2 Implement baseline survey of O&M of sewage pipe network and identify the issues 1-3 Conduct training courses on O&M and diagnosis of sewage pipe network 1-4 Select pilot areas for sewage pipe diagnosis 1-5 Conduct OJT on sewage pipe network diagnosis using TV camera 1-6 Conduct OJT on monitoring sewage quantity using flowmeter 1-7 Grasp flow volume of sewerage system 1-8 Establish the policy of improvement plan of sewage pipe system 1-9 Analyze results of diagnosis, study rehabilitation or renewal of sewer pipe in pilot areas including non-open trench method, and establish rehabilitation/renewal and improvement plan of it 1-10 Implement rehabilitation, renewal and	**Inputs** Japanese Side: (1) JICA Experts - Chief advisor/O&M of sewage treatment plant - O&M of sewage pipe network - Sewage pipe diagnosis technology - O&M of water treatment plant - Sewage treatment technology - Water treatment technology - Electric/mechanical engineering (2) Training - Training in Japan (three to five persons/year) (3) Local cost - Cost for workshop/seminar - Cost for training materials (4) Equipment - TV cameras for sewage pipe diagnosis - Ultrasonic flow meters	Brazilian Side: (1) Counterpart personnel - Project director - Project manager - Staff for sewage pipe network diagnosis team - Staff for Standard Operation Procedure (SOP) team for sewage treatment plants - Staff for Standard Operation Procedure (SOP) team for water treatment plants (2) Office space, meeting room - Office space for JICA experts - Office facilities - Internet connections - Rooms for training/workshops (3) Local cost - Cost for diagnosis and rehabilitation/renewal of sewage pipe network - Cost for installation of equipment provided by the Project - Activity cost for the pilot project of advanced water supply and sewage treatment	

improvement of sewage pipe network in the pilot areas 1-11 Formulate a draft diagnosis plan for whole sewage pipe network in CMA and coastal area 1-12 Conduct workshop/seminar to disseminate of the results of pilot project and the improvement plan of sewage pipe network 2-1 Conduct a baseline survey on the sewage treatment plants and relay pumping stations in CMA and coastal area 2-2 Establish measurement system for monitoring sewage quantity flowing into sewage treatment plants 2-3 Conduct field survey and experiment for improving issues regarding operation and maintenance of sewage treatment plants 2-4 Conduct measure for improving issues on equipment in sewage treatment plants and pumping stations 2-5 Organize a Standard Operation Procedure (SOP) Team for sewage treatment plants 2-6 Conduct training courses on O&M of sewage treatment plants 2-7 Review/develop manual(s) for O&M of sewage treatment plants 2-8 Formulate a plan for rehabilitation and renewal of sewage treatment plants and		(including equipment, construction, running cost) - Other costs such as customs, value-added tax (VAT), custom clearance, storage, domestic transportation fee of the equipment provided by the Project etc.	

pumping stations 2-9 Study on introduction of advanced treatment facility for reuse of treated sewage 2-10 (Tentative) Implement a pilot project for advanced treatment 2-11 Conduct monitoring of performance indicators (actual results) on O&M of sewage treatment plants 2-12 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of sewage treatment plants 3-1 Conduct a baseline survey on the WTPs in CMA and coastal area 3-2 Organize a Standard Operation Procedure (SOP) team for WTPs 3-3 Conduct training courses on O&M of WTP 3-4 Review/develop manual(s) for O&M of WTPs 3-5 Formulate a plan for rehabilitation and renewal of WTPs 3-6 Study on introduction of advanced treatment facility for removal of algae 3-7 (Tentative) Implement a pilot project for advanced treatment based on the result of the study conducted in Activity 3-6		

3-8 Conduct monitoring of performance indicators (actual results) on O&M of WTPs 3-9 Conduct workshop/seminar to disseminate the O&M manual and rehabilitation/renewal plan of water treatment plants 3-10 Conduct a survey on the improvement of the existing DAF system, and conduct a pilot project for improving the existing DAF system		

A4-1 Results of Survey on Actual Condition of O&M of Sewage Pipe Network

Results of survey on actual condition of O/M of sewage pipe network

1 Actual condition of sewage pipe Network System

Total length of sewage pipe in CMA and coastal area amounts 9,202 km. Concerning the material of it, 56.7% of it, 5,216km is made of PVC and 31.8%, 2,929km, is made of ceramics. The fact that ceramic pipe which has poor watertight shares about 30% causes infiltration. On the other hand share of small bore pipe is high and the length of sewage pipe more than 300mm is 361km which shares only about 4% because 150mm is adopted for minimum diameter (in Japan 200mm in usual) and the margin of safety adopts 6% (in Japan 100% in case of small bore pipe). It is estimated that the whole system with smaller capacity causes blockage or backflow easily.

On the other hand the sewage pipe network of project area has 103 pumping stations which convey sewage to the STPs. In CMA 37 stations are installed in watershed of targeted 7 STPs in this project and 27 stations for the other STPs, and in coastal area 39 stations in basins of 5 STPs. The number of pumping stations is shown in **Table 1-1** in each basin of STP.

Table1-1 The number of pumping stations in each watershed of STP

Area	STP	No. of Pumping Stations
CMA	Atuba Sul	17
	Belem	4
	Santa Quiteria	4
	CIC Xisto	11
	Padilha Sul	1
	Sao Jorge	0
	Faz Rio Grande	0
	Subtotal	37
	The Other Watersheds	27
Coastal Area	Matinhos	10
	Pontal do Parana	6
	Guaraquecaba	6
	Morretes	4
	Guaratuba	13
	Subtotal	39
Total		103

2 Work of O/M of Sewage Pipe Network

The following is a list of the organization of O/M of sewage pipe network and results of investigation for each work.

1) The organization of O/M of sewage pipe network

The O/M of sewage pipe network in CMA and coastal area is conducted by Regional Unit (GGML) in Directory of Operation (DO) in which 4 regional units – URCT-L, URCT-N, URCT-S and URLI operate actual works and have 30 teams of O/M (60 staffs) and 23 team of repair (58 staffs). Sewage Service Unit (USEG) in GGML conducts investigation of sewage pipe, and Operation and Service Development Unit (USDO) in GPDO conducts the ledger system of sewage pipe network.

2) The Ledger System

In SANEPAR, IT Services Unit in the Bureau of Internal Affairs and Communications (DA) is

engaged in the centralized management of IT, including GIS information system (SANEGIS – upgraded by payware from freeware in 2012) , the data base of which is utilized and overlaid by each unit for its system. Building of the ledger system of waterworks was finished and that of sewage pipe network is finishing now. The drawings of sewage pipe were digitized by AutoCAD and information of them (materials and diameter etc.) was input by ArcGIS. In addition to this, the ledger called CODDOPE which overlays user data on the sewage pipe network data is under constructing. These systems are becoming enhanced and the technical assistance in this field is not much needed. It should be investigated how to take advantage of this system to this project in the SDT team. It seems that SANEPAR is enthusiastic about the IT management and makes a significant investment to it (compared to the investment for maintenance of actual facilities).

It should be noted as a drawback that this system do not have data of area and data of the year of construction were lost in transition to GIS finished in 2006 being complemented by data of house connection.

3) Cleaning of Sewage Pipe


Sewer cleaning by high pressure cleaning truck

SANEPAR has 15 sewer cleaning trucks (combining sludge sucker truck) in CMA and 4 trucks in coastal area. Since teams of sewer cleaning do good job devising and utilizing equipment, need for technical support to sewer cleaning method is not high. However, they do not work inside manhole usually because of the Brazilian national law which obliges safety measures which is hard to conduct in daily works. For this reason the visual inspection (including still camera photographing) after cleaning is not conducted and causes of blockage such as damages or projection of house connection are not identified. This situation makes the preventive O/M more difficult. It should be noted that SANEPAR is considering procurement of more sophisticated equipment and more trucks.

4) Inspection by TV camera


Investigation by TV camera

URCT-L of GGML possesses 1 insert formula TV camera, which is utilized for inspection of house connections, and is inspecting aged sewage pipe in Belem watershed sequentially. This camera was purchased by the loan of the national saving bank and it is obliged to investigate 98km in 3 years. The results of investigation are summarized to the report of the table for each route in which route number, location, person in charge, diameter, photograph, condition (such as illegal connection, ejection of house connection, corruption, intrusion of roots, reverse gradient etc.) are listed. However, prioritizing of rehabilitation of sewage pipe is not listed.

Because the insert method of this camera utilizes sewage flow, it is inserted and photographs after pipe cleaning without water stop usually. In case of our inspection the camera was inserted without finishing pipe cleaning and could not photograph because of submerge of it. In this case up flow of sewage pipe was stopped and longer distance was photographed than without stop.

This type of TV camera is effective to know about the status of sewage pipes for Brazilian O/M of them without visual inspection in the manhole. And also simple TV camera is very effective as an

alternative of visual inspection. On the other hand a detailed survey of the implementation of pipe rehabilitation, it is necessary to inspect by self-propelled TV camera.

It should be noted that SANEPAR purchased 10 insert formula TV cameras in February 2013. And 3 of them were deployed at CMA and 1 at coastal area. For inspection and diagnosis of sewage pipe network these insert formula TV cameras should be taken advantage of in addition to simple TV cameras and self-propelled TV camera.


Ultrasonic Flowmeter of SANEPAR

5) Team of House Connection Investigation

URCT-L of GGML possessing 3 teams of SANEPAR staffs and 4 or 5 teams of contractors pairing two people per team, 7 or 8 teams in total are investigating of the house connection. They are investigating about 90 thousand per year from 1995 and have investigated about 1.3 million in total.

Actually they are coping with complaints of inhabitants or verification process of new house construction, and not only with illegal house connections. Through this work 12% is recognized as illegal house connection (18% is non-survey) in CMA and 8% in coastal area. The investigation method is to use dyes which adopt tree different colors for toilet, kitchen and rainwater.


Survey of cross connection dye survey

When sewage pipe is newly installed, the inhabitants obliged to connect to it. After 30 days of the explanation to them, this team investigates the site, also after 30 days of investigation fee collection will be performed and houses without connection are noticed to Department of Environment of City Hall. These works are conducted by these teams.

6) Team of Sewage Pipe Investigation

Team of sewage pipe investigation was established in USEG of GGML in fiscal year of 2012 and began operation in August 2012. This team investigates manhole with more than 300mm of diameter visually records the result to unified table. In October 2012 investigation of 16.5 km was finished resulting about 18% of total manholes could not found because of covering by pavement that will make future inspection and diagnosis difficult. And also some pipes are exposed to air and broken by erosion of land. This team is in charge of the flow investigation of sewage pipe and of C/P of the project and plays a central role of it.


Investigation of Manhole
by sewage pipe investigation team

7) Flow Investigation using Flowmeter

USEG of GGML possesses 3 portable ultrasonic flowmeter, and is beginning preliminary investigation in basins of Belem, Santa Quiteria and Atuba Sul to grasp the amount of infiltration in wet weather. To analyze the data of 9 manholes in Belem basin, it was revealed that 7 manholes are influenced by the operation of pumping stations and at 2 of these 7 manholes existence of outfalls to the river by


Construction demo of pipe rehabilitation

bypass is suspected because the water level did not changed. At only 2 manholes gravity flow was investigated. These results will make the investigation only for the identification of the amount of infiltration.

8) Results of the Rehabilitation of Sewage Pipe

A couples years ago SANEPAR implemented rehabilitation of sewage pipe by lining experimentally. About 30km of rehabilitation by lining was conducted but in a lot of interval the lining was deformed, sewage flow was obstructed and remarkably deformed pipes were reconstructed. A contractor in Sao Paulo that constructed them is not currently serves. It is estimated that thermosetting resin was utilized and reason of deform was deficiencies in construction management such as lack of temperature control when cured because in the construction of a demonstration on the ground had been properly cured.

On the other hand because the thickness of the material is about 7mm by survey of demonstration in case of minimum diameter in Brazil (150mm), cross-sectional area after lining will reduce to about 80% of that before lining. The capacity after lining will be very small compared with 200mm (minimum diameter in Brazil). So that the lining of pipes makes rehabilitation of them but will cause issues on O/M because they will be blocked easily and overflowed easily by infiltration of rainwater. From these facts with regard to the application of the method to the rehabilitation of sewer pipe of 150 mm by lining method, it is necessary to perform a careful consideration, including whether it is good or bad.

9) Material for Sewage Pipe

Table 2-1 Length of Sewage Pipe for each Material

Material	Length(m)	Percentage (%)
PVC Pipe	5,216,230	56.7
Ceramic Pipe	2,929,959	31.8
Reinforced Concrete Pipe	245,705	2.7
Polyethylene Pipe	82,566	0.9
Cast Iron Pipe	31,248	0.3
Polyester Pipe	31,509	0.3
Polypropylene Pipe	9,696	0.1
Materials Unknown	656,073	7.1
Total	9,202,987	100.0

＜General＞

The length of sewage pipe for each material is shown in **Table 1-2**. Initially sewage pipe of less than about 300 mm was a ceramic pipe, but thereafter that of less than 400mm has been PVC. As a result of the total 9,200 km extension, PVC pipe is 56.7% and ceramic pipe is 31.8%, accounting for 88.5% of the total. On the other hand medium and large diameter pipe is a reinforced concrete pipe.

＜Ceramic Pipe＞

As for Ceramic Pipe aging by material deterioration such as corrosion is less likely to occur, but meandering and displacement of the joint by uneven settlement of the ground, damage caused by external force such as vehicle load or other construction and projection of house connection constructed after occur and cause problems on the maintenance.

＜PVC Pipe＞

PVC Pipe is utilized for sewage pipe less than 400mm and so almost all the pipe constructed newly and reconstructed employs this material currently. As for specification in Brazil, thickness is slightly less compared to rigid PVC pipe for sewage pipe in Japan (in case of 150mm, Japanese: 5.1mm, Brazilian: 3.6mm). According to the person in charge it will be applied up to 2m depth but actually it is applied more than 2m specially in the coastal area.

＜Management of Materials and Others＞

SANEPAR purchases factory products, such as water pipe, sewage pipe, manhole, manhole cover etc., of pipe facilities for repair or small construction other than large-scale construction and supplies to contractors. These materials are examined strictly including by factory inspection on Brazilian Standard. On the other hand, quite a large amount of materials has been stored in the office for the materials, it was observed as an administrative issue, the PVC pipe which is degraded by ultraviolet light does not covered.

Although the study on the materials of sewage pipe should be conducted in this project, it is not required because currently the same materials as Japan such as reinforced concrete pipe for medium and large diameter gravity pipe, PVC pipe for small diameter gravity pipe and polyethylene pipe for pressure pipe, and specifications of them are based on Brazilian standard.

10) Pumping Stations


Daily maintenance of pumping station

64 pumping stations of 103 stations in the target area are located in CMA. Out of these stations Piracuara Pumping Station in Atuba Sur watershed was inspected. In this station a mechanical trash screen has been removed by failure but other equipment is well operated. It has reserve tank and by-pass pipe to the river for support at the time of stopping. Pumping stations in CMA have by-pass pipe like this. While at large pumping stations flowmeter is installed and data is controlled well as for O/M, at smaller pumping stations it is not installed and data of operating time is checked every day or every few days. In this time at 6 pumping stations flowmeter is installed, and there is a plan to install it sequentially, installing it at 11 pumping stations (Atuba Sul basin : 3, CIC Xist basin : 5). Details of the result of investigation of pumping stations are shown at Activity 2-3 of Result 2.

11) Summary of O/M of Sewage Pipe Network

For the works shown in 2) to 7), from the point of view of maintenance of the actual facilities, it is considered that SANEPAR has high in both experience and capacity and skill training such as how to operate the pipe cleaning truck is not required. SANAPAR is energetically new initiatives such as upgrade of ledger system, establishment of the investigation team and purchase of high pressure pipe clean trucks or TV cameras. However consideration or systematization aiming at more efficient and proactive O/M, investigation method and attention at the time of introducing new technology have a room for improvement and can be the subject of this project.

With respect to pumping stations it is required to promote the conservation efforts of mechanical and electrical equipment. Some pumping stations need for installation of flowmeter but flowmeters granted in this project for investigation is not suitable for permanent installation. SANEPAR has been putting into budget of this integrated with remote monitoring.

12) Plan for Rehabilitation of Water Quality of Urban River

For the purpose of improving water pollution of urban rivers by sewage discharge from sewage pipe system, SANEPAR is promoting Plan for Rehabilitation of Water Quality of Urban River (PRRU) which is made around USHI cooperating with relating sections such as URCT, URCT and USEA. Improvement procedure is as follows: to identifying the location of the discharge from the sewage pipe by measuring the DO of the river and to repair its place. By this procedure it can be improved effectively. In addition, efforts to cooperate with local residents are also made.

But judging from the report of the results it was improved so short term of up to two months by few staff members that there is a need to examine the contents. This method is effective in case of point cause such as damage of sewage pipe near the river but in case of non-point cause such as illegal house connection it may need long time to identify the cause. This project will cooperate with PRRU and not only investigation of sewage pipe but also investigation of water quality of the river and cooperation with inhabitants will be conducted.

3 Issues on O/M of Sewage Pipe Network

1) Actual Condition of O/M of Sewage Pipe Network

Data of troubles (blockage and back flow of sewage pipe etc.) occurred in last 2 years on O/M of sewage pipe in CMA is shown in Table 2-2. Too many troubles - about 3 times per year per 1 km – occur. Percentage of the repaired sewage pipe to the number of trouble is 10 to 20 %. That means that most of the troubles were eliminated by pipe cleaning. But that also means that the causes of troubles are not eliminated and may cause another trouble. So it needs to make effort to eliminate these causes and to establish the system of implementation of it.

Table 2-2 Number of Troubles and Repair in last 2 years

Area	Number of Troubles		Number of Repaired Sewer	
	2010	2011	2010	2011
CMA	24,759	27,388	4,870	4,435
Coastal Area	986	610	95	97
Total	25,745	27,998	4,965	4,532

2) Blockage of Sewage Pipe and Others

a) Structural Problem of Sewage Pipe

Structural Problem of Sewage Pipe is aging, damage or misalignment of the joint by external force such as construction of road etc. and ejection of house connection in the new construction. To cope with this problem in case that the sewage pipe network is deteriorated generally, the whole interval between the manholes will be reconstructed or rehabilitated.

One of the problems in coastal area is a drop of PVC house connection pipe into the sewage pipe in case of installed to a depth of more than 2 m. This caused by lack of specification, and to cope with this problem the specification was improved and when the drop of a pipe is identified at pipe cleaning work it is reconstructed by open cut method.

b) Causes by Flowing Matter

The most common cause of blockage is solidification of the oil in the sewage pipe that accounts 20 or 30 % of the total causes and inputs of waste material is the second. Countermeasure for blockage by these flowing matters is to install oil trap in residential land and to stimulate citizen awareness.

c) Others

Sometime the intrusion of roots of tree causes blockage of sewage pipe, and measures to prevent

re-intrusion of them such as repair by open cut method. In japan in many cases it is removed by high pressure water of pipe cleaning truck monitoring by TV camera or by perforator for pipe rehabilitation method and is repaired by partial lining to prevent re-intrusion.
On the other hand in case of inflow of sand at coastal area damage or misalignment of the joint is presumed and repair or rehabilitation of sewage pipe will be needed. In this case partial repair or whole interval reconstruction will be selected after detail investigation.

3) Backflow in Wet Weather

Backflow of sewage pipe occurs frequently in wet weather, and many complaints are received in this reason. This causes from infiltration of rainwater into the sewage pipe. And infiltration causes mainly from illegal house connection, which was revealed by investigation of house connection. Countermeasure of this is to reduce the amount of infiltration of rainwater by improving house connection by means of the order of improvement by City Hall. It is pointed out that this procedure is not effective. So it is necessary to cooperate with City Hall. Other hand the countermeasure for deficit of capacity of both trunk sewers and collectors should be studied.

4) SSO (Sanitary Sewer Overflow) in wet weather

Discharge of sewage to the river in wet weather may occurs through by-pass pipe in STP, in some pumping station, and in siphon part of trunk sewer, or damaged collector (in some case sewage pipe near the river is damaged by erosion). The countermeasure of it is to reduce the amount of infiltration same as section 2). It is important to clarify the policy that attempts to eliminate the SSO and to make effort to set priorities for improvement of facility (or structure).

5) SSO (Sanitary Sewer Overflow) in Dry Weather

The overflow from sewage pipe network seems to occur also in dry weather. Especially in Belem basin, big amount of wastewater is discharged to the Belem river that flows from north to south of central area of the city and is covered in some area, and it causes remarkable water pollution. Major cause of SSO in dry weather is the leakage from manhole of blocked siphon at river cross sections and the discharge through previously installed discharge pipe (unidentified) in addition to cross connection. In CMA a lot of siphons are installed, and some of them are broken and ordered to be reconstructed. It needs detail investigation of siphons immediately. It is very difficult to clean up pipes of siphon structure when it is blocked by deposition of sand and dirt, and difficulty increases as time passes. Although siphon structure is designed of two lines basically, SANEPAR adopts single line except for some cases, and adopts bended siphon in which sand and dirt is easy to be deposited. These structures make the maintenance more difficult. From these facts to keep the basic function of sewage facility a fundamental countermeasure on broken siphon structure must be conducted base on the investigation of actual conditions.

Leakage of wastewater from siphon manhole is inspected visually (near the Headquarters of SANEPAR)

Inflow of wastewater from storm drainage culvert to the Belem river
(Belem River may have very little specific flow volume in dry weather)

6) Infiltration in dry weather (Infiltration of dry weather)

Especially in coastal area the infiltration of ground water is reported. In CMA area the amount of infiltration of ground water will be identified by data of flowmeter complemented by EC meter (Electric Conductivity – it will reduce when the infiltration is much). Generally speaking the infiltration of rainwater is caused by cross connection in the houses and infiltration of ground water in dry weather is caused by gap of sewage pipe under the road. The countermeasure of it is the reconstruction or rehabilitation by lining to water tight structure. Infiltration of groundwater brings the increase of the amount of sewage and the decrease in the concentration of organic matter that influences the treatment of sewage.

7) Issues on the O/M of Sewage Pipe Network in Coastal Area


Infiltration at manhole near seashore

In coastal area in general sewage pipe is installed deeply and many pumping stations are installed because of flat geography (Out of 103 pumping stations in targeted area 39 stations are installed in coastal area). There is a problem of infiltration of ground water because of the high ground water level and soil quality with high permeability. Because infiltration is accompanied by intrusion of sand preventive cleaning of sewage pipe to remove deposited sand is conducted before tourist season when tourist population increases. Some trunk sewage pipe near the seashore intruded by much sand, and in some cases the road will be sunk after cleaning up sand and so there is a need for immediate action.

The causes of the infiltration of rainwater are cross connection of house and acts of residents of opening manhole cover and flowing rainwater to sanitary sewage pipe because of delay stormwater management.

Also in coastal area since the house connection pipe falls down to the collector because of lack of specification when installed at depth of more than 4m, specification was changed and dropped pipe is replaced.

USLI did not have TV camera at the time of the survey and above mentioned dropped pipe was identified by estimation through the work of pipe cleaning. And so the acquisition of TV camera has very high priority. As for the material of sewage pipe at some part of Matinhos installed in the old days area employed ceramic pipe which has been replaced by PVC pipe because there is a problem of intrusion of sand caused by misalignment of the joint etc..

Several pumping stations were surveyed and generally good management has been made. In case of newly constructed one the storage tank for 3 hours is equipped for to correspond to stopping or increased infiltration. Old facilities do not have the storage tank and have by- pass pipe to the river.

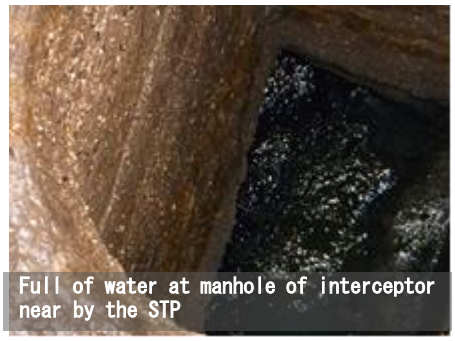

Sewer repair work by well-point method

Especially in the place near the seashore where there is highly liquid sand high groundwater level, in case of small repair work normal open cut method cannot be applied and well-point method (method of lowering the groundwater level by pumping groundwater by a number of underground pipe) is applied

8) Deficit of the Capacity of Sewage Pipe

The collector of Belem river basin, which is installed along with the Belem River, was surveyed from the most downstream near the STP to the upstream portion at Centro Civico district. Attached photo is

a manhole of interceptor at most downstream, which shows full of water due to the back water of high water level of grit chamber of STP of Belem. Judging from the figure pointing the site of occurrence of back flow, it occurs near by the trunk sewer. It is presumed that the trunk sewer, which is lack of capacity in dry weather, may be in a pressured state in wet weather by increase of flow by infiltration and back flow will be occur in the collector of tributary of it.


Full of water at manhole of interceptor near by the STP

On the other hand about 40% of the amount of sewage estimated by water supply does not reach to the STP. In the dry weather the sewage is discharged to the river from sewage pipe. To solve this problem make the capacity of trunk sewer such as interceptor deficit. The capacity of service pipe of 150mm is also a problem. (See note 2)

Note 2：Cross-sectional area of sewage pipe of 150mm corresponds to that of 56% of 200mm. After rehabilitation of 150mm by lining of 7mm reduces it to 46%.

9) Summary

Issues on O/M of sewage pipe network, causes, grasping method, investigation method and countermeasures are summarize in **Table 2-3**. "Therapeutic measures" are carried out at present time, and in this project "preventive measures" should be carried out as underlined in the table.

In this project comprehensive approach should be carried out corresponding to each issue.

Table 2-3 Issues, cause, investigation method and countermeasure on O/M of sewage pipe network

Problems		Causes	Investigation Method	Measures
1)	Blockage of Sewer	Structural problem	TV camera (After blockage) TV camera (Preventive)	Repair after blockage (Th) Proactive measure (Pr)
		Flowing matter (oil、waste etc.)	Check at cleaning of sewer Data analysis of frequent place	Cleaning after blockage (Th) Cooperation of inhabitants (Pr) Preventive cleaning at frequent place (Pr)
		others (root)	TV camera (After blockage) TV camera (Preventive)	Removal after blockage (Th) Proactive removal (Pr)
2)	Back flow in dry weather	Infiltration of rain water	Investigation on site Investigation by flow meter	Installation of valve (Th) Solution of cross connection (Pr)
3)	SSO in wet weather	Infiltration of rain water structural problem	check of house connection investigation by flow meter	Solution of cross connection (Pr) Increase of capacity, Structural improvement (Pr)
4)	SSO in dry weather	Structural problem	Investigation on site Investigation by flow meter	Rehabilitation of siphon (Th) Increase of capacity, Structural improvement (Pr)
5)	Infiltration in dry weather	Infiltration of ground water	Investigation on site Investigation by flow meter	Re-install of sewer, Into watertight by lining (Th, Pr)

Th: Therapeutic deal Pr: Preventive deal

A4-2 Study Method of Infiltration by Water Quality Measurement

潤いある未来へ

2014/2/21

Método de Estudo da Infiltração Através da Medição de Qualidade da Água

JICA Expert Team

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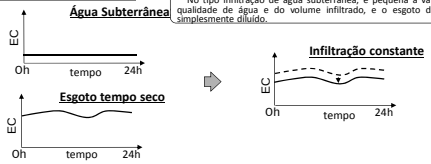
1. Método de Estudo

Comportamento da qualidade de água

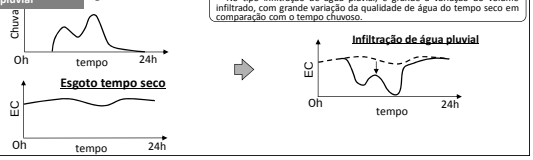
Infiltração de água subterrânea

Água Subterrânea — No tipo infiltração de água subterrânea, é pequena a variação horária da qualidade de água e do volume infiltrado, e o esgoto do tempo seco é simplesmente diluído.



Infiltração de água pluvial

Água Pluvial — No tipo infiltração de água pluvial, é grande a variação do volume infiltrado, com grande variação da qualidade de água do tempo seco em comparação com o tempo chuvoso.



JICA Expert Team

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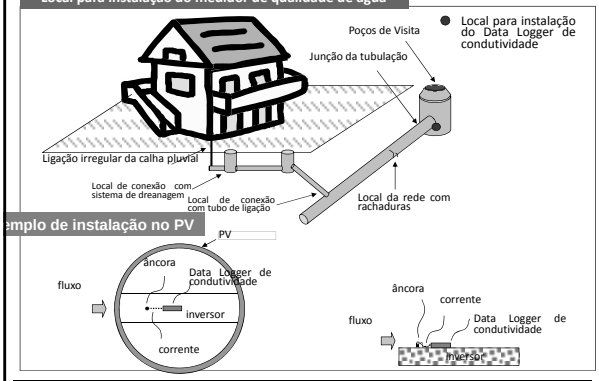
1. Método de Estudo

Local para instalação do medidor de qualidade de água



Exemplo de instalação no PV

JICA Expert Team

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1. Método de Estudo

Princípio

$$C_{A+B}=\frac{C_A\times Q_A+C_B\times Q_B}{Q_A+Q_B}$$

C_{A+B} : qualidade de água do esgoto misturada com água pluvial
C_A : qualidade de água do esgoto
Q_A : volume do esgoto
C_B : qualidade de água pluvial
Q_B : volume da água pluvial

Indicadores de qualidade de água: eletrocondutividade, temperatura, etc.

(exemplo de eletrocondutividade)
esgoto: valor médio oscila entre 800 ～ 1.300μS/cm
água pluvial: inferior a 150 μS/cm (ocorrência maior: inferior a 75 μS/cm)
água subterrânea: inferior a 300 μS/cm
μS/cm : micro simens por centímetro

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1. Método de Estudo

Método de instalação do medidor de qualidade de água

Exemplo de instalação no PV

[Fixar no fundo do PV com âncora]
(Data Logger de condutividade)

[Referência: medição da vazão (Calha PB)]

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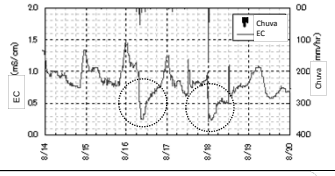
1. Método de Estudo

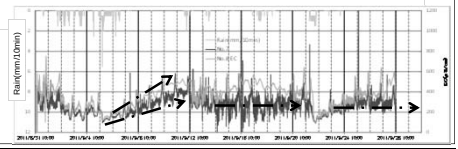
Exemplo do comportamento da qualidade de água (tempo seco/tempo chuvoso)

Eletrocondutividade

Infiltração de Água Pluvial
No momento da chuva ocorre a redução de eletrocondutividade



Infiltração de Água Subterrânea Mesmo após a chuva não ocorre o aumento de eletrocondutividade ⇒ Devido a grande volume de água subterrânea, ocorre a diluição do esgoto.



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2.1 Exemplo do Estudo

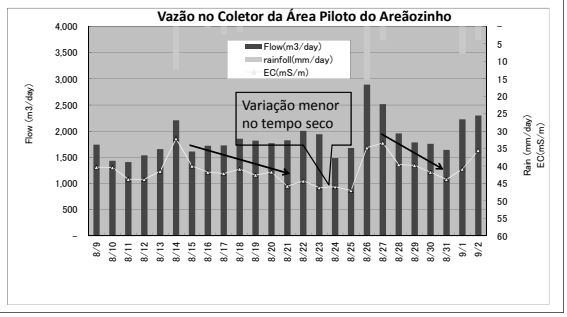
Área de Estudo

Campo de estudo de água infiltrada

Relação entre qualidade de água (eletrocondutividade) e vazão

Alteração da Qualidade de Água (Eletrocondutividade)

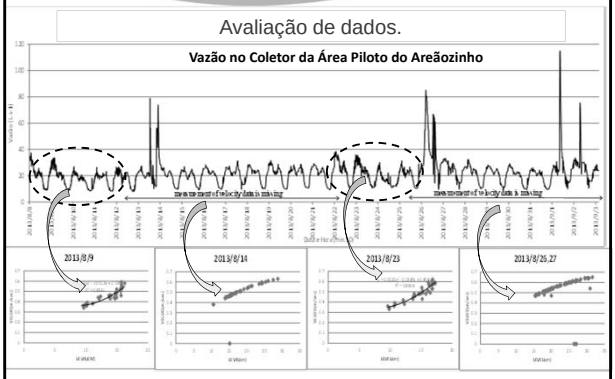
Com redução do volume de água infiltrada, aumenta a eletrocondutividade.



DIAGNÓSTICO DE REDE DE ESGOTO

Avaliação de dados.

Vazão no Coletor da Área Piloto do Areãozinho

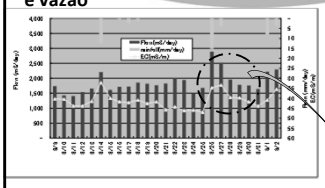


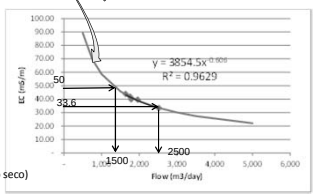
Relação entre qualidade de água (eletrocondutividade) e vazão

Relação entre qualidade de água (eletrocondutividade) e vazão

Carga no tempo seco = 50（EC）× 1,500（m3/day）
=75,000

Carga no tempo chuvoso = 33.6（EC）× 2,500(m3/day)
=84,000



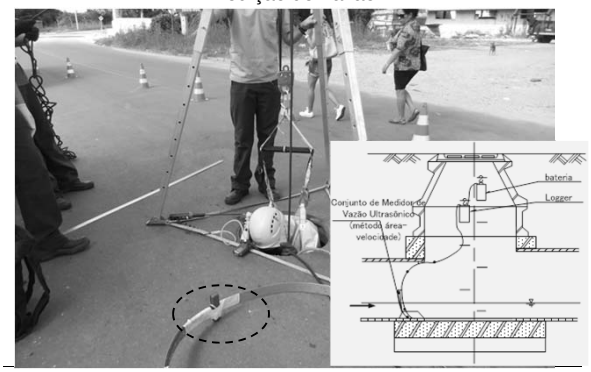


Vazão mínima noturna no tempo seco (8/12：4.8m3/h)
≒ se consideramos como volume de água subterrânea,
Volume de água subterrânea no tempo seco ≒4.8m3/h × 24h
=115m3/dia

Considerando que qualidade de água subterrânea ≒qualidade de água pluvial = **a**, e considerando a Qualidade de água do esgoto **b**,
115a+1,425b＝75,000
1,075a+1,425b=84,000

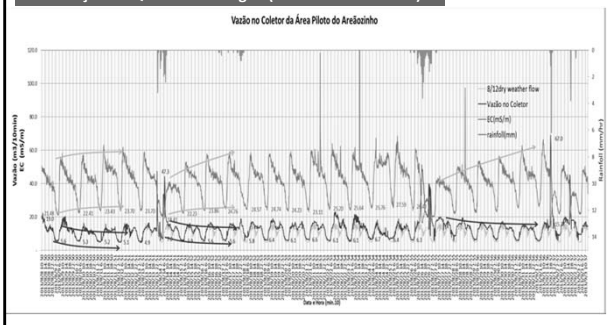
a=9.4 (EC água subterrânea), b=51.9 (EC esgoto no tempo seco)

Medição de Vazão



Relação entre qualidade de água (eletrocondutividade) e vazão

Alteração da Qualidade de Água (eletrocondutividade)



Muito Obrigado!

JICA Expert Team

A4-3 Flow Rate Survey at the Pilot Area in CMA

PROJETO PARA MELHORIA DA OPERAÇÃO E MANUTENÇÃO DOS SISTMEAS DE ÁGUA E ESGOTO DO ESTADO DO PARANÁ – JICA

MEDIÇÃO DE VAZÃO

DEFINIÇÃO DE DIAS SECOS E CHUVOSOS

Dia	Precipitação	Condição
06/08/13	0	U
07/08/13	0	U
08/08/13	0,2	S
09/08/13	0	S
10/08/13	0,6	S
11/08/13	0	S
12/08/13	0	S
13/08/13	3,2	S
14/08/13	9,2	N
15/08/13	0	S
16/08/13	0,4	S
17/08/13	3,2	S
18/08/13	0,8	S
19/08/13	0	S
20/08/13	0	S
21/08/13	0	S
22/08/13	0	S
23/08/13	0	S
24/08/13	0	S
25/08/13	0	S
26/08/13	16,8	C
27/08/13	2,4	U
28/08/13	0	U
29/08/13	0	S
30/08/13	0	S
31/08/13	0	S
01/09/13	7,8	N
02/09/13	4,4	N
03/09/13	0	S

(C) Dia Chuvoso ≥ 10 mm

(U) Dia Húmido = dois dias após um dia chuvoso.

(N) 4mm ≤ Dia chuvoso não representativo < 10 mm

(S) Dia seco < 4 mm

MEDIÇÃO DE VAZÃO

Levantamento e apresentação de dados de vazão, eletro-condutividade e precipitação na área piloto da bacia do rio Areãozinho.

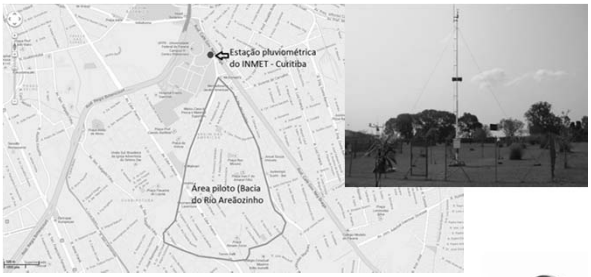
- **Precipitação (dados do INMET);**
- **Medição da Vazão e eletro-condutividade realizada no período de 08/08/2013 a 03/09/2013.**

MEDIÇÃO DE VAZÃO

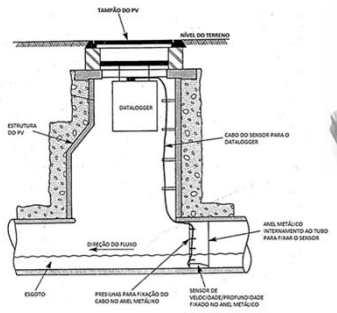
- **Definição dos coletores;**
- **Divisão dos polígonos conforme o CODOPE;**
- **Medição de vazão;**
- **Obtenção dos dados de chuva no período de medição de vazão;**
- **Tabulação dos dados;**
- **Avaliação dos dados de medição de vazão.**

DADOS PLUVIOMÉTRICOS

Estação pluviométrica do INMET em Curitiba.



MEDIÇÃO DE VAZÃO

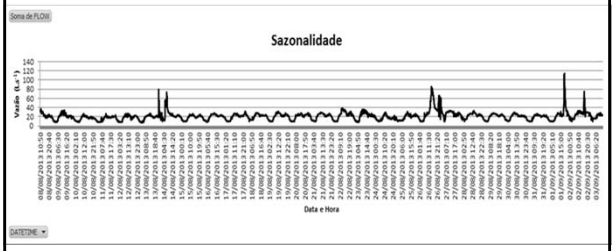


MEDIÇÃO DE VAZÃO

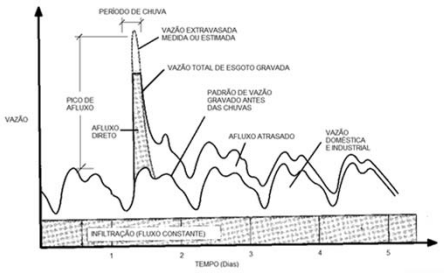




MEDIÇÃO DE VAZÃO



MEDIÇÃO DE VAZÃO



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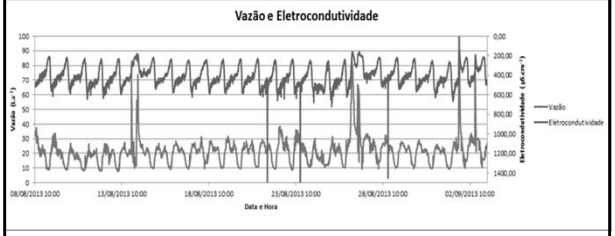
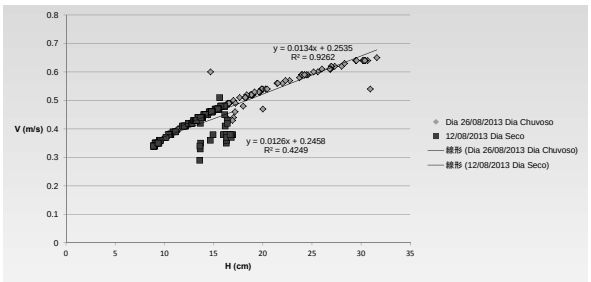
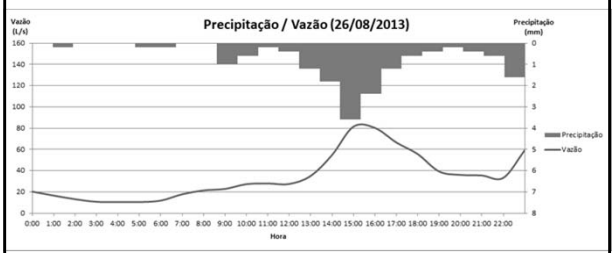


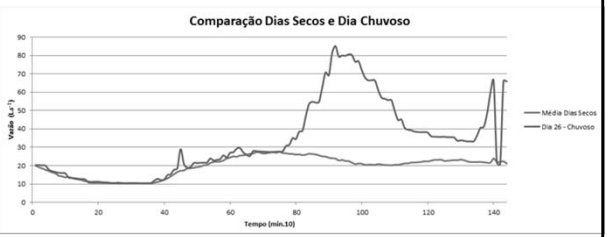
MEDIÇÃO DE VAZÃO



MEDIÇÃO DE VAZÃO

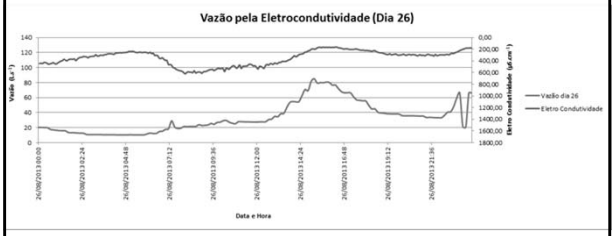


MEDIÇÃO DE VAZÃO



MEDIÇÃO DE VAZÃO

MEDIÇÃO DE VAZÃO



PRIORIZAÇÃO DE TRABALHOS

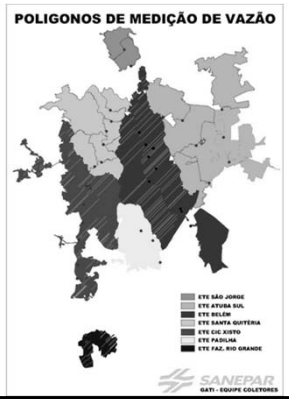
MEDIÇÃO DE VAZÃO

PRIORIZAÇÃO DE POLÍGONOS

INSTALAÇÃO DE MEDIDORES DE VAZÃO

CONTRATAÇÃO DE EMPRESA PARA INSTALAR MEDIDORES DE VAZÃO NO VALOR DE: R$ 299.000,00

FORAM INSTALADOS MEDIDORES DE VAZÃO EM 38 PONTOS DOS COLETORES POR EMPRESA TERCEIRIZADA



PRIORIZAÇÃO DE POLÍGONOS

Cálculo das vazões teóricas com base nas vazões micro medidas

Parâmetros de cálculo		
coef. retorno	0,90	
sub medição	0,15	
K1	1,2	
K2	1,5	
K3	0,5	
taxa infiltração	0,0001	l/s.m para junta elástica
	0,0005	l/s.m para junta argamassada

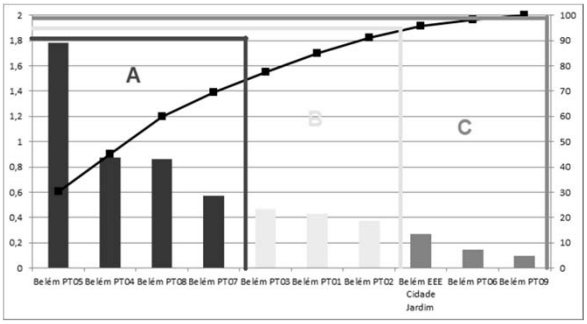
PRIORIZAÇÃO DE POLÍGONOS

Ponto	Fator 0,4	Fator 0,6	Soma dos Fatores	Área	Vazão/Área	Curva ABC	
Belém PT05	3,390945	2,393836	5,784781	3,244825	1,7827715	30,3203	30,3203
Belém PT04	25,81246	9,810453	35,62291	40,66625	0,8759823	14,89818	45,21848
Belém PT08	2,611932	1,941245	4,553177	5,266096	0,8646209	14,70495	59,92343
Belém PT07	1,541588	3,039629	4,581216	8,02307	0,5710054	9,711316	69,63475
Belém PT03	0,920569	4,7722	5,692769	12,1942	0,4668423	7,939773	77,57452
Belém PT01	1,234731	1,583641	2,818373	6,58573	0,4279515	7,27834	84,85286
Belém PT02		31,18155	31,18155	82,98935	0,3757296	6,390182	91,24304
Belém EEE Cidade Jardim	4,487774	0,809765	5,297539	19,559	0,2708492	4,60644	95,84948
Belém PT06		3,268288	3,268288	22,43402	0,1456845	2,477713	98,3272
Belém PT09		1,19939	1,19939	12,1942	0,0983574	1,672803	100

PRIORIZAÇÃO DE POLÍGONOS

VAZÕES TEÓRICAS DOS PONTOS DO SES ETE BELÉM								
PONTO DE CONTROLE	TUBULAÇÕES (M)		VAZÕES (L/s)	VAZÕES (L/s) - CONSIDERANDO MICROMEDIDO				
	CER / CA	PVC E OUTRAS	Qinfiltração	Qsanitária	Qmédia	Qmaxdiária	Qmaxhorária	Qmínima
PTO1	99.597,68	31.202,62	52,92	58,38	111,30	122,97	158,00	82,11
PTO2	305.326,52	124.508,61	165,11	185,66	350,77	387,90	499,30	257,94
PTO3	217.221,97	56.274,77	114,24	194,63	308,87	347,80	464,58	211,56
PTO4	101.212,19	25.584,19	53,16	153,50	206,67	237,37	329,47	129,91
PTO5	67.597,40	4.718,31	34,27	99,18	133,45	153,28	212,79	83,86
PTO6	58.232,44	6.998,22	29,82	100,97	130,78	150,98	211,56	80,30
PTO7	166.420,40	8.743,11	84,08	175,97	260,05	295,25	400,83	172,07
PTO8	105.341,95	6.996,50	53,37	201,63	255,00	295,33	416,31	154,19
PTO9	179.569,07	67.679,87	96,55	97,26	193,82	213,27	271,63	145,18
EEE	88.021,59	141.363,48	58,15	55,59	113,73	124,85	158,20	85,94
S/MEDICAO	140.709,43	104.707,45	80,83	105,00	185,83	206,83	269,83	133,33

PRIORIZAÇÃO DE POLÍGONOS



PRIORIZAÇÃO DE POLÍGONOS

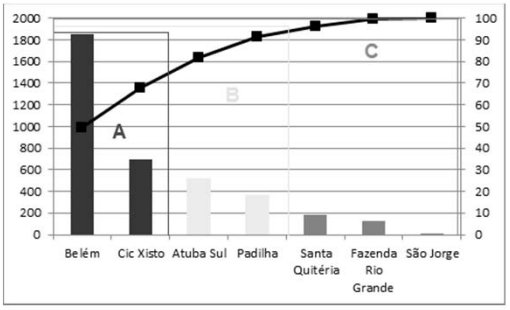
VAZÕES MEDIDAS

PONTO	Q média (Micro) (L*s-1)	Q Média Seco (Medida) (L*s-1)	Variação Média de Q (L*s-1) (Micro Medido - Medido Seco)	Variação Média de Q (Dia Seco) (%)	Q Média Chuvoso (Medido) (L*s-1)	Variação Média de Q (L*s-1) (Chuvoso - Seco)	Variação Média de Q (Dia Chuvoso) (%)
Belém PT02	1950,71	499,77	1450,94	74,38	456,99	-42,78	-8,56
Belém PT04	1179,77	723,27	456,5	38,69	1005,91	282,64	39,08
Belém PT03	308,87	86,81	222,06	71,89	96,89	10,08	11,61
Belém PT06	579,6	427,52	152,08	26,24	423,83	-3,69	-0,86
Belém PT07	260,05	118,61	141,44	54,39	135,49	16,88	14,23
Belém PT05	133,45	22,06	111,39	83,47	59,19	37,13	168,31
Belém PT08	255	164,67	90,33	35,42	193,27	28,6	17,37
Belém PT01	111,3	37,61	73,69	66,21	51,13	13,52	35,95
Belém PT09	193,82	138,01	55,81	28,79	120,21	-17,8	-12,90
Belém EEE Cidade Jardim	113,73	76,05	37,68	33,13	125,19	49,14	64,62

PRIORIZAÇÃO DE POLÍGONOS

ETE	Seco	Fator 0,6	Chuva	Fator 0,4	Soma dos Fatores	Prioridade
Belém	2791,92	1675,152	437,99	175,196	1850,348	1
Cic Xisto	812,18	487,308	512,24	204,896	692,204	2
Atuba Sul	700,65	420,39	260,21	104,084	524,474	3
Padilha	466,52	279,912	225,28	90,112	370,024	4
Santa Quitéria	232,81	139,686	102,91	41,164	180,85	5
Fazenda Rio Grande	0,74	0,444	318,78	127,512	127,956	6
São Jorge	0,05	0,03	18,84	7,536	7,566	7

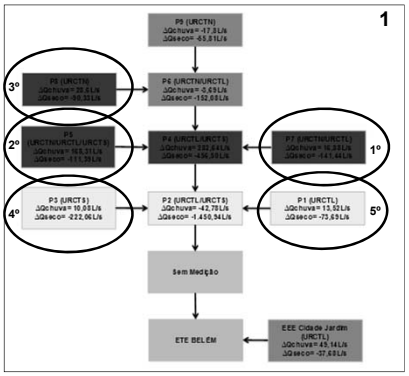
PRIORIZAÇÃO DE POLÍGONOS



PRIORIZAÇÃO DE POLÍGONOS

URCT	ETE	Polígono	Prioridade
URCTN	Belém Prioridade 1	P7	1
		P5	2
		P8	3
	Cic Xisto Prioridade 2	P7	4
	Atuba Sul Prioridade 3	P7	5
	Santa Quitéria 5	P8	6
		P6	7
		P5	8
	São Jorge 7	P1	9

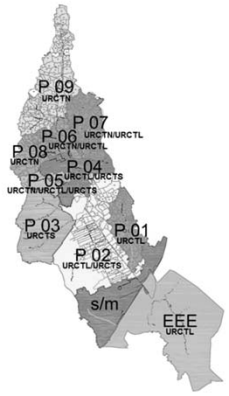
PRIORIZAÇÃO DE POLÍGONOS



PRIORIZAÇÃO DE POLÍGONOS

URCT	ETE	Polígono	Prioridade
URCTS	Belém Prioridade 1	P5	1
		P3	2
	Cic Xisto Prioridade 2	P10	3
		P7	4
		P5	5
	Padilha Prioridade 4	P3	6
		P1	7
	Fazenda Rio Grande Prioridade 6	P1	8
		P3	9

PRIORIZAÇÃO DE POLÍGONOS



A4-4 Flow Rate Survey at the Pilot Area in the Coastal Area

Measurement and Analysis of Sewage Flow Volume at Pontal do Parana

JICA Expert Team

2014/01/29

1 Measurement of sewage flow volume at coastal area

1.1 Summary

In coastal area sewered area of Pontal do Parana was selected as the pilot area of investigation of flow volume, because of its high infiltration volume of rain water in wet weather.

- The four pumping stations were selected to install flow meters in six stations.
- Multiple-items water quality meter was installed at the inlet section of STP to estimate the amount of water infiltration by analyzing the EC value.

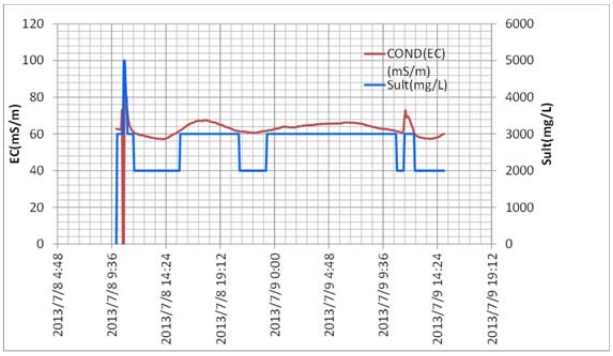
Figure 1.1.1 Overall Sewerage System Plan

1.2 Methods of measurement

(1) Preliminary measurement 07/2013

・The purpose of this investigation was to estimate the groundwater infiltration and the amount of dry weather flow.

・Time variation of water inflow volume to STP. (The 24-hour survey by multiple items water quality meter)



Example of the measurement results

EC value follows the salt concentration and is being leveled afterwards.

⇒ Infiltration of seawater is considered. (Salt concentration; 3000 ~ 5000mg / l).

Measurement of flow volume at four pumping stations. (Using two ultrasonic flow meter)

- Period of measurement : More than 24 hours

(2) The secondary measurement

・The purpose of this measurement was to estimate the infiltration of rain water at wet weather: 10/2013

・Time variation of influent quality of the treatment plant. (A-week survey with multiple items water quality meter)

・Measurement of flow volume at four pumping stations. (Using two ultrasonic flow meter)

・Period of measurement of flow volume : For more than one week

1.3 Results of investigation

1.3.1 Flow volume of influent of STP and water consumption volume(by CODOPE)

The water consumption volume of sewered area of Pontal do Parana estimated from data of CODOPE is shown in Table 1.3.1. Water consumption volume in this treatment area is about 1,000m3/day.

It is shown in Table 1.3.2 and Figure 1.3.1 that the relations between water consumption volume and inflow volume to STP and rainfall amount.

Table 1.3.1 The water consumption volume of sewered area of Pontal do Parana

month	days	① VOL.MED .AGUA	② VOL.MED .AGUA	③ LIG.AGUA	④ LIG.ESG OTO	⑤ VOL.ESG OTO ④/③×②
		(m3)	(m3/day)	Number	Number	
JAN	31	350,851	11,320	22,205	5,290	2,700
FEV	28	265,665	9,490	22,295	5,311	2,260
MAR	31	158,823	5,120	22,363	5,309	1,220
ABR	30	144,358	4,810	22,386	5,304	1,140
MAI	31	126,682	4,090	22,411	5,298	970
JUN	30	127,961	4,270	22,485	5,301	1,010
JUL	31	121,564	3,920	22,551	5,304	920
AGO	31	124,043	4,000	22,594	5,303	940
SET	30	130,484	4,350	22,691	5,325	1,020
OUT	31	135,975	4,390	22,750	5,337	1,030

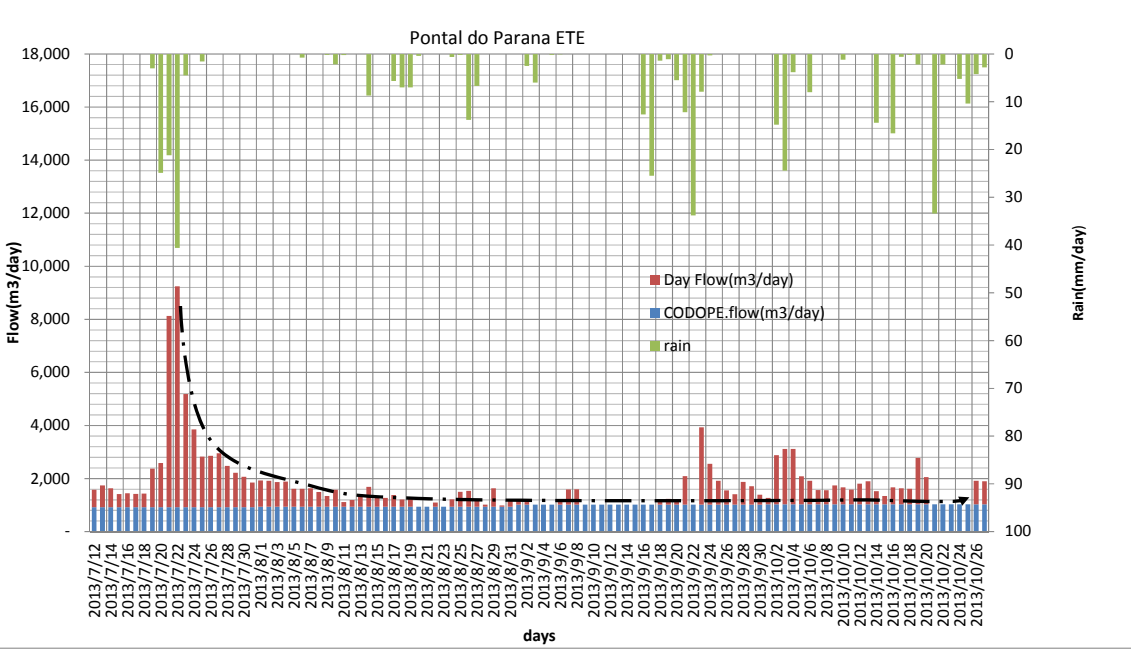


Figure 1.3.1 The relationship between water consumption and inflow volume to STP and rainfall amount.

Table 1.3.2 The relationship between water consumption volume and inflow volume to STP and rainfall amount.

Timestamp	Day of the week		Rain mm/day	①Day Flow M3/day	①－②flow m3/day	②CODOPE.flow m3/day	②/① accounted-for water %
2013/7/12	Sexta	金	0	1,576	656	920	
2013/7/13	Dabado	土	0	1,742	822	920	
2013/7/14	Domingo	日	0	1,632	712	920	
2013/7/15	Segunda	月	0	1,416	496	920	
2013/7/16	Terca	火	0	1,446	526	920	
2013/7/17	Quarta	水	0	1,423	503	920	
2013/7/18	Quinta	木	0	1,435	515	920	60.4%
2013/7/19	Sexta	金	3	2,376	1,456	920	
2013/7/20	Dabado	土	25	2,583	1,663	920	
2013/7/21	Domingo	日	21	8,132	7,212	920	
2013/7/22	Segunda	月	41	9,243	8,323	920	
2013/7/23	Terca	火	4	5,188	4,268	920	
2013/7/24	Quarta	水	0	3,853	2,933	920	
2013/7/25	Quinta	木	2	2,829	1,909	920	
2013/7/26	Sexta	金	0	2,860	1,940	920	
2013/7/27	Dabado	土	0	2,951	2,031	920	
2013/7/28	Domingo	日	0	2,478	1,558	920	
2013/7/29	Segunda	月	0	2,219	1,299	920	
2013/7/30	Terca	火	0	2,063	1,143	920	
2013/7/31	Quarta	水	0	1,850	930	920	
2013/8/1	Quinta	木	0	1,928	988	940	
2013/8/2	Sexta	金	0	1,916	976	940	
2013/8/3	Dabado	土	0	1,867	927	940	
2013/8/4	Domingo	日	0	1,885	945	940	
2013/8/5	Segunda	月	0	1,620	680	940	
2013/8/6	Terca	火	1	1,616	676	940	
2013/8/7	Quarta	水	0	1,633	693	940	
2013/8/8	Quinta	木	0	1,491	551	940	
2013/8/9	Sexta	金	0	1,342	402	940	
2013/8/10	Dabado	土	2	1,575	635	940	
2013/8/11	Domingo	日	0	1,112	172	940	
2013/8/12	Segunda	月	0	1,190	250	940	
2013/8/13	Terca	火	0	1,411	471	940	70.9%
2013/8/14	Quarta	水	9	1,688	748	940	
2013/8/15	Quinta	木	0	1,274	334	940	
2013/8/16	Sexta	金	0	1,271	331	940	
2013/8/17	Dabado	土	6	1,380	440	940	
2013/8/18	Domingo	日	7	1,207	267	940	
2013/8/19	Segunda	月	7	1,286	346	940	
2013/8/20	Terca	火	0	810	(130)	940	
2013/8/21	Quarta	水	0	829	(111)	940	
2013/8/22	Quinta	木	0	1,096	156	940	
2013/8/23	Sexta	金	0	645	(295)	940	
2013/8/24	Dabado	土	1	1,220	280	940	
2013/8/25	Domingo	日	0	1,498	558	940	82.6%
2013/8/26	Segunda	月	14	1,539	599	940	
2013/8/27	Terca	火	7	1,193	253	940	
2013/8/28	Quarta	水	0	1,022	82	940	
2013/8/29	Quinta	木	0	1,629	689	940	
2013/8/30	Sexta	金	0	986	46	940	
2013/8/31	Dabado	土	0	1,216	276	940	
2013/9/1	Domingo	日	0	1,191	171	1,020	
2013/9/2	Segunda	月	3	1,130	110	1,020	80.9%
2013/9/3	Terca	火	6	#VALUE!	#VALUE!	1,020	
2013/9/4	Quarta	水	0	#VALUE!	#VALUE!	1,020	
2013/9/5	Quinta	木	0	#VALUE!	#VALUE!	1,020	
2013/9/6	Sexta	金	0	1,200	180	1,020	
2013/9/7	Dabado	土	0	1,594	574	1,020	
2013/9/8	Domingo	日	0	1,596	576	1,020	69.7%
2013/9/9	Segunda	月	0	#VALUE!	#VALUE!	1,020	
2013/9/10	Terca	火	0	#VALUE!	#VALUE!	1,020	
2013/9/11	Quarta	水	0	#VALUE!	#VALUE!	1,020	
2013/9/12	Quinta	木	0	#VALUE!	#VALUE!	1,020	
2013/9/13	Sexta	金	0	#VALUE!	#VALUE!	1,020	
2013/9/14	Dabado	土	0	#VALUE!	#VALUE!	1,020	
2013/9/15	Domingo	日	0	#VALUE!	#VALUE!	1,020	
2013/9/16	Segunda	月	13	#VALUE!	#VALUE!	1,020	
2013/9/17	Terca	火	26	#VALUE!	#VALUE!	1,020	
2013/9/18	Quarta	水	1	1,163	143	1,020	
2013/9/19	Quinta	木	1	1,237	217	1,020	
2013/9/20	Sexta	金	6	1,124	104	1,020	
2013/9/21	Dabado	土	12	2,094	1,074	1,020	
2013/9/22	Domingo	日	34	#VALUE!	#VALUE!	1,020	
2013/9/23	Segunda	月	8	3,933	2,913	1,020	
2013/9/24	Terca	火	0	2,555	1,535	1,020	
2013/9/25	Quarta	水	0	1,913	893	1,020	
2013/9/26	Quinta	木	0	1,554	534	1,020	
2013/9/27	Sexta	金	0	1,405	385	1,020	
2013/9/28	Dabado	土	0	1,873	853	1,020	
2013/9/29	Domingo	日	0	1,707	687	1,020	
2013/9/30	Segunda	月	0	1,395	375	1,020	
2013/10/1	Terca	火	0	1,272	242	1,030	66.6%
2013/10/2	Quarta	水	15	2,877	1,847	1,030	
2013/10/3	Quinta	木	24	3,113	2,083	1,030	
2013/10/4	Sexta	金	4	3,114	2,084	1,030	
2013/10/5	Dabado	土	0	2,084	1,054	1,030	
2013/10/6	Domingo	日	8	1,912	882	1,030	
2013/10/7	Segunda	月	0	1,566	536	1,030	
2013/10/8	Terca	火	0	1,557	527	1,030	
2013/10/9	Quarta	水	0	1,743	713	1,030	
2013/10/10	Quinta	木	1	1,671	641	1,030	
2013/10/11	Sexta	金	0	1,584	554	1,030	
2013/10/12	Dabado	土	0	1,809	779	1,030	
2013/10/13	Domingo	日	0	1,900	870	1,030	
2013/10/14	Segunda	月	14	1,525	495	1,030	
2013/10/15	Terca	火	0	1,339	309	1,030	
2013/10/16	Quarta	水	17	1,668	638	1,030	
2013/10/17	Quinta	木	1	1,631	601	1,030	
2013/10/18	Sexta	金	0	1,616	586	1,030	
2013/10/19	Dabado	土	2	2,778	1,748	1,030	
2013/10/20	Domingo	日	0	2,061	1,031	1,030	58.6%
2013/10/21	Segunda	月	33	#VALUE!	#VALUE!	1,030	
2013/10/22	Terca	火	2	#VALUE!	#VALUE!	1,030	
2013/10/23	Quarta	水	0	#VALUE!	#VALUE!	1,030	
2013/10/24	Quinta	木	5	#VALUE!	#VALUE!	1,030	
2013/10/25	Sexta	金	10	#VALUE!	#VALUE!	1,030	
2013/10/26	Dabado	土	4	1,917	887	1,030	
2013/10/27	Domingo	日	3	1,902	872	1,030	

Rainfall data：「http://www.inmet.gov.br/sonabra/maps/pg_automaticas.php」

Legend: Yellow represents a major rainfall days. Gray measurement data missing.黄色：主な降雨日を示す。灰色：データ欠測

1.3.2 Infiltration amount of the treatment plant

(1) Groundwater infiltration

According to Table 1.3.2 and Figure 1.3.1, at the period of small rainfall, the accounted water volume is corresponded to 70-80% of the inflow volume to STP. The rest of the inflow volume is considered as the infiltration of groundwater.

(2) Infiltration volume of rain water

Surplus sewage volume at rainy day compared to dry weather is estimated as rain water infiltration volume as shown in Figure 1.3.2.

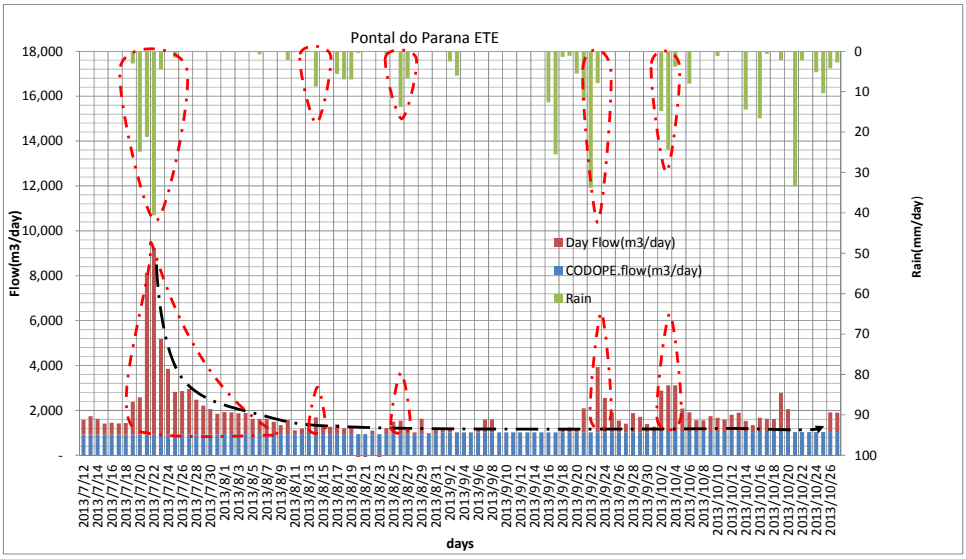


Figure 1.3.2 Estimated rain water infiltration volume corresponding to the rainy days

Table 1.3.3 Estimated infiltration volume

7/19-23Rain	94	mm
7/19-8/8 Total Flow	62,580	m3/21days
CODOPE Flow	19,320	m3/21days
7/19-8/8 Infiltration	43,260	m3/21days
8/14 Rain	9	mm
8/14 Total Flow	1688	m3/day
8/14Infiltration	768	m3/day
8/26 Rain	14	mm
8/26 Total Flow	1539	m3/day
CODOPE Flow	940	m3/day
8/26 Infiltration	599	m3/day
8/26-27 Rain	21	mm
8/26-27 Total Flow	2732	m3/2days
CODOPE Flow	1880	m3/day
8/26-27 Infiltration	852	m3/day
9/22-23 Rain	42	mm
9/23-25 Total Flow	8,401	m3/3days
CODOPE Flow	3060	m3/3days
9/23-25 Infiltration	5,341	m3/3days
10/2-4 Rain	43	mm
10/2-5 Total Flow	11,188	m3/4days
CODOPE Flow	4080	m3/4days
10/2-5 Infiltration	7,108	m3/4days

Relation in Figure 1.3.3 was drawn by plotting precipitation volume vs infiltration volume in Table 1.3.3.

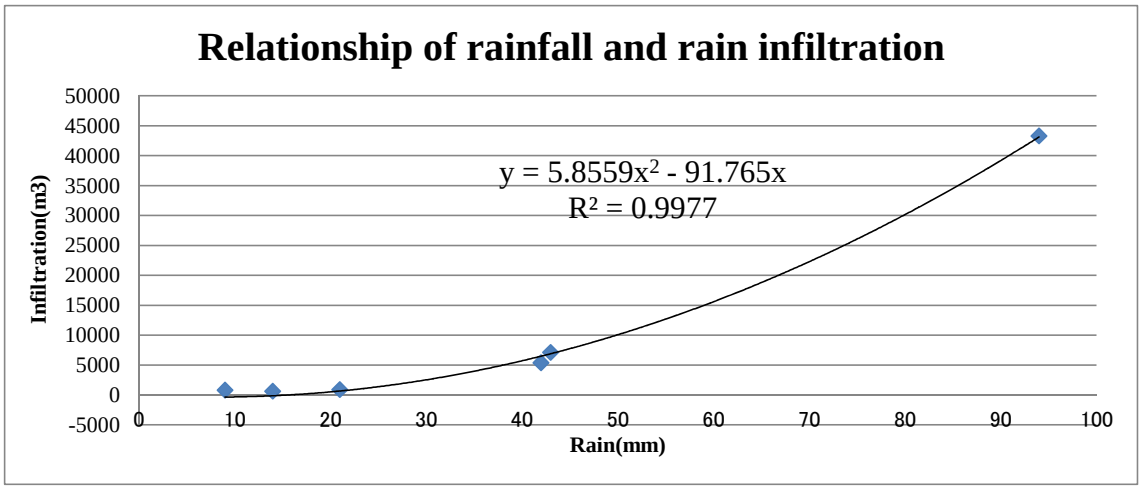


Figure 1.3.3 The relation between rainfall amount and infiltration volume

(3)Result of measurement by multiple items water quality meter

EC value of influent of STP is shown in Figure 1.3.4. Time variation of EC value is not observed because of the averaging effect by the big storage capacity of each EEEs.

Average EC value is high at 76.0mS/m and the concentration of Salt is about 3%, that deduces the infiltration of sea water. On the other hand EC value was reduced from 95mS/m to 60mS/m by the effect of rainfall at Nov3rd. Infiltration volume of rain water is estimated to about 1000m^3, as being shown at following equation assuming that EC of rain water is 10mS/m and sewage volume at dry weather is 1,500m^3/day and putting that infiltration volume at wet weather is Q.

$$60\text{mS/m} \times (Q + 1{,}500) = 95\text{mS/m} \times 1{,}500\text{m3/day} + 10\text{mS/m} \times Q \quad Q = 1{,}050\text{m3/day}$$

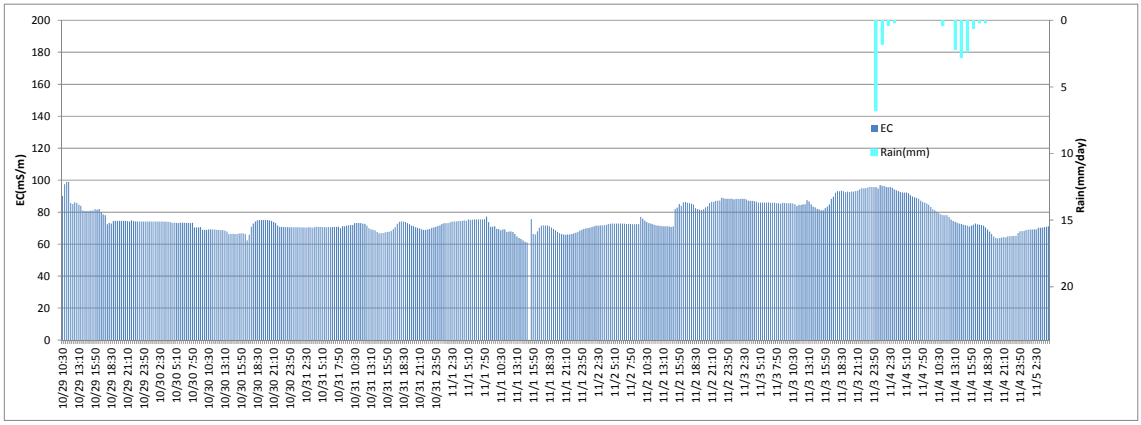


Figure 1.3.4 EC value of influent of STP

1.3.3 Result of measurement at pumping stations

Table 1.3.4 shows the duration of measurement of sewage volume, principal precipitations and the capacity of pumps.

Table 1.3.4 The period of measurement of sewage volume, principal precipitations and the capacity of pumps

Name of EEE	Period of measurement	Principal precipitations (mm)	Capacity of pumps (l/s)	Flow volume of dry weather (m3/day)
ATAMI	10/22 14:30 ~ 10/28 14:30	35.4(10/22 22:00~24:00)	58.25	200~500
SHANGRI-LA	10/29 12:30 ~ 11/5 10:00	18.2(11/4 2:00~20:00)	10.00	300
TEREZINHA	10/21 19:30 ~ 10/29 17:00	35.4(10/22 22:00~24:00)	23.60	500
CANOAS	10/29 15:40 ~ 11/5 22:40	18.2(11/4 2:00~20:00)	23.10	400

It is desired that the infiltration volume at wet weather will be evaluated by comparing with other pumping stations by the infiltration volume per sewered area. But here it is evaluated by the magnification of the flow volume at wet weather/that of dry weather.

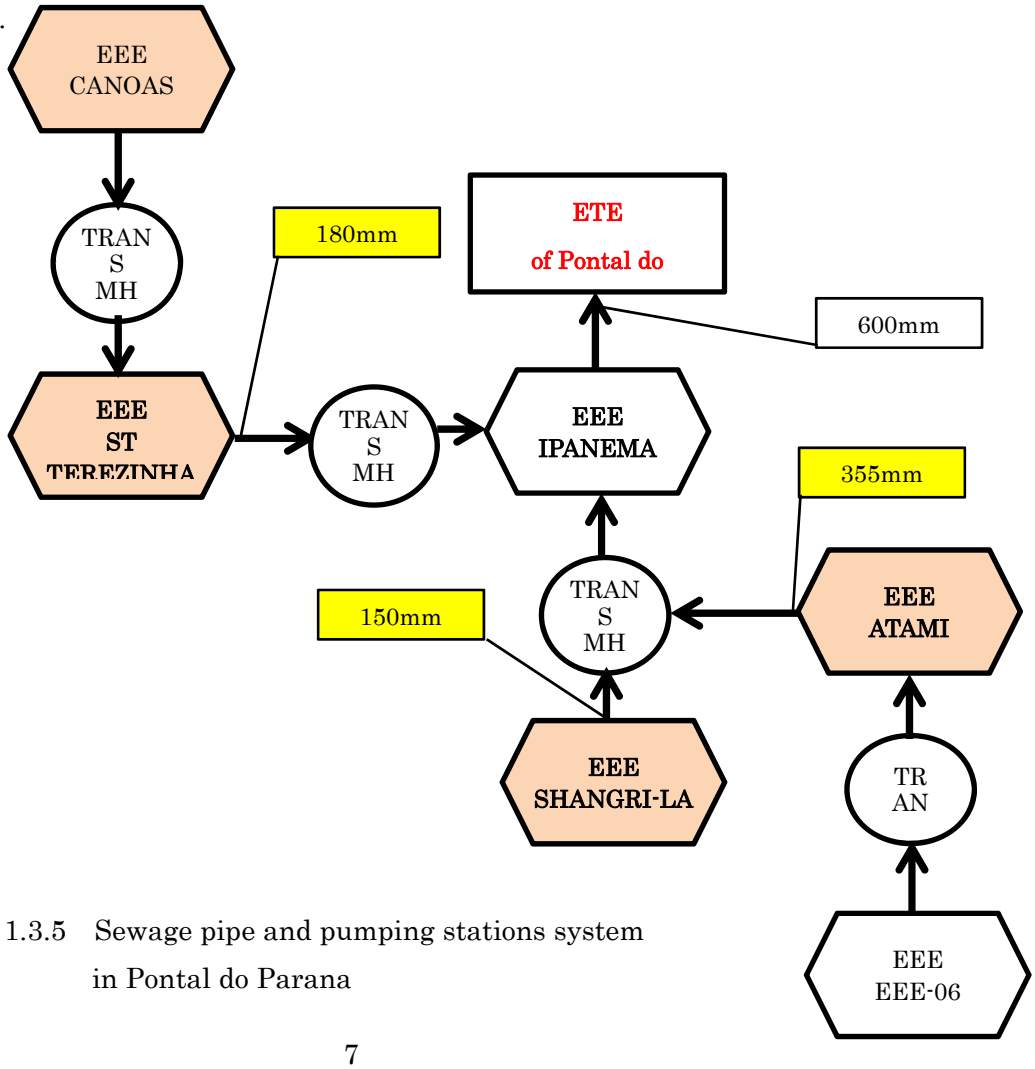


Figure 1.3.5 Sewage pipe and pumping stations system in Pontal do Parana

(1) CANOAS EEE

The result of the measurement is shown in Figure 1.3.6. Flow volume of dry weather is about 400m^3/day.

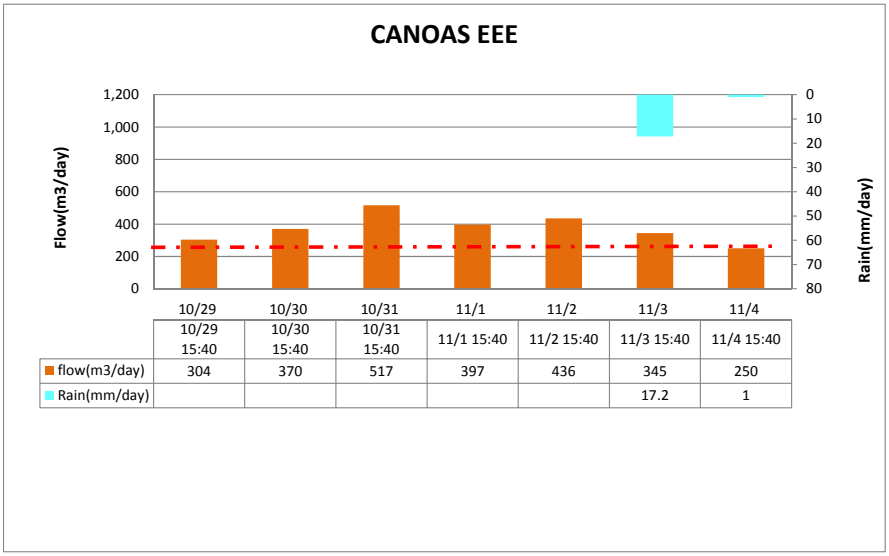


Figure 1.3.6 Result of the measurement at Canoas EEE

Table 1.3.5 Estimated infiltration volume in wet weather at Canoas EEE

Sunny day flow11/4	250	m3/day
11/3 Rain	17.2	mm
11/3 Total Flow	345	m3/day
11/3Infiltration	95	m3/day
11/3 Total Flow / Sunny day flow	1.38	

(2) TEREZINHA EEE

The result of the measurement is shown in Figure 1.3.7. Flow volume of dry weather is about 500m^3/day.

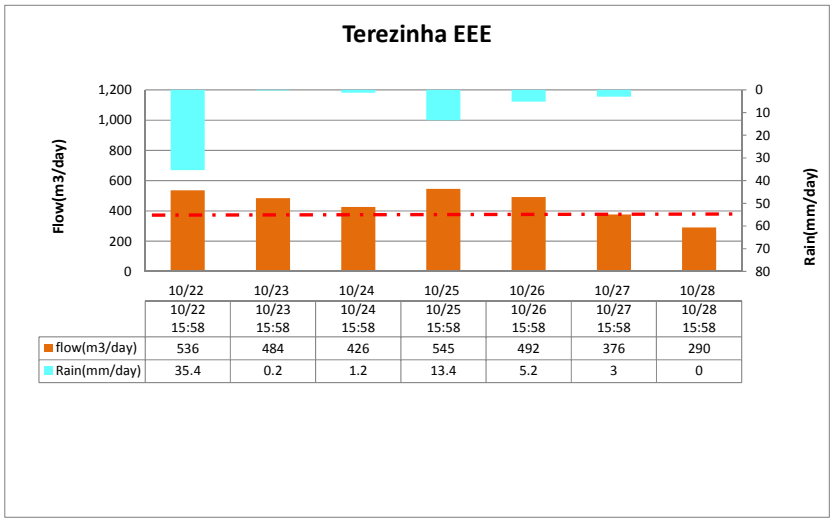


Figure 1.3.7 Result of the measurement at Terezinha EEE

Table 1.3.6 Estimated infiltration volume in wet weather at Terezinha EEE

Sunny day flow 10/27	376	m3/day
10/22Rain	37	mm
10/22-24 Total Flow	1,446	m3/3days
10/22-24Infiltration	318	m3/3days
10/22-24 Total Flow / Sunny day flow	1.85	
Sunny day flow 10/27	376	m3/day
10/25 Rain	18.6	mm
10/25-26 Total Flow	1,037	m3/day
10/25-26Infiltration	285	m3/day
10/25-26 Total Flow / Sunny day flow	1.76	

The result of the measurement of flow volume by 0.5hr at Terezinha EEE is shown in Figure 1.3.8. The direct infiltration of rain water is estimated at the data of Oct/22.

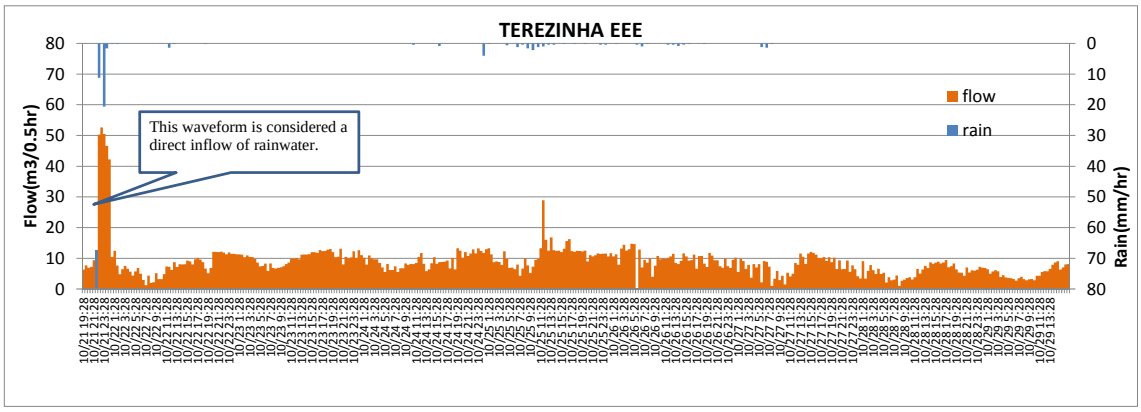


Figure 1.3.8 The result of the measurement of flow volume by 0.5hr at Terezinha EEE

(3) SHANGRI-LA EEE

The result of the measurement is shown in Figure 1.3.9. Flow volume of dry weather is about 300m^3/day. It is difficult to estimate the infiltration volume of rain water at Nov/3rd.

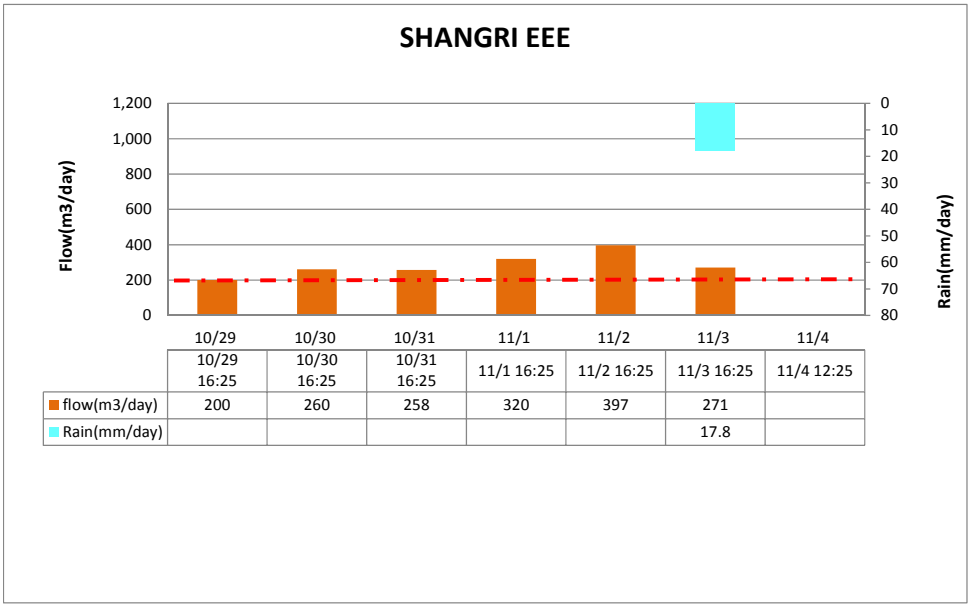


Figure 1.3.9 Result of the measurement at Shangri-La EEE

(4) ATAMI EEE

The result of the measurement is shown in Figure 1.3.10. The fluctuation of flow volume at dry weather is rather big showing the range of 200 to 500m³/day.

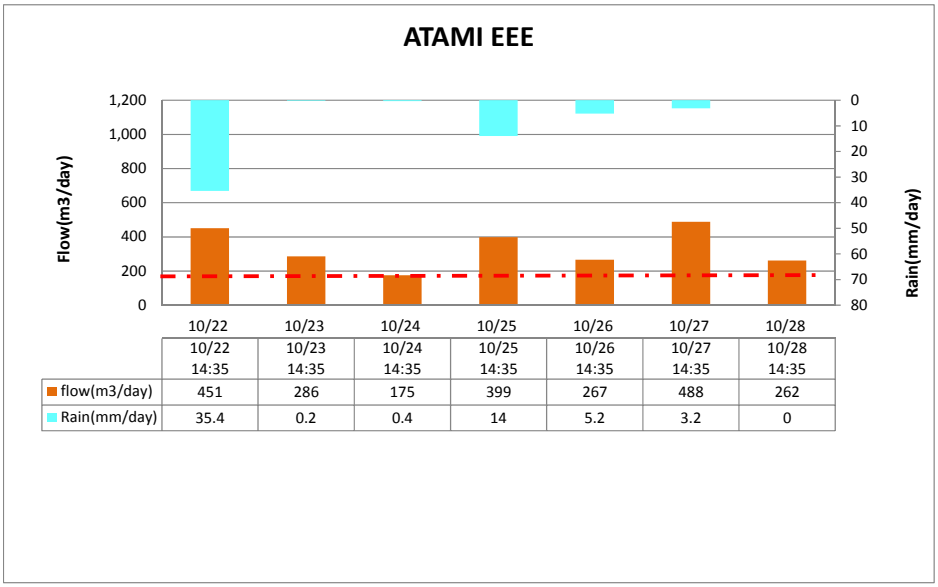


Figure 1.3.9 Result of the measurement at Atami EEE

Table 1.3.7 Estimated infiltration volume in wet weather at Atami EEE

Sunny day flow10/24	175	m3/day
10/22Rain	35	mm
10/22-23 Total Flow	737	m3/2days
10/22-23 Infiltration	387	m3/2days
10/22-23 Total Flow / Sunny day flow	3.2	
Sunny day flow10/26	267	m3/day
10/25 Rain	14	mm
10/25 Total Flow	399	m3/day
10/25Infiltration	132	m3/day
10/25 Total Flow / Sunny day flow	1.5	

The result of the measurement of flow volume by 0.5hr is shown in Figure 1.3.11. The direct infiltration of rain water is estimated at the data of Oct/22th that shows the largest infiltration in the pumping stations measured in this investigation.

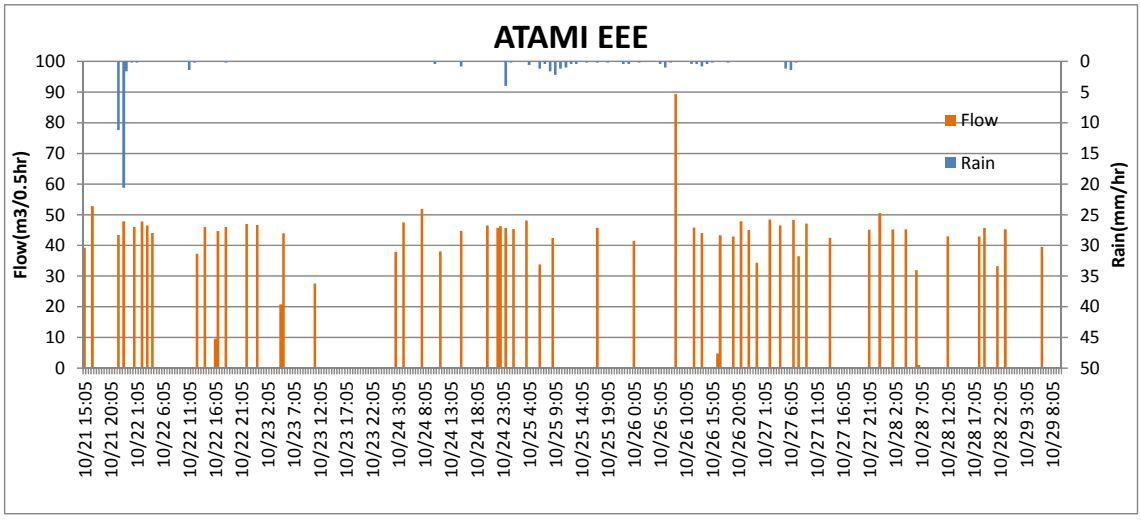


Figure 1.3.11 The result of the measurement of flow volume by 0.5hr at Atami EEE

A4-5 Consideration on Demonstrative Construction of Partial Repair of Sewage Pipe by Pipe Rehabilitation Method

Considerações sobre a demonstração do método de reparo parcial por revestimento da rede coletora de esgoto

1. Demonstração do método de reparo parcial

1-1. Execução do método para demonstração

A demonstração do método foi realizada na rede coletora da bacia do Rio Areãozinho, área piloto do Projeto da JICA.

Data da realização: novembro de 2013

Local: tubulação da rede coletora da bacia do Rio Areãozinho, da URCT-L

Número de reparos realizados: 3 (diâmetro de 150mm, 200mm e 250mm)

1-2. Método utilizado para reparo da rede coletora de esgoto

Método PipePatch cured-in-place pipe (CIPP)

O reparo parcial da tubulação é realizado através da montagem de tecido de fibra de vidro impregnado com a mistura de 2 líquidos que compõem adesivos à base da resina na máquina reparadora. A máquina introduz ao local determinado dentro da tubulação de esgoto, colado por pressão e endurecido. O método de cura é endurecimento natural, contudo, de forma geral, existe também o termoendurecimento e fotoendurecimento.

1-3. Resultado do processo

Após determinado tempo de cura e endurecimento, retirada da máquina reparadora e lavagem por hidrojateamento, verificou-se o resultado através da câmera por inserção.

1) ϕ 150mm: resultado satisfatório
2) ϕ 200mm: resultado satisfatório
3) ϕ 250mm: resultado insatisfatório
   - ✓ material de reparo não aderiu na tubulação e foi observada lacuna;
   - ✓ confirmação da raiz de árvore que infiltrou pela rachadura;
   - ✓ devido a curta distância entre a borda do material para reparo e a raiz da árvore, aparentemente indica que o material para reparo não foi devidamente centrado no local da rachadura.

2. Suposição acerca do motivo da falha

De acordo com a imagem fotografada por câmera de inserção após o procedimento, podemos confirmar ou supor os seguintes pontos como motivo da falha.

✓ Devido a protuberância da raiz da árvore que invadiu o interior da tubulação de esgoto, não ocorreu a adesão do material de reparo na tubulação.

✓ Em adição ao acima mencionado, o grande fluxo do esgoto impediu a adesão do material de

reparo na tubulação;

✓ O fato da protubelância da raiz da árvore localizar perto da borda do material de reparo, não permitiu a adesão deste na tubulação.

3. Condições gerais requeridas para o processo de reparo

As especificações e condições do processo utilizado no Japão, similar (método de reparo da superfície interna FRP <termosetting>) ao processo demonstrativo realizado estão abaixo relacionados.

Especificação

Diâmetro da tubulação	ϕ 150mm ～ ϕ 600mm
Material da tubulação	Concreto armado, cerâmica, PVC
Largura da reabilitação	Largura padrão 400mm, Largura longa 1000mm
Resistência à pressão externa da tubulação composta (ex.: cerâmica + revestimento)	Igual e acima de tubulação nova
Fadiga à pressão externa da tubulação composta (ex.: cerâmica + revestimento)	Não houve anomalia após aplicação de 2 milhões de vezes de carga com Carga Limite Mínima 340kgf ~ Carga Limite Máxima 1.020kgf. Resistência à pressão externa após o texte: carga de ruptura 31.1KN/m (3.167kgf/m).
Hidrojateamento	Com pressão da bomba a 15Mpa (150kgf/cm^2), não houve anomalia após 50 jateamentos com duração de 5 segundos cada.
Tempo do processo	Processo padrão (processo preparatório ~ processo de limpeza) - de 1 hora e 50 minutos a 2 horas (no caso do reparo de 1 ponto, por seção)

Condição do Processo

Localização da obra		Espaço entre PV, de até 120m
Formato do PV		Diâmetro interno acima de 500mm
Vazão do esgoto permitido		Pequeno fluxo, que permite a inspeção por câmera
Situação do dano da tubulação existente	1) Dano	Largura padrão: permitido até 200mm Largura longa: permitido até 800mm
	2) Rachadura	Permissível quando a circunferência total e seção da tubulação for mantida.
	3) Desalinhamento da junção (degrau)	Acima da espessura da tubulação, até 1/4 do diâmetro
	4) Barriga (sifonamento?)	Até 1/3 do diâmetro da tubulação
	5) Dobra, curva da rede	Acima de 45 graus
	6) Sujeira acumulada (argamassa aderente, etc)	Até 1/5 do diâmetro da tubulação. Superior a 1/5, ncessita limpeza prévia.
	7) Infiltração	Permissível para água escorrendo. Referência: Vazão 2l/s e pressão da água 0.05Mpa (0.5Kgf/cm^2).
	8) Ligação irregular	Até 1/5 do diâmetro da tubulação
	9) Corrosão da tubulação	Permissível a exposição da vergalhão (desde que não

		estoure o balão com o produto)

4. Motivo da falha e Medidas a serem tomadas

4-1. Motivo da falha do ponto de vista da condição do processo

O motivo da falha visto pela condição do processo para reparo parcial indicado no item 3 acima se encontra abaixo relacionado.

Apesar de não existir referência sobre condição do processo com invasão da raiz de árvore, o entendimento geral é a remoção da raiz de árvore que invadiu a tubulação. Por outro lado, como a condição para o processo relacionado a sujeira acumulada e ligação irregular é de até 1/5, podemos supor que o principal motivo da falha é ter efetuado o processo sem a retirada da raiz de árvore invasora.

Ademais, a existência do orifício para drenagem de água no equipamento de reparo possibilita a realização do procedimento, mesmo havendo certo fluxo de esgoto. Contudo, nesta demonstração o fluxo de esgoto era considerável que dificultava a filmagem, e mesmo que tenha sido temporariamente retido no momento da instalação da máquina reparadora, o fato de não ter parado a vazão incluindo o tempo de cura poderá ser considerado como um dos fatores da falha.

Outrossim, do ponto de vista das condições do processo, é considerado que é possível efetuar o processo desde que haja margem de 100mm como largura do reparo a partir da borda da rachadura. Contudo, pelo fato da raiz de árvore estar visível perto do material de reparo, podemos supor que houve também problemas quanto ao estabelecimento da posição da máquina reparadora.

4-2. Medidas a serem tomadas

As medidas a serem tomadas limitadas ao processo que falhou, se encontram abaixo relacionadas. Entretanto, para terceiro item podemos esperar a melhoria através da repetição do processo.

- ✓ Efetuar o processo após ter retirado completamente a raiz de árvore que invadiu a tubulação.
- ✓ No momento da preparação da máquina de reparo, bem como durante o processo, na medida do possível parar o fluxo do esgoto.
- ✓ Armar no centro da máquina de reparo a parte danificada.

5. Condições para ser aplicado pela SANEPAR

5-1. Garantir as condições do processo

Ao avaliar as condições do processo sobre a situação do dano da tubulação existente indicado no 3 acima, teremos o seguinte resultado.

1) Dano e

2) Rachadura são passíveis de serem reparados, mesmo que a situação seja grave.
3) Desalinhamento da junção e
4) Barriga e sinuosidade trazem problemas na capacidade de descarga da tubulação, portanto, quando o problema é grande, deverá executar a troca da tubulação.
5) A dobra/curvatura da tubulação, quando for normal, não consiste em problema.
6) O ponto importante é a retirada da sujeira acumulada, invasão de raiz da árvore e 8) ligação irregular
7) Quanto a infiltração, observar o volume e pressão para avaliar a necessidade ou não do reparo.
9) Quando corrosão grave é observada, avaliar a adequação ou não do processo.

Aqui, quando efetuar o reparo parcial da tubulação de esgoto pelo método de revestimento, com relação a 6) retirada de sujeira acumulada e invasão de raiz de árvore e 8) retirada da ligação irregular, surge a necessidade de efetuar pelo método não destrutivo. Isto porque não tem sentido efetuar o conserto da tubulação por meio do revestimento, ou seja por método não destrutivo, se o procedimento para retirada de raiz de árvore invasor ou da argamassa aderente, ou retirada da ligação irregular for realizado pelo método de corte aberto. Com relação a revestimento por seção entre PVs, mesmo que parte da seção seja realizado pelo método de corte aberto para remoção de obstáculos, poderá ser que haja mérito em efetuar obras com método não destrutivo, contudo, não existe mérito com relação ao reparo parcial.

5-2. Possibilidade da aplicação do reparo parcial na SANEPAR

No Japão, para remoção da raiz de árvore que invadiu a tubulação, remoção da argamassa aderente e remoção da ligação irregular, tem sido estabelecida metodologia de efetuar o serviço dentro do PV. Como exemplo, temos métodos de remoção ou corte através do hidrojateamento do caminhão de hidrojato por meio do acompanhamento do processo pela câmera autopropulsora, ou após o procedimento para revestimento cortar fora utilizando a perfuradora (serra cone) para abrir orifícios para ligação. Contudo, de forma geral o Brasil, inclusive a SANEPAR, não se encontra em situação para utilização desta metodologia/tecnologia. Na atual situação existe a necessidade de selecionar o método de intervenção, tendo como premissa que não é possível remover obstáculos pelo método não destrutivo. Neste momento, considera-se que são poucos os casos onde é possível aplicar o método de revestimento para reparo parcial da tubulação.

Entretanto, podemos considerar a possibilidade de estabelecer a técnica de remoção de obstáculos utilizando bico de limpeza de hidrojateamento especial, juntamente com a implementação do reparo parcial da tubulação por meio do método de revestimento.

A5-1 Reconnaissance Survey for the Target STPs

Reconnaissance Survey for the Target STPs

(1)-3-1 Present situation of STP

＜STP of CMA＞

(1)-3-1-1 Sao Jorge STP

- Capacity: 70 l/sec (6,048 m^3/day)
- Process : UASB + DAF（Dissolved air floatation）
- Situation of Treatment :

Influent : At present, organic load increased higher than last year. Sometimes influent COD exceeds 1,000mg/L. The source of wastewater is not known yet. Automatic operation of two submerged pumps. Number of operator at night is one person until 10pm, no one until morning next day, while three persons at daytime.

UASB: Removal rate of UASB is approximately 70%. Higher COD value of effluent is caused by higher influent.

Addition of Hydrogen peroxide: To control odor problems, oxygen peroxide is added to the effluent conduit of UASB. Oxygen peroxide is safer and more effective than chlorine gas of the past.

DAF: Stop operation at present. However, floatation tank is used as a settling one by introducing UASB effluent. Operation of DAF is completely manual. To operate 24hours a day, the plant lacks operators.

Sludge drying bed: Once in every 40 days, the withdrawal of sludge from the UASB is made. Every time 200m^3 of sludge is discarded. Dried sludge is conveyed to CIC Xisto and mixed with lime and used for agriculture.

(1)-3-1-2 Santa Quiteria STP

- Capacity: 450 l/sec (38,880 m^3/day)
- Process: UASB + DAF（Dissolved air floatation）
- Situation of Treatment:

Influent: When it rains, influent water level increase 1m more. Normally, influent flow ranges around 400 L/sec. The flow peaks from 12 (noon) to 16 (4pm), while 200 L/sec for night time. On the other

hand, the amount increases higher than 600 to 800 L/sec in rain storms, although the sewage system belongs to Separate System. Submerged Pumps were of 3 units.

UASB: The dimension of UASB unit is 21m(W)×21m(L)×5m(H), Height of sludge blanket is measured routinely by sticking a transparent pipe into the tank. Though odor protection cover over the UASB was made by FRP, there is corrosion problem. To get on those covers is prohibited. Each UASB unit has an inscribed angle distributor. To avoid clogging of it, cleaning of screen and piping is major maintenance work. At beginning, a cover unit was installed for it, but in practice, the cover was removed because of its maintenance work. Corrosion level of upper part of effluent conduit is remarkable. Corrosion invaded until the crusher layer.

Addition of Chlorine to effluent of UASB: In practice, further countermeasure is taken as chlorine gas is added to effluent of UASB to oxidize hydrogen-sulfide. In spite of the reduction of hydrogen sulfide in the effluent by dosing chlorine gas to the effluent, there is some fear of turbidity increase because of the dosing(i.e. precipitation of sulfur).

DAF: Scum rise is already seen in open conduits before entering floatation unit. Operational period is 5min operation, 10min of suspension. Frequent faults occur. The cause of derailment is thought to be too long span of sludge collector.

Sludge Dewatering Machine: Made in France. Only one unit is installed. In the past when failure was occurred, long period was needed as parts was not available soon. So in those days, floatation could not be operated thus made effluent quality worth for a long time.

Stockyard of Dewatered Sludge: Dewatered sludge is mixed with lime (dose rate is 57% of dry solid of sludge) and keep pH over 12 for one month. In those holding period, parasite eggs will be annihilated. In one month, after checking parasite egg and heavy metal content, the sludge will be used for agriculture field of beans and corns.

(1)-3-1-3 CIC Xisto STP

- Capacity: 490 l/sec (42,336 m^3/day)
- Process: UASB +（un-aerated）Lagoon
- Situation of Treatment:

Influent: Depth of sewer main entering the plant seems relatively shallow. Sometimes, there may have unusual dark influent (as witnessed on 22nd of October) that was brought about by some factories upstream. (However, any suspect has not been pointed out so far.) Three submerged pumps. One of them is for a spare. Because of low performance of the existing mechanical screen, another screen was installed which operator must clean every two or three times per a shift.

UASB: Being suffered by settlement of facility, overflow weirs could not keep horizontal and cannot provide uniform overflow. The gas-liquid separator that had been said to be able to sustain for 10 years could not keep its original position and had floated itself two years ago. The situation continues to this day. Almost all the UASB tanks continue operation without solving problems of collapsed separator sheet. Insufficient gas separation brings high odor strength problems of the plant site. Scum buildup problem is remarkable.

Addition of Chlorine to effluent of UASB: The plant doses chlorine gas to the effluent of UASB to reduce odor from the lagoon.

LAGOON: No aerator at present. There is a plan to install aerators to the lagoon to increase treatment capacity of 420 l/sec（36,288 m^3/day）. (However, the point was not clear whether it has a plan to build another lagoon or not.)

Sludge dewatering machine: Sludge drawn from UASB is dewatered by a centrifugal dewatering machine, mixed with lime and stored and finally used for agriculture.

(1)-3-1-4 Atuba Sul STP

- Capacity: 1,120 l/sec (96,768 m^3/day)
- Process: UASB + DAF（Dissolved air floatation）
- Situation of Treatment:

Influent: Depth of sewer main entering the plant seems to be 4m depth from the ground. Substantial

amount of screen debris is discovered (when sampling tube was got around by those debris). The JICA team noticed blackish wastewater 3m depth from the ground which flows into pump well. Three screw type main lifting pumps are installed. Normally, one unit is operated. Basically there is no need of control for pump operation. Normally one pump is operated while another one is added when increase of inflow. Mechanical screen (2 units).



After the screens, there is a weir to bypass the surplus wastewater when sewage flows beyond the treatment capacity. At the time of visit, water level is scarcely below the overflow level. However, when entering into UASB, its concentration increase substantially due to the in-site side stream (see cylinder sample).

Samples of every hour were collected from 2PM of 15 Oct. to 1PM of 16. The influent concentration increase from 6PM a little, but decrease by 2AM.

UASB: Total 16 units. Each tank capacity 2,000m^3. Retention time that does not include in-site recycling wastewater remains around 9 hours. Concrete covers are installed as they were built, while FRP covers seemed to be removed because of some disadvantage. The chlorine gas is added to effluent of UASB to reduce odor emitted from the effluent. There is a bypass route to pass effluent



of UASB directly to the final effluent conduit. On the 15th and 16th of Oct. when some failure was occurred to the DAF, 500 ℓ/sec of effluent UASB was bypassed to the final effluent conduit while design total treating capacity is 1,000ℓ/sec.

DAF: Treatment capacity is said to reach 280 ℓ/sec for average, 420 l/sec for maximum.(32,288 m^3/day). Retention time is 20min. Four units were estimated to be able to treat 800ℓ/sec in all. Ferric Chloride is added as a coagulant. Dose rate is 60 mg$FeCl_3$/L. Accidents in which froth collector chain ran off the wheel occur frequently. SANEPAR required the contractor to repair and improve the situations. However the company could not correspond satisfactorily and SANEPAR ceased dealing with the contractor.

Frequent failures were reported such as froth collectors ran off the wheel. Urgent countermeasure is needed. As stated before, long absence of operation of DAF is directly connected to getting worth of final effluent.




Sludge Dewatering Machine: Two units. French made. Sludge cakes leaking from between two filter-meshes and insufficient cake separation which deteriorate quality of filtrate was confirmed. Total amount of sludge cake production is designed to 1,400 ton/month. When 26days of operation is supposed, daily rate should be 54 tons. Amount of daily dewatering sludge should be 11 m^3 from UASB, while 294 m^3 from DAF.

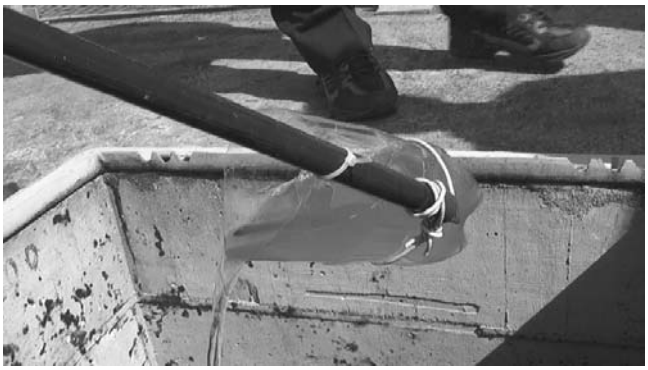

Stockyard of Dewatered Sludge: After mixed with lime, sludge cake is preserved for one month. It can only be used as a fertilizer for soybeans and corns after sterilization of coliform (10^3 MPN) and Ascaris egg and low content of heavy metals were confirmed. Distance to the sludge utilization site is around 150 km. At present, Curitiba city office has a landfill site only for garbage and does not accept sewage sludge. So incineration process might be needed in future (from the point of view of person handling the process). For the time being, "Drying Process" is said now being planned.

(1)-3-1-5 Fazenda Rio Grande STP

- Capacity: 210 l/sec (18,144 m^3/day)
- Process: UASB + (aerated and un-aerated) Lagoon
- Situation of Treatment:

Influent: Depth of influent sewage from the ground seemed to be around 4m. The color of sewage was remarkably blackish. The lifting pumps are of submerged pumps as those of other plants. Number of units is three. Grit chamber is installed one unit of circular one as those of other plants.

UASB: Three units of UASB are installed. The unit has a new scum removing device using gate-mechanism. One unit is planned to be installed additionally in future. As for the treatment of UASB, the effluent seemed better in transparence and odor emission compared with those of other UASB facilities in Curitiba-city. The reason has been assumed of the low loadings around one fourth of the design value. At the time of visit, retention time of UASB is around 30 hours, while the design standard was set to 8 hours. Under those light load UASB seems to give relatively good quality effluent.



LAGOON: There is one unit of Lagoon. The Lagoon is separated into two parts. In the first half, 5 aerators are installed, while the latter half remains sedimentation area where effluent of Lagoon is withdrawn from relatively midpoint of the area. Further more, there is no odor detected around the lagoon as aerators are installed. Also no foams build-up was discovered on the lagoon surface. On the other hand, tendency of greenish of lagoon effluent is remarkable. This is due to the algae build-up as the poor removal of nitrogen and phosphorus effluent has been kept longer period with sufficient light under warm temperature. The countermeasure should only be existed to eliminate those causes.

(1)-3-1-6 Padilha Sul STP

- Capacity: 420 l/sec (36,288 m^3/day)
- Process: UASB + (un-aerated) Lagoon

・ Situation of Treatment:

Influent: Three units of submerged pump are installed. One unit is operated continuously. Fine screens are installed two units of mechanical and one unit of manual scrape. Efficiency of those mechanical screens were assumed low and the plan is going on to replace to other products. Grit chamber is installed one unit of circular one as those of other plants.

UASB: As the influent amount ranges about the design value with the operation of 6 units of UASB, odor is remarkably detected for whole plant site to meet the odor problem, hydrogen peroxide is added to the effluent of UASB. Scum build-up rate seems to exceed the removal rate and scum remains untreated and dried on the surface of UASB. Removed scum is conveyed to Belem sewage treatment plant and is treated by casting to influent sewage. Impression of effluent on the site was tolerable level.

LAGOON: Addition of Hydrogen Peroxide to the effluent of UASB is estimated high in improving odor emission from the lagoon Hereafter the plan is going on to install aerators to the lagoon to expect further improvement. The both lagoons are operated parallel. In the future, a pump system is planned to withdraw settled sludge from the lagoon. At present, Hydrogen Peroxide is dosed again to the effluent of lagoon.

(1)-3-1-7 Belem STP

・ Capacity: 840 l/sec (72,576 m^3/day)

・ Process: OD

・ Situation of Treatment:

Influent: The pump type is screw pump. One unit of 2,200 L/sec, two units of 1,100 L/sec are installed. The screw pumps receive favorable evaluation by the operators because of less trouble. Sewage after lifting pumps flows into a conduit to pass screens one by mechanical driven

then manual scraping and flows to a grit chamber.

OD: OD has 16 units of mechanical aerators and each reveals strong agitation. These aerators are operated by intervals controlled by MLDO, although all aerators are operated continuously because of overload situation at present. Operation is controlled around MLSS 5,000mg/L, MLDO 0.5 to 1.5mg/L. Monitoring instrument is not installed for MLDO. The value is measured in the laboratory. Thick layer of scum is floating over the channel of OD tank seemingly because of high concentration of MLSS. The scum buildup seemed to be brought by low efficient performance of the aerators which is apt to cause unnecessary turbulance of liquid surface and make fine bubbles which might to adhere the sludge One of the two sedimentation tanks were covered with scum built up the water surface. The main reason is because of over load operation to avoid discharge untreated wastewater which flows into the plant recently.




Sludge Dewatering Machine: Sludge dewatering is attained by three centrifugal dewatering machines. At the time of visit, dewatering has been stopped because of lack of space to store dewatered sludge which follows dewatering. On the other hand, water content of dewatered sludge is pretty high as a part of the dewatered sludge was remained.


Stockyard of Dewatered Sludge: The major characteristics of this plant should be on this large sludge holding yard. Recently roofing was being constructed to make drying to be stable as it should be called

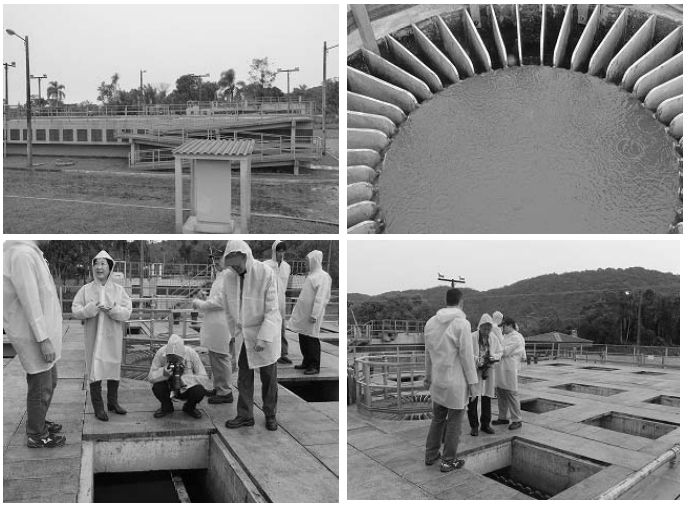
improvement work. However, occupying of so much space by sludge holding tank should be extraordinary as a sense of Japanese practice. Furthermore stop of dewatering process because of lack of holding space on such large plant might not be understandable from the sense of Japanese practice.

＜STP of coastal area＞

(1)-3-1-8 Guaraquecaba STP

- Capacity: 30 l/sec (2,592 m^3/day)
- Process: UASB + BAF(Biological Aerated Filter)
- Situation of Treatment:

Influent: Raw sewage is received by pressure sewer from a pumping station. Screen is of manual bar screen.



UASB: Plant capacity is said to be 30 L/sec. In those conditions, the retention time will be 9.3 hr. Effluent seemed clear when seen at the overflow notch. However at collective point the effluent showed much darker, which indicates sludge was eluted from somewhere else in the tank. No scum was observed.

BAF: Volume of BAF is (supposed to be) 64 m^3 as the dimensions are estimated to 4m×4m×4mH. The retention time is at present 1.5hr. Plastic scraps are used as contact media inside. No need of backwash. It started operation from May 2012. Covering net to prevent bubbles from blow away. Too much foam is built up and treatment level seems insufficient. Improper contact media may causes less efficiency of treatment. The volume of sedimentation tank is supposed 615 m^3,as the dimension is estimated to be 14m diameter by 4mH. Before starting operation of BAF, the sedimentation tank has been used for settling of solid from effluent of UASB.

Sludge drying bed: All the sludge is withdrawn from UASB and dewatered and dried in sludge drying bed. License for agricultural use is already obtained. However, agriculture here does not have need for such materials, and sludge has not been used so far. At present, possibility use as land filling soil is being considered.

(1)-3-1-9 Guaratuba STP

- Capacity: 210 l/sec (18,144 m^3/day)
- Process: UASB + (aerated) Lagoon
- Situation of Treatment:

Influent: Sewage is pumped up directly to the STP via 4 pumping stations from north, south, east and west directions. The sewer connection rate remains about 40% at present, the plan is going on to cover as much as 80% by developing sewer service area near the STP. Screen consists of two kinds; manual and mechanical

for each. The mechanical one has been stopped and been waiting for repair because it had damage from a timber stuck accident. Putrid sewer is received and mal odor becomes high around raw sewer receiving chamber especially at rain. The large volume of equalization tanks of upstream pumping stations and development of anaerobic reaction in the pressure sewers are

presumed as the causes. At summer sea bathing season, the amount of flow increases to large extent.

UASB: There are 3 UASB tanks. The retention time in winter is 16 hours, while 9 to 10 hours in summer which is high season for this coastal area. Production of methane gas is high (as 70% removal rate against influent). The piping system which was installed to break scum build-up has not revealed good from the beginning. Two UASB tanks are operated (daily alternated manner) except high peaks in summer. UASB as a whole was covered by PC plates, but odor is leaking from some openings and not so perfect On the other hand, scum build-up was not so remarkable. The reason for this is explained as practicing scum removal twice in a day is working for the elimination of scum although there might be other effect depending on influent sewage. i.e. longer holding time in sewer pipes might accelerate oil decomposition. On the other side, effluent of UASB has scarcely no evident of sludge overflow, the color was still blackish.

LAGOON: The lagoon is divided into 2 sections, upper part is aerated zone, and down part is un-aerated (settling) zone. Retention time of lagoon is 20 to 29 days in winter, 16 to 20 days in summer. Sludge has not withdrawn from the lagoon yet. At first, the lagoon had 15 units of aerators, but many of them being faced severe corrosive gas and broke down and only 4 units are surviving.

Foam is building up on the surface of lagoon. Algae are apt to grow after rain season and effluent becomes greenish.

Sludge drying bed: The sludge withdrawn from UASB is dried naturally on the sludge drying beds and mixed with lime and stored on the pile in the plant site. The plant start operation on 2004, but sludge has not carried out so far. In the original plan, sludge was concentrated in the thickener and dewatered by centrifugal machine. However, at the final stage, the plan was altered to present combination. The sludge is withdrawn once a month (once in three months for each unit of UASB).

(1)-3-1-10 Matinhos STP

- Capacity: 210 l/sec (18,144 m^3/day)

- Process: UASB + DAF（Dissolved air floatation）
- Situation of Treatment:

Influent: Raw sewage is received by pressure sewer from a pumping station. Screen if of two types; manual bar screen and mechanical one. Mechanical instruments have been wrong and settled grit has been removed by draining the chamber regularly.


UASB: Six units of UASB

DAF: Having three units of DAF as current treatment facility. However, operation of the facility practiced recently. Formerly, DAF facility has not been operated because the effluent quality has been well under the standard without DAF, and because it needs to manual-operate froth collectors (and watch for any trouble in collector mechanism). In coastal area where personnel are limited, the operation of DAF thus has been delayed. At present, another type of pump "Micro-bubble pump" is now on test operation. As the test result revealed good performance, a plan is now going on to promote introducing the same type of pump to all other plants in SANEPAR. Green part is of the "Micro-bubble pump" now testing. Principle is that an ejector is installed on the upstream side of the pump and air is aspirated into the water stream and given pressure and mixing by the pump impellers and pressured saturated water is conveyed to the holding tank. No need of air compressor and easier operation is the merit.





Sludge drying bed: More than 30days are needed to make sludge dry. At present, construction of additional drying bed is planned. Like other treatment plants, final disposal of sludge has not established yet. Sludge is stored inside the plant site. After operation of DAF is started, sludge treatment and disposal of DAF have to be needed. At present, temporary pipe is laid out to sludge drying bed and DAF sludge is dewatered and dried there. Increasing sludge disposal will possibly be the problem in future.


(1)-3-1-11 Morretes STP

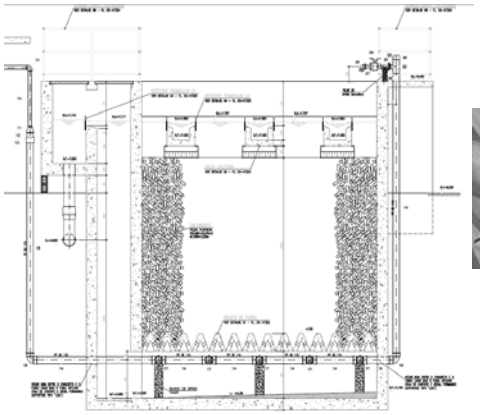
- Capacity: 35 l/sec (3,024 m^3/day)
- Process: UASB + BAF(Biological Aerated Filter)
- Situation of Treatment:

Influent: Raw sewage is received by pressure sewer from a pumping station. Influent sewage keeps low in concentration. The problem is thought to be of sewer pipes. The reason should be explained as such that the sewage collection system only covers 40% of water supply area but receives almost equal amount of sewage to the whole amount of the water supply already. BOD of influent in 2011 is mostly less than 100 mg/L. Screen if of two types; manual bar screen and mechanical one. Circular type of grit chamber with an air lift type sand lifter.

UASB: Volume of UASB is 1,000 m^3, retention time is 8 hours. All the designs including other facilities are same as those of Guaraquecabe. UASB proves no remarkable floating scum and no sludge flock overflow and maintains relatively preferable treatment. No odor noticed from UASB. On the other hand, when sampling sludge from UASB, extraordinary


thickened sludge (apparently 10% of solid concentration) was drawn from the bottom of the tank.

BAF: Volume of BAF is supposed to be 64 ㎥ as the dimensions are estimated to 4m×4m×4mH. Relatively large contact materials are accumulated 2.5m high. (Photo is of partially broken.)。Contrary to the general "Biological Aerated Filters" that usually has down-flow system, this type of filter adopts upflow type which should be considered unique. The volume of sedimentation tank is supposed 615 ㎥ as, the dimension is estimated to 14m diameter by 4mH. Retention time is estimated to 4.9hours. Short period of retention and with too large material for BAF, degree of how much aerobic bio-film treatment functions is not clear. The BAF started operation only 4 months ago.



Sludge drying bed: Centrifugal dewatering machine was originally designed in PARANASAN. But in practice, sludge drying bed is adopted. Sludge drawn from UASB is dried in the bed for 40 days, then mixed with lime and stored. Sludge from the sedimentation tank was designed to be discharged to UASB inlet. After the accumulation of floating sludge on the UASB became apparent, the sludge is conveyed to drying bed directly at present. Stored sludge has a license to be used for agriculture but no practice is made until now. (Just stored in the site now.) Until now, no stored sludge is exported to disposal site. At present, lack of sludge drying beds is apparent. Longer needs of period to dry sludge means longer sludge withdrawal intervals.

(1)-3-1-12 Pontal do Parana STP

- Capacity: 140 l/sec (12,100 m^3/day)
- Process: UASB + DAF（Dissolved air floatation）
- Situation of Treatment:

Influent: Influent sewage is directly pumped from collective pumping station (EEE09) to receiving conduit of sewage treatment plant. At the time of visit, sewage flowed small quantity as 20 liters per second (1,28 m^3/day) of the average and the concentration seemed very low. On the other hand, in summer season, when the amount of flow increases much as 140 litter per second (12,096 m^3/day), the concentration also increases. As for the screen, there is one mechanical unit and one manual one as those of other coastal area. Grit chamber is circular one as same as other coastal area. However, in this plant, the grit chamber is operated with stopped mechanical device of removing grit. So, dredging work has to be done every 30 to 40 days.


UASB: The plant has 4 units of UASB tanks, each has volume of 1000 m^3. For this case, the mean retention time for the design flow 140 litter per second (12,096 m^3/day) will be 7.9 hours, while at the present when 20 litter per second (1,728 m^3/day) will be long as 55.5 hours of light load. The operation of UASB under wet weather is pretty difficult to control as the sudden increase of flow produce overflow of sludge inside the UASB. So in some cases, the operation of bypassing UASB and directly introduce effluent of grit chamber to DAF is being done. Originally, UASB was covered by PC plate to hold odor gas inside. But after discovery of advancement of serious corrosion, PC plates have been removed totally. from the point of safety. For the inside the UASB tanks where anti-corrosion paint was practiced, the effect of anti-corrosion seemed remarkable. At the time of visit, operation was under low loading and so the time of fine quality of effluent.

DAF: While the plant started operation in 2008, DAF had not been operated fully until recently because of the problems of the necessary manpower and the operational knowledge. However at the present, operation of DAF is restricted within daytime while in nighttime DAF receive flow without adding pressurized water nor coagulant dosing. As for froth skimming device, automatic operation is not adopted and is operated manually in order to meet accidents if it may happen. DAF facilities on this plant do not seem to have any problems regarding pressurizing pumps nor froth collectors as those of other plants.


Sludge drying bed: At the time of visit, dried sludge had just removed from the sludge drying bed and sludge had just mixed with lime. As for sludge from DAF may be dewatered in the bag because of the operation hours remain small. As for the sludge disposal, the sludge had not ever transported outside and

no license is obtained yet for agriculture use.

(1)-3-1-13 Summary of problems for STP of CMA

From the above extracted problems (of total 60) by the baseline survey, further analysis was made as followings for CMA STP (7 STP, 40 problems) and for coastal area STP (5 STP, 20 problems).

Table 3.3-2 shows the number of problems found in each STP.

The table indicates CIC Xisto that suffers facility sink problem, damage in separators, and sludge accumulation in lagoon has exceedingly many problems. However number of visit there is most frequent because of water quality samplings while visit hours for Faz. Rio Grande and Padilha Sul was a limited one because of itinerary. So author would like to mention here that one cannot evaluate STP by those numbers of problems alone.

Table 3.3-2 Number of problems for each STP of CMA

Name of STP	Treatment Capacity	Process	Number of Problems
①Sao Jorge	70ℓ/sec(6048㎥/day)	UASB + DAF	5
②Santa Quiteria	450ℓ/sec(38,880㎥/day)	UASB + DAF	6
③CIC Xisto	490ℓ/sec(42336㎥/day)	UASB + (Unaerated) LAGOON	17
④Atuba Sul	1120ℓ/sec(96768㎥/day)	UASB + DAF	4
⑤Faz. Rio Grande	210ℓ/sec(18144㎥/day)	UASB + (Aerated) LAGOON	2
⑥Padilha Sul	420ℓ/sec(36288㎥/day)	UASB + (Unaerated) LAGOON	2
⑦Belem	840ℓ/sec(72576㎥/day)	OD	4

Next, problems were classified into categories as in the following figure. The result shows the maximum problem is related with "UASB", next with "Sludge Treatment and Disposal", "Lagoon", "Final Effluent" and "Odor" as it follows. At this point, "Lagoon" must be noticed to have so many problems in fact as it has long been thought as easy to operate so far.

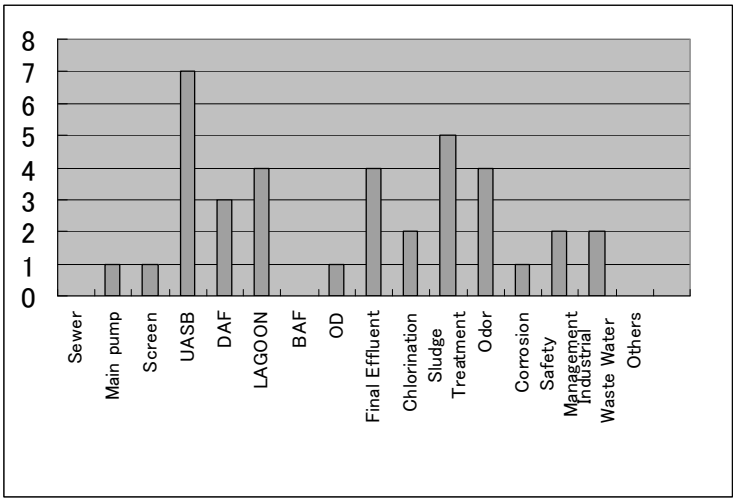


Fig. 3.3-1 Problems in categories for STP of CMA

(1)-3-1-14 Summary of problems for STP of coastal area

Table 3.3-3 shows the number of problems found in each STP.

The table shows Guaraquecaba, a small STP of remote area has largest amount of problems. Guaratuba and Morretes also have problems.

Table 3.3-3 Number of problems for each STP of coastal area

Name of STP	Treatment Capacity	Process	Number of Problems
⑧Guaraquecaba	30ℓ/sec(2592㎥/day)	UASB+BAF	8
⑨Guaratuba	210ℓ/sec(18144㎥/day)	UASB+LAGOON	4
⑩Matinhos	210ℓ/sec(18144㎥/day)	UASB+DAF	2
⑪Morretes	35ℓ/sec(3024㎥/day)	UASB+BAF	4
⑫Pontal do Parana	140ℓ/sec(12100㎥/day)	UASB+DAF	2

Next, problems were classified into categories as in the following fig. 3.3-2.

Most significant distinction in coastal area is that so many problems were found in "Influent Sewer". There contains "corrosibe tendency of influent" because sewage flows into STP via pressure sewer from pumping stations as well as garbage landfilling leachate and others.

Odor problems however, were not recognized at any sites. However, the tendency may be effected by the fact the visiting was made in off season.

It also should be notified that problem contains one that is apart from treatment plant itself such as "Others" category which includes lack of man power desposition problem at night time.

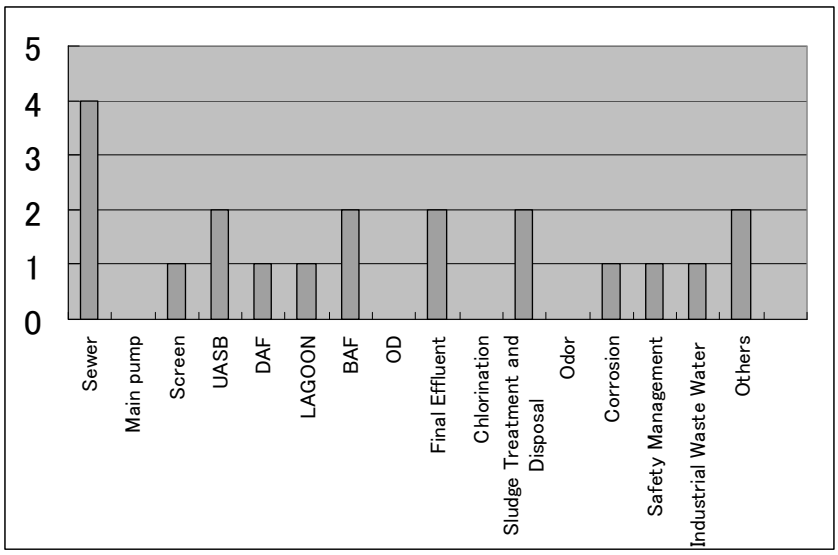


Fig. 3.3-2 Problems in categories for STP of coastal area

(1)-3-1-15 Classification of problems into the responsible sections

Those problems were again classified into the sections in SANEPAR that are thought to have responsibility and power to solve the problems. Fig. 3.3-3 shows the results.

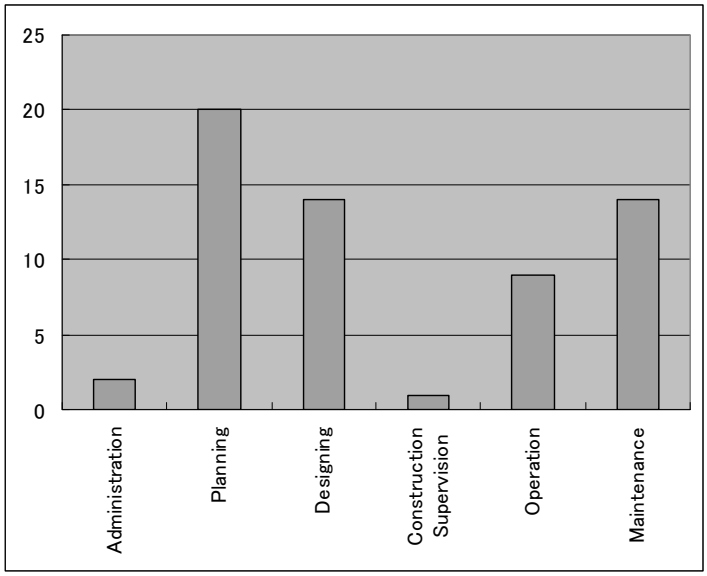


Fig. 3.3-3 Problems classified into the responsible section

In short, among the problems of STP, "Operation" is only responsible to solve 9 problems, while "Maintenance" responsible 14. That is remaining 37 problems should be solved by other section, such as 2 by "Administration" section, 20 by "Planning", 14 by "Designing", 1 by "Construction Supervision". It should be noted that efforts by sections other than O&M section is needed.

(1)-3-2 Evaluation of treatment performance of STP

Results of 24hours sample by using automatic sampler was shown in (1)-3-2-1 Results of detailed analysis, while past one year water quality analysis data recorded by SANEPAR was described in (1)-3-2-2 Statistical analysis of annual water quality data.

(1)-3-2-1 Results of detailed analysis

"Influent" and "Effluent" data for 7 STP where 24hour sample was analyzed were described shortly in the following Figure 3.3-4 to 3.3-8.

However, CIC Xisto of those data may not have proper sample as there was an accident of lifting pump at night that may have effected effluent quality and may not represent normal effluent.

BOD: As to BOD, many STP attains approximately 75% removal rate. For further removal was attained by Morretes which adopts "BAF" and Faz. Rio Grande "Aerated Lagoon". "Aerobic biological

treatment" shows far more efficient treatment performance than "DAF" nor "Un-aerated Lagoon".

COD: Removal ratio of COD is lower than BOD ranging lower than 75%. Lower value of 50% was found. In addition to Morretes and Faz. Rio Grande which are relatively good performance, "Un-aerated Lagoon" of Padilha Sul indicate preferable performance too.

SS: As for SS, removal ratio is mostly in the range of 75%. Those of Morretes and Faz. Rio Grande show higher values as the case of BOD removal.

T-N: As for nitrogen removal, removal rate remain almost zero. That is why nitrogen removal begins from biological oxidation of ammonia to nitric acid but existing process which includes "DAF" or "BAF" and "Aerated Lagoon" of little aeration time cannot afford to supply enough treating hours to accelerate those nitrifications.

T-P: As for phosphorus, except for some removal tendency for Faz. Rio Grande and Padilha Sul where lagoon is adopted, removal ratio seems insufficient too.

It should be noticed here that influent concentration of Padilha Sul is extremely higher than normal domestic sewage as T-N over 100mg/L, T-P over 10mg/L and it may be notified as some industrial wastewater is influencing the STP.

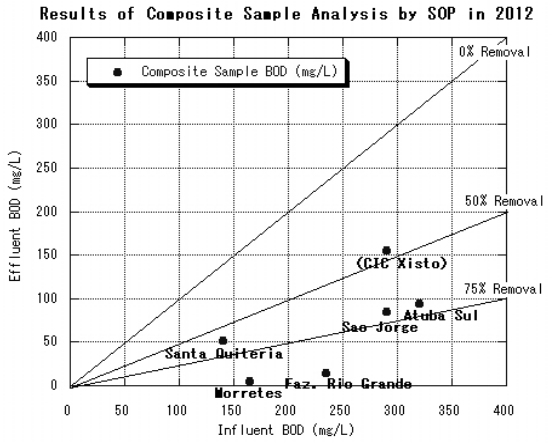


Fig. 3.3-4 BOD removal

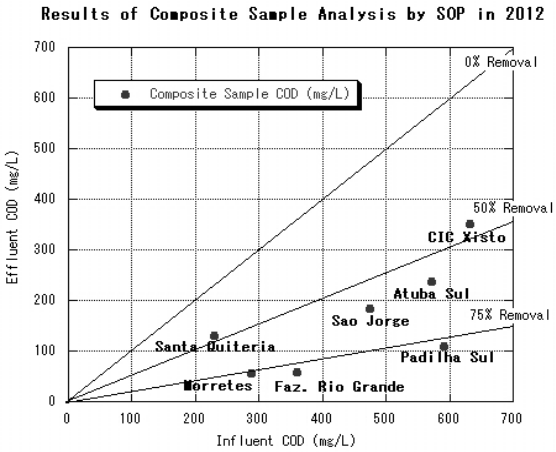


Fig. 3.3-5 COD removal

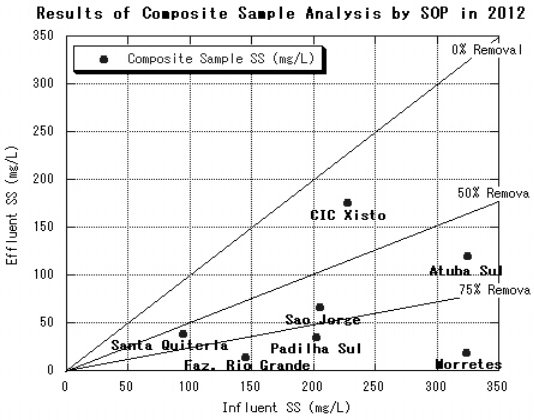


Fig. 3.3-6 SS removal

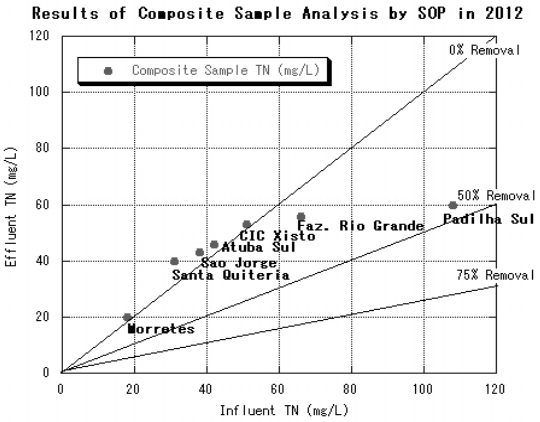


Fig. 3.3-7 T-N removal

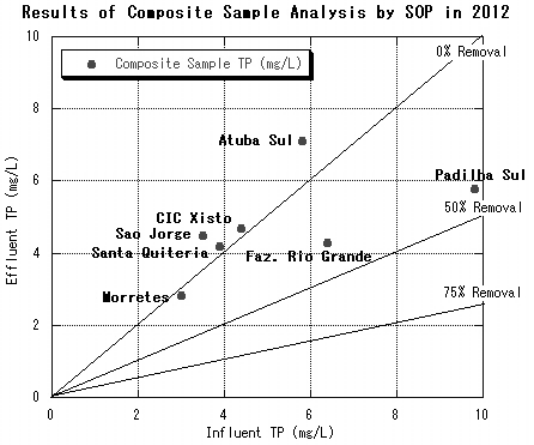


Fig. 3.3-8 T-P removal