EUROPEAN COMMISSION

FWC BENEF 2013 - Lot 2

Final Evaluation of the Bonaire Sewerage and Sanitation Project FED/2007/19113

Letter of Contract N. 2014/356542/1

Final Report

19/06/2015

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This project is funded by the European Union

This project is realised by ARS Progetti & PPM

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AWZI	Existing WWTP used treating sludge from septic tanks
BOD	Biochemical Oxygen Demand
BoQ	Bill of Quantities
C	Carbon
COD	Chemical oxygen demand
DNP	Defects Notification Period under FIDIC
DROB	Departement Ruimtelijke Ontwikkeling Bonaire / Department of Physical Planning & Management, Bonaire),
EUD	European Union Delegation
E.coli	Escherichia coli
EDF	European Development Fund
GCC	General Conditions of Contract
IenM	Netherlands Ministry of Infrastructure and Environment (Previously V&W and VROM)
IPC	Interim Payment Certificate
MOM	Minutes of Meeting
NA	Netherlands Antilles
O&M	Operation and Maintenance
OLB	Openbaar Lichaam Bonaire / Public Entity of Bonaire
PE	Population Equivalent or units per capita loading wastewater works
PCC	Particular Conditions of Contract
PRAG	Practical Guide to Contract procedures for EU external actions
Salina	Salt pan
SBR	Sequential Batch Reactor
SONA	Stichting Ontwikkeling Nederlandse Antillen / Foundation Development of Netherlands Antilles
TA	Technical Assistance
TOR	Terms of Reference
UV	Ultra Violet
(U)SONA	Uitvoeringsorganisatie SONA / Executing organization SONA
WEB	Water- en Energiebedrijf Bonaire / Water and Electricity Utility Bonaire
WWTP	Wastewater Treatment Plant

0. EXECUTIVE SUMMARY

The present document represents the Final Report of the final evaluation of the project '*Bonaire Sewerage and Sanitation'*.

The Final Report is in accordance with the Terms of Reference (ToR) of the **Final Evaluation of *the Bonaire Sewerage and Sanitation Project - FED/2007/19113.*** The contract corresponds to the Framework Contract n°2015-356542-1 for Lot 2 (Transport and Infrastructures). See Appendix A for the ToR.

The two experts of the Evaluation Team of the ARS Progetti Consortium have prepared the Final Report; Victor HRUSKA is the expert of ARS Progetti Company, whereas Jan SPIT is the expert of the company PPM. For the curricula vitae, see Appendix B.

The Evaluation Team started the assignment on 07.04.2015 with a Kick-off Meeting at the premises of EU Delegation (EUD) in Guyana and continued with visits to Curacao and Bonaire.

A kick of meeting on Curacao was organized on 8.04.2015 and 9.04.2015 with the participation of representatives of:

- USONA (Uitvoeringsorganisatie Stichting Ontwikkeling Nederlandse Antillen / Executing organization Foundation Development of Netherlands Antilles).

A kick of meeting on Bonaire was organized on 10.04.2015 with the participation of representatives of:

- USONA;
- The Beneficiary OLB (Openbaar Lichaam Bonaire / Public Entity of Bonaire); and
- WEB (Water- en Energiebedrijf Bonaire / Water and Electricity Utility Bonaire).

The evaluation team has visited the Wastewater Treatment Plant (WWTP) and the pumping stations in the sewerage network. Discussions have been taken place with the Supervisor Mr. Franklin Blom and many stakeholders, see list in Appendix C. In addition many sources and resources were consulted; see list in Appendix D.

An Inception Report was submitted on 13.04.2015. The EUD sent her comments on 14.04. 2015.

An intermediary Note was submitted to EUD on 21.04.2015. The EUD sent her comments on 24.04. 2015.

A de-briefing meeting has been held on 28.04.2015 in Bonaire and on 29.04.2015 on Curacao (with USONA).

The evaluation team has completed their mission in Bonaire on 27.04.15 (Mr. Hruska) and on 29.04.15. (Mr. Jan Spit).

The Draft Final Report was submitted to the EUD on 06.05.2015. The comments of the EUD were discussed by Skype on 10.06.2015 and were sent on 12.06. 2015.

Output and Outcome. The main expected results of the project are the implementation of a vacuum sewer system and a WWTP on Bonaire. By this it is expected to reduce the amount of Nitrogen discharged into the sea, thus safeguarding the coral reef and assuring the survival of the most important attraction for the tourists on Bonaire Island. The works started on October 16th, 2010 and on October 29th, 2012 the contractually defined 2 years and 13 days of implementation time had elapsed. The Supervisors Representative granted a time extension of 13 days.

Findings. The main findings are the following:

- Regarding the Works Contract for the sewerage network and the WWTP Bonaire, a Partial Provisional Acceptance was issued on June 30th, 2014 with about 20 months of delay. Part of Works of the WWTP are not included in the Partial Provisional Acceptance;
- The Beneficiary - guided by the Supervisor – started up the system, which has been operational since September 9th, 2014. The Water and Electricity Utility (Water- en Energiebedrijf Bonaire, WEB) is operating the system since then, although parts of the works have not passed the performance test yet. The WWTP is operating in manual mode only, while the de-nitrification, methanol dosing, filtration, Ultra Violet (UV) disinfection and irrigation system are not in operation;
- In November 2014 the Contractor MNO gave a 14 days notice to USONA claiming 'Termination by the Contractor' and left the site. USONA (the Delegatee Authority) initiated an amiable settlement procedure, which is not concluded yet;
- At present the financial aspects of the Works Contract are as follows:
    - Performances Guarantee over 10 % of the Contract value in place and valid;
    - Retention money (10 %) available;
    - Advance Payment returned completely;
    - Total amount of IPC (Interim Payment Certificate) approved and paid is around € 16 million;
    - Total value of certified works to date: € 19,277,371.03;
    - IPCs not paid: IPC 20 with a value of € 1,005,402 and IPC 21 with a value of € 225,246;
    - Works paid but not accepted: pressure pipe for irrigation - estimated amount € 1 million;
    - The total Works accepted and paid to date are estimated at € 15 million;
    - The financial progress of the contract to date: € 15 million/ € 19.6 million = 76.5 %.

Main findings evaluation. The main findings of the evaluation are:

- The proposed Works are relevant for the protection of the coral reef;
- The arrangements have been appropriate to the project;
- From the point of view of the effectiveness, the objectives are currently partially achieved. Important is to mention that the Works Contract is in a delay of 24 months and not yet complete;
- The factors, which have contributed to the present situation, are as follows:
    a. Poor performance of Works Contractor;
    b. Poor performance of Supervisor Representative;
    c. Relatively unknown and relatively complex system for the Bonaire conditions;
    d. Underestimation of the costs in the Feasibility Study;
    e. Overestimation of the wastewater flows and loads in the design of the WWTP;
    f. Reduced number of bidders in the works tender procedure;
- With respect to the quality of the financial project management by the Delegated Authority USONA, the evaluators are the opinion that the management has worked properly and the Contractor was not overpaid;
- With regard to non-financial aspects, the project management by the Delegated Authority USONA should have had a more active and a stronger position towards the poor performance of the Supervision Representative and especially towards the Works Contractor. It is also noted that the progress of the amiable settlement is very slow. The fact that the action needs careful analysis is obvious, but it has also to be considered that urgent measures are needed to complete the works;
- As complementary activities such as house/commercial connections have been implemented, other donors have had an important contribution to the implementation and operation of the project;
- Other donors have also contributed to the implementation of the project: Apart from the € 5 million share in the sewerage and WWTP costs, the Dutch Government provided € 10 million for the necessary house/hotel connections on private premises as defined in the Special Conditions to the Financing Agreement. The Netherlands Ministry of Infrastructure and the Environment (IenM, formally the ministries of Verkeer en Waterstaat en VROM) finances the house/hotel

connections in Phase 2 of the ongoing connection project. IenM has also committed itself to finance operation and maintenance (O&M) as long as the fees collected from house/hotel connections and sales of irrigation water are insufficient to cover O&M;

- The sustainability is assured by the following:
  a. The legal frame for operating the system is in place. All households and commercial enterprises are obliged to connect to the sewer system, although law enforcement by OLB is a point of attention;
  b. The Dutch Government has assured topping up of finances to guarantee operation and maintenance in the future: on the long run people on Bonaire are to pay a fee that is comparable to the fee paid in The Netherlands and the difference is paid by the Kingdom of The Netherlands (IenM);
  c. An important issue is the completion of the works for house/hotel connections and to assure a more substantial flow and organic load to the WWTP;
  d. The WEB operates the energy and water supply on Bonaire efficiently and therefore the operation of the WWTP and the sewer system should not create special difficulties. Due to the specifics of the wastewater treatment and the sewerage system, WEB has to assure skilled personnel like a process engineer for the WWTP and mechanical staff for the operation and maintenance of the sewer system. A point of attention is that WEB needs to increase its technical capacity with additional staff and should enhance the professional capacity of the available staff by training and change of experience with similar WWTP.

Conclusions. As far as the current project Sewerage and Sanitation Project is concerned the conclusions are:

a. The system is not completed and not fully operational yet. It is also under utilized as some parts were over designed. This leads to underperformance, especially when it concerns the operation of the WWTP;
b. The project has made an excellent start in achieving the objective of protecting the coral reefs from Nitrate pollution. However, Nitrate from sewage is only one of many sources. Hence, the current solution is only part of the beginning.

As far as conclusions are concerned that contain transferable lessens for future similar projects, the evaluators refer to the major factors for only partially achieving the project objectives that are identified being: Relatively unknown and relatively complex system; Underestimate of the costs in the feasibility study; Overestimation wastewater flows; Reduced number of bidders; Poor performance of supervisor representative; and Poor performance of works contractor.

When clustering these factors, the evaluators come to the following main 3 conclusions:

c. The project was technology driven and could have been better prepared. Signals from parties that were questioning the choices made, seem to have been neglected;
d. The choice amongst the bidders for the project was restricted to only two, who did not really have experience with the technology at hand, which caused a lot of problems;
e. The execution of the works and the initial supervision leave a lot to be desired. Only when it was too late, parties were selected that had both the expertise and skills to work in the region.

Recommendations. As far as the current project Sewerage and Sanitation Project is concerned the recommendations are:

a. Target group: *OLB/Public Entity Bonaire, WEB, USONA, EU and the Ministry of IenM in The Netherlands*. The evaluators recommend undertaking everything that is possible to complete and operationalize the system. In terms of completion:
   - Add as many connections as possible and include grease traps in new connections;

- Install grease traps[1] at house connections, repair leaking vacuum pipes and optimise pumping stations, refurbish vacuum shafts in such a way that there is no storm water entering the vacuum sewers. In addition, order enough spare parts to be able to repair any broken parts on time;
- Complete and optimise the WWTP:
    - In order to do this, it is indispensable to *investigate the cause of the small flow*. The evaluators recommend to WEB combining the database of water sales with the database of sewer connections. In this way it can easily be found out how much drinking water is used and how much ends up in the WWTP. If there appears to be a large discrepancy, it is recommended to investigate the causes: are people using the excess water for irrigation at home or are there on-site systems that are not connected to the vacuum system? It is clear that the design parameters used in the project are not valid, but it is not clear which parameters: occupancy rate hotels? Number of persons in a household? Per capita water use hotels and households? % Water used for irrigation at home? Or … is the system leaking? Or… have people closed the valves to the system? Once the cause is found, initiate actions to maximize the flow;
    - Repair the defects and shortcomings at the WWTP;
    - Investigate the best way for adding a carbon source for denitrification. Once the methanol dosing is in operation, this could be a significant extra operational cost. The evaluators recommend to investigate other, less costly, methods;
    - Install a new irrigation line and start distributing irrigation water so that the hotels can harvest the fruits of the project and so that income can be generated to cover part of the O&M costs[2];

b. Target group *OLB/Public Entity of Bonaire*:
- Monitor the effects of the project on the quality of the groundwater by sampling twice a year (dry season and wet season) from the 32 installed groundwater 'stations'. The evaluators recommend to find funds (around € 10,000 per year for two rounds) and recommence the sampling so that there is an objective method to assess the effects of the project;
- Continue to support monitoring of the effects of the project on the quality of the coral reef by Stinapa, IMARES/WUR, etc.;
- Take all other actions needed to harvest the benefits of the investment by eliminating as many Nitrogen sources as possible. The evaluators recommend to improve solid waste management, prevent the discharge of untreated storm water runoff into the ocean, upgrade cesspools to septic tank systems, seal all septic tanks and install post treatment of the septic tank effluent, ban the import, sale and use of chemical fertilizers, reduce the influx of excrements of goats and donkeys into the ocean etc. etc.

As far as transferable lessens for future similar projects are concerned the recommendations are as follows:

c. Target group: *staff that prepares Terms of References for studies in the Caribbean:* The situation on small islands as Bonaire demands a careful approach: the environment is delicate, the community is rather small and income levels are relatively low. Interventions from outside can have other effects than anticipated. Hence, the evaluators recommend for the future that a process be assured where the consultants that are hired incorporate non-technological aspects and are open to inputs from all stakeholders involved. As far as future wastewater projects are concerned in areas where there are no systems yet, it is recommended to design solutions that are capable of coping with many uncertainties and unknowns: quality and quantity of domestic and non-domestic wastewater, urban growth, spatial planning, economic

[1] According to the supervisor, Mr. Franklin Blom, the material that causes problems in the pump sump of the booster station is not grease but protein that got this 'foamy' structure due the venturi effect of the 'lyre' at the booster station. According to OLB the local businesses that do not have grease traps have their used oils collected for bio diesel production in The Netherlands. The evaluators, we not in the position to verify this, but are the opinion that a grease trap is a 'must' for any sewerage system.

[2] It is not unclear how the irrigation system will operate (according to the Supervisor Mr. Blom the system is supply based and not demand based – source: debriefing on 28 April 2015). According to the evaluators it would be good to reassess the system for instance by considering decentralized storages. However, such a move, at this moment might jeopardize the outcome of the dispute with the contractor.

development, local skills and experiences etc. In short, the process needs to be designed in such a way that it is appropriate to the local conditions;

d. Target group: *USONA and WEB*. When supervisors are hired to assess the quality of the work of the contractors, assure that they are active in the field and do not accept work that is not up to the quality that is required. Assure that the supervisor is familiar with the way of working and the attitude on Bonaire[3].

[3] According to USONA: when tendering for supervisory services, the CV's of personnel proposed are the most determining factor for the selection of a particular party. In this practice, temporary employment agencies such as Hydroplan (with little or no backstopping capacity) often score better than renown engineering consultancy firms (with backstopping capacity) . When following this line of thought, it would be recommendable to change the ranking procedure in such a way that engineering firms with backstopping capacity are favoured (Source: discussion during debriefing with Mr. Thielemans, 29 April 2015).

1. INTRODUCTION

1.1. GENERAL

The '*Bonaire Sewerage and Sanitation Project*' has as overall objective to safeguard Bonaire's marine environment (coral reefs) thereby sustaining the island's economic base. The main results of the project are the implementation of a sewer network using vacuum technology and the construction of a Wastewater treatment Plant (WWTP), using Sequential Batch Reactor (SBR) technology. The total cost of the project was estimated at € 23,846,668.12. The Commission committed itself to finance a maximum of € 19,062,021.18 (79.9 % of the total project cost estimate). The project is co-funded by the Dutch Ministry of Infrastructure & Environment (IenM, formally V&W and VROM) (€ 5 million).

The Delegation Agreement, by which the European Commission delegated the authority of implementing the 9th EDF Program to the EU member state body SONA (Stichting Ontwikkeling Nederlandse Antillen / Foundation Development of Netherlands Antilles), was signed on December 22nd, 2008 and ended on December 31st, 2014.

The Delegation Agreement installed a system of indirect centralized management, by which the Commission delegates its budget implementing powers to a Delegatee (Delegated Authority) to implement the project. The Delegatee, SONA, is responsible for carrying out the tasks relating to the implementation of the actions described in Annex I of the Delegation Agreement. SONA entrusted the work to its implementing organization USONA (Uitvoeringsorganisatie SONA / Executing Organization SONA).

The Financing Agreement of this project was signed with the Territorial Authorizing Officer of the (former) Netherlands Antilles in May 2008.

The budget of the project is shown below.

Bonaire Sewerage & Sanitation **Budget lines Financing Agreement 9th EDF**	**TOTAL BUDGET LINE EU** **€**	**TOTAL BUDGET LINE NL** **€**
Works	16,700,000	3,000,000
Services including Supervision and TA	2,100,000	0
Auditing	150,000	0
Monitoring and Evaluation	250,000	0
Contingencies	406,231	2,000,000
Total	**19,606,231**	**5,000,000**

Table 1 Budget of the program

For the budget from the Netherlands, SONA has the similar management function as for the EU funding.

The works contract tender between USONA and the Contractor was signed on September 16th, 2010. The summary of the major milestones of the project is as follows:

- Date of commencement: October 16th 2010;
- Initial date of completion: October 16th 2012;
- Date of completion per GC 35.3 Works Contract: October 29th 2012;
- Initial completion of the Contract: October 15th 2013;
- Maintenance Period 12 months;
- Modified date of completion: June 30th 2014;

- Modified completion of Contract: June 29th 2015.

The services contract for supervision was awarded to Hydroplan GmbH on October 29th, 2009 for an initial contract amount of € 1,295,700. Final contract amount: € 2,086,630.09
The Beneficiary (now Public Entity Bonaire / Openbaar Lichaam of Bonaire) has chosen the following participants:

- The Supervisor is TNO, represented by Mr. Michael Franklin Blom;
- The Operator is WEB (Water- en Energiebedrijf Bonaire / Water and Energy Utility Bonaire).

The present document represents the Final Report of the final evaluation of the project '*Bonaire Sewerage and Sanitation'*. An Inception Report was submitted to EUD on 13.04.2015 while an Intermediary Note was submitted on 21.04.2015.

The Final Report is prepared using the provisions of the ToR (Appendix A) and is structured as follows:

- Executive summary (Chapter 0);
- Introduction (Chapter 1);
- Evaluation questions and responses (Chapter 2);
- Overall assessment (Chapter 3);
- Conclusions and Recommendations (Chapter 4).

1.2. EVALUATION PURPOSE AND PROCESS

Evaluation purpose. The global purpose of this evaluation is to provide the relevant external co-operation services of the European Union, the partner government and, when appropriate, the wider public with:

- An overall independent assessment of the past performance of the Bonaire Sewerage and Sanitation project, paying particularly attention to the results of the project against its objectives;
- Key lessons and recommendations in order to improve current and future actions of similar character.

Evaluation process. The evaluators have followed a straightforward process:

- Preparation in the home country by studying the ToR, collecting information from the internet, newspapers, books, etc.;
- Kick-off meeting with the EUD to collect information available at the EUD and gain insight into the 'question behind the question';
- Kick-off meeting with USONA, to collect more information and reports, get insight in their view on the developments and deep discussions in order to understand the complex situation at hand;
- Kick-off meeting with all stakeholders on Bonaire, mainly to introduce the evaluators and make appointments;
- Studying and discussing the information obtained and requesting and receiving additional information;
- Intensive field visits to the project area, the vacuum system, the pumping stations, the WWTP and the AWZI;
- Discussions with direct and indirect stakeholders (see list in Appendix C);
- Reporting and discussing the intermediate findings at briefing sessions (WEB on 24 April in presence WEB, stakeholders and EU at USONA office on 28 April, USONA on 29 April);
- Report writing and incorporating feedback on draft reports.

Hence, the evaluators have considered and included the views of SONA, USONA, TAO office, OLB, WEB and important stakeholders like Stinapa. Where relevant their views have been explicitly mentioned.

1.3. EXPECTED RESULTS

Despite the fact that Bonaire has recognized its marine environment as a natural resource and has taken measures towards its protection, the quality of the coral reefs around Bonaire is declining, a trend which was observable throughout the last decade. Live coral cover has decreased and algae growth has increased. Recent scientific investigations indicate that one of the main contributory factors to the decline of the reef is

wastewater infiltration from residential properties and hotels. Other factors are climate change/ increase of seawater temperature that leads to coral bleaching, runoff from storm water, brine from salt works, etc. To limit the wastewater infiltration, it was decided to connect the houses and hotels to a vacuum sewer system, which conveys the wastewater to a treatment facility. The facility is to reduce the pollutants, especially Nitrogen, which contributes to the increase of algae in the coastal area. As water is scarce on Bonaire, the treated water (with a limited content of Nitrogen) is to be used for irrigation of the hotel premises. As the treated effluent should have a Nitrogen content of less than 5 mg/l N, use of this water for irrigation in the sensitive zone along the coast is expected to be without risk to the coral reef. The layout of the system is presented in Figure 1 and Figure 2 and Appendix G.

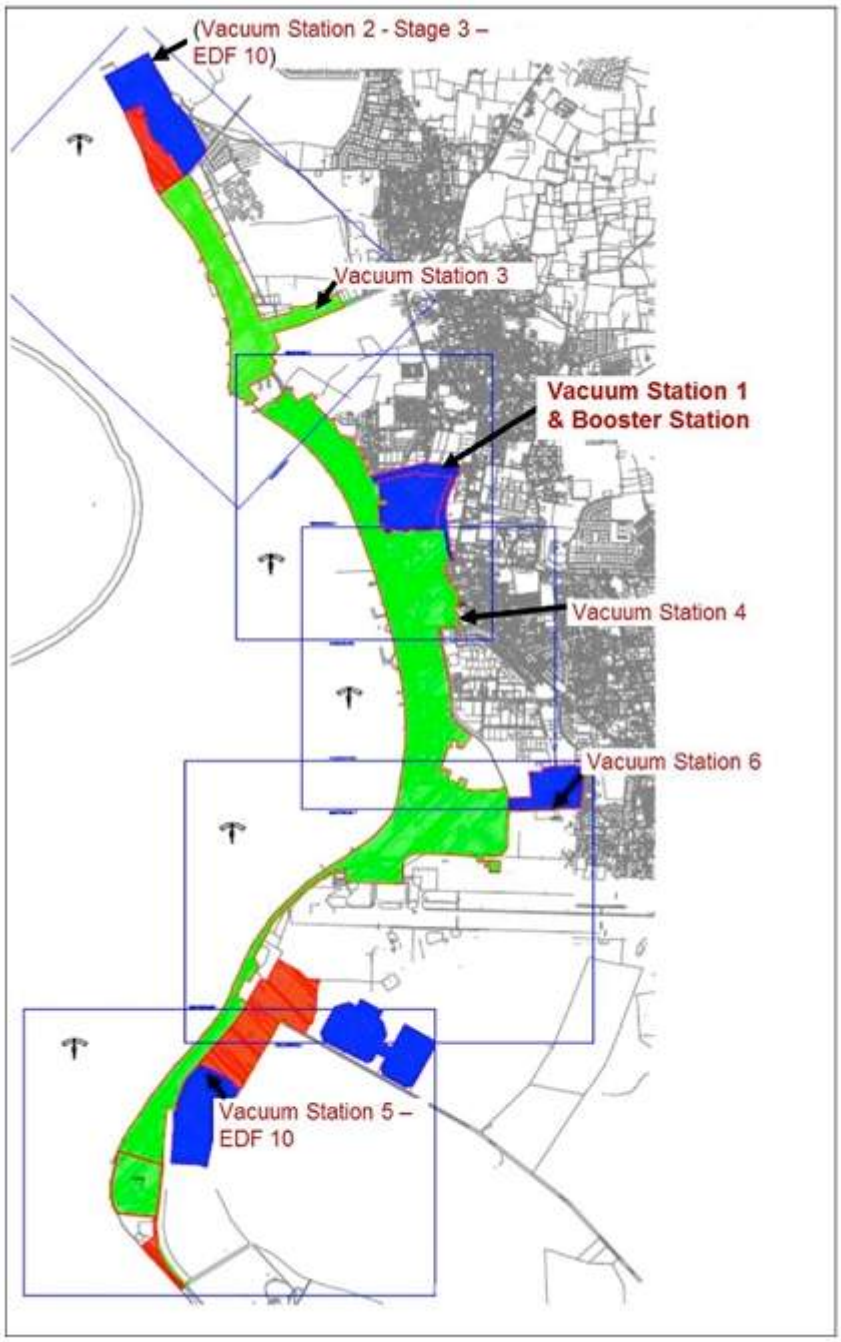

Figure 1 Areas to be connected (Source: Hydroplan)

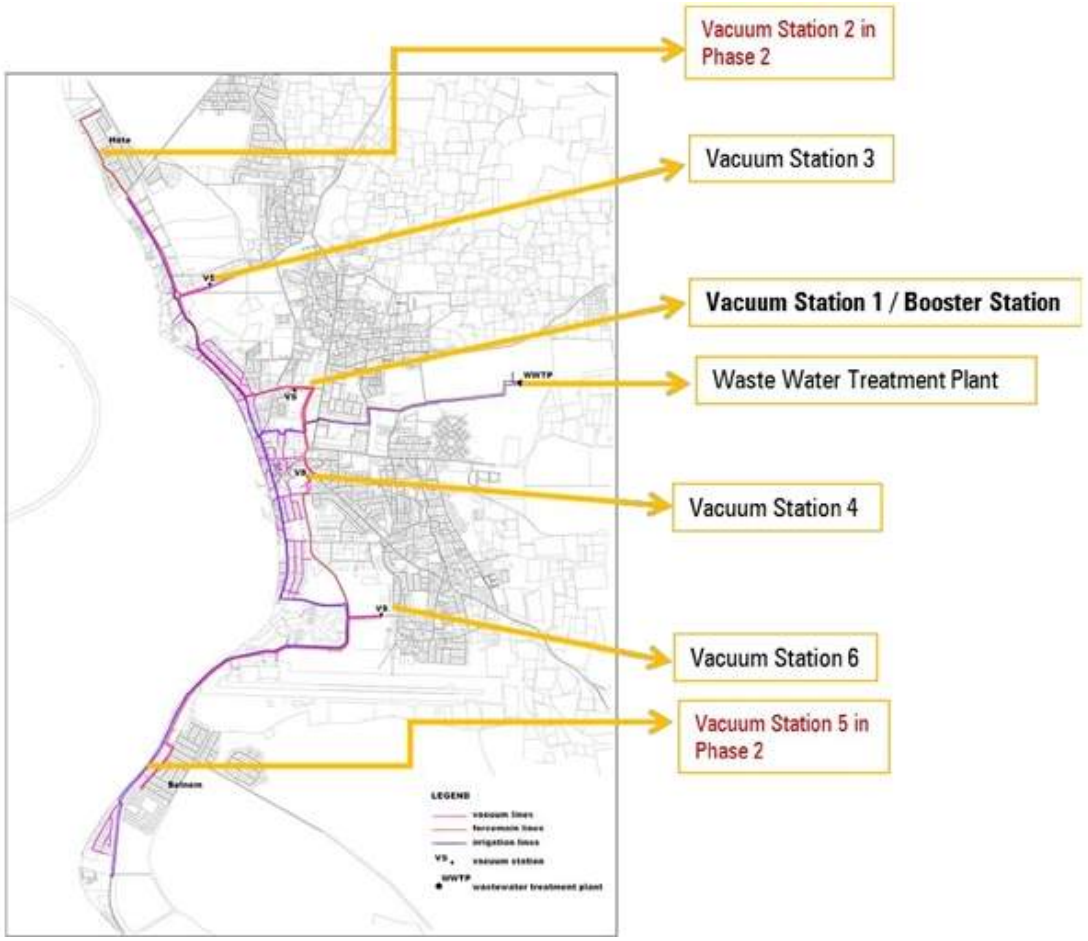

Figure 2: Overview network and components (Source: Hydroplan)

The project has financed the implementation of a sewer system using vacuum technology and the construction of a wastewater treatment plant on Bonaire using the SBR technology. As a complementary measure, house connections from 818 private houses and connections of 78 commercial units have been financed. As not all valves to the system have been opened yet, at the moment, wastewater from 801 private connections and 63 commercial units is treated in the wastewater treatment plant.

At the moment (April 2015), the foreseen outcomes have been achieved partly, as the collecting system, the wastewater treatment plant and the irrigation system are not complete and not fully operational.

Due to the fact that the system is not yet fully completed and fully operational, the 'final' assessment of the indicators cannot be made at this stage. For the current assessment, see the following table.

Indicator	Assessment
Overall objective: Significant slowdown / stabilization of coral reef deterioration.	Unknown, too early to judge.
Project purpose:	
Health indicators.	Unknown, too early to judge.
Achievement budget.	Unknown, depends on amiable settlement with contractor.
Comparison WEB data with similar wastewater operations – use of benchmarking.	A comparison at this stage it is not possible because the WWTP is not operating long enough to generate reliable data.
Result indicators:	
Sewer system and wastewater treatment plant constructed.	99% constructed but not fully operational yet.
Vacuum network and pump stations constructed.	100% constructed and operational, yet with defects.
Storm water system constructed.	Not constructed due to cost reductions.
Establishment of community services groups that participate actively in planning and implementation of the programme.	None as far as we know.
The actual flow on daily basis treated against the design capacity (500 m^3/d).	Less than 80% of design flow;
Number of times to exceed effluent quality standard.	The WWTP is not fully operational and Performance tests have not been performed.
Number of employees per unit of effluent produced.	Too early to define at this stage.
Number of employees per km pipe of the total network.	Unknown.
Costs per m^3 treated wastewater versus calculated costs.	Unknown as the project is not finished yet, as claims of the contractor are to be expected and as O&M costs are not known exactly.
Result activator activities: costs € 19.6 million and € 5 million co-financing.	Unknown as the project is not finished yet and claims are to be expected.

Table 2 Indicators update

1.4. ACKNOWLEDGMENTS

The authors would like to acknowledge the assistance and kind support provided by:

EUD

- Cristobal Delgado-Matas, Operations Manager Dutch Overseas Countries and Territories Delegation of the EU to Guyana, Suriname, Trinidad and Tobago, and for the Dutch Overseas Countries and Territories (EEAS-GEORGETOWN)
- Rajesh Majeed, Programme Officer Delegation of the EU to Guyana, Suriname, Trinidad and Tobago, and for the Dutch Overseas Countries and Territories (EEAS-GEORGETOWN)

USONA

- Drs. Reginaldo Doran - director
- Jeroen Thielemans - Deputy director
- Paula Sijbranda - Secretary
- Dr.ir. Marinus A. Pool - Project Advisor 9th EDF

OLB / Bonaire Public Entity of Bonaire

- Drs. F.A.V. Tiemessen - Financial Officer
- Marco Gravenhorst - Legislation and projects

Supervisor

- Franklin Blom

Water and Energy Bonaire

- Alfredo Koolman CEO
- Hans Staring- Coordinator
- All other staff that showed the evaluators around

2. ANSWERED QUESTIONS / FINDINGS

2.1. RELEVANCE

2.1.1. Question regarding project relevance

What is the (expected) influence of the project on the condition of the coral reef?

2.1.2. Answer to question regarding project relevance

As the evaluators are not coral reef experts, they consulted the biologist of the Stinapa[4] and consulted monitoring reports on the Stinapa Internet site. From this, the evaluators learn that Bonaire has a long tradition of monitoring the quality of the coral reefs. Compared to other islands in the region, the coral reef is in relatively good condition. However, there is definitely a negative impact from the leaching of untreated/partially treated wastewater into the sea. At southern and urban locations (Kralendijk), threshold levels of Nitrogen are exceeded. Chlorophyll-a shows an increase in time and Phosphorus seems to show a similar trend. These eutrophication indicators are likely to exceed threshold levels in near future if the observed trend continues[5]. Figure 3 shows the results of monitoring by the Institute for Marine Resources & Ecosystem Studies (IMARES).

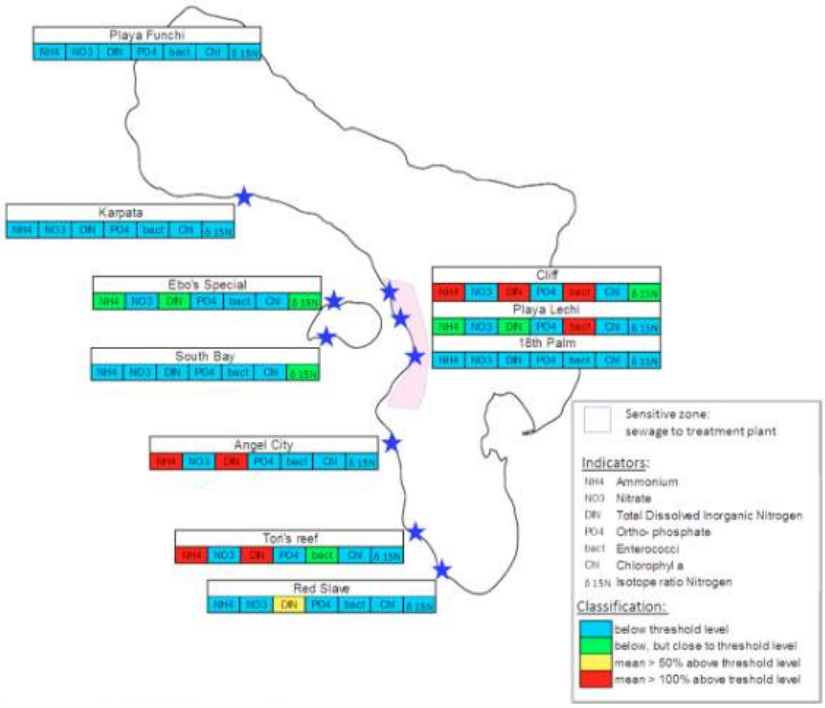

Figure 3: Results field monitoring 2011-2013

(Source: Water quality of the coastal zone of Bonaire, from Stinapa site accessed 25 April 2015).

Another indication is the comparison with Curacao: in Curacao the marine park is far from urban areas and urban pollution and the marine park in Curacao is in a better shape than the corals near Kralendijk[6].

[4] Paulo Roberto Bertuol, STINAPA Bonaire, Wildlife Biologist, Natural and Historic Resources Unit Barkadera, z/n PO Box 368 Kralendijk, Bonaire, Dutch Caribbean (on 20 April, 2014) and http://www.stinapa.org accessed 20 April 2015

[5] Source: A baseline water quality assessment of the coastal reefs of Bonaire, Southern Caribbean by Diana M.E. Slijkerman , Ramón de León, Pepijn de Vries in Marine Pollution Bulletin, 2014

[6] Source: Paulo Roberto Bertuol, STINAPA Bonaire, Wildlife Biologist interview on 20 April 2015, no quantitative and qualitative data available.

The evaluators also consulted experts from the IMARES / Wageningen University (WUR) in The Netherlands. On the request of the Ministry of Infrastructure and Environment, IMARES has been trying to measure the effect of sewage on the concentration of nutrients in the seawater during 3 years. WUR failed to do so, but admits that it is extremely difficult to measure these, as concentrations are 1000 times lower than in the Netherlands. Nutrients that are available are almost immediately taken up by plankton and disappear. The result is that the water becomes turbid. Next to large hotels with a poor sewage management such as the Plaza, this turbidity can be observed clearly. At the moment IMARES/WUR is measuring the effects of the land runoff on the coral reef. They observe that at certain depths, fields of blue algae are found and these fields appear to be denser close to Kralendijk then further away[7]. See picture below and you-tube: https://www.youtube.com/watch?v=YElUmwd84fA&feature=youtu.be

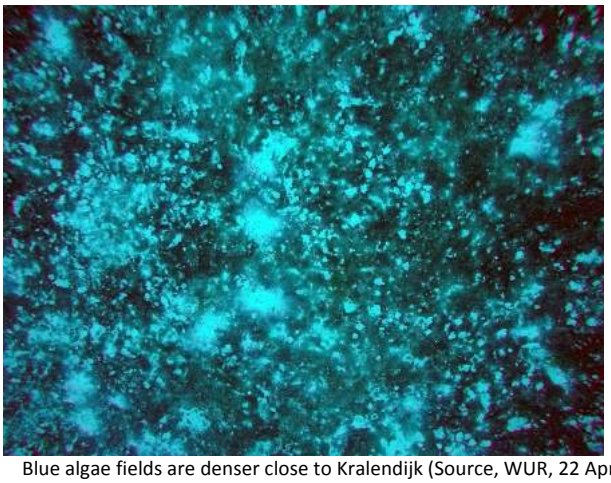

Figure 4: Blue algae fields are denser close to Kralendijk (Source, WUR, 22 April 2015)

OLB IenM have started monitoring groundwater at 32 stations around the west coast. See § 2.6 on this monitoring.

It must be noted that there are many other factors that influence the quality of the coral in a negative way: the southern locations shown in Figure 1 are probably affected by the salt pans (IMARES monitoring report, 2014).

2.1.3. Conclusion and recommendation regarding project relevance

Conclusion. According to the specialists of Stinapa and IMARES it is clear that if and when the project is successful in stopping the pollution associated with leaching of untreated wastewater, this will have a positive influence on the condition of the coral reef. Scientifically it is difficult to measure the effects on the nutrient concentration in the seawater as nutrients are almost immediately taken up by plankton and disappears. The results of project will be visible only in time after a few years. For the time being it can be only stated that the project reduces the discharge of nitrogen into the sea. See section § 2.4 (Effectiveness) for a quantitative analysis.

Recommendation. The evaluators recommend to *Stinapa and IenM* to continue the research on the quality of the reef so that the influence of the project can be measured. The same accounts for the *Public Entity of Bonaire*: it is recommended to restart the measuring of groundwater quality in the stations. As eutrophication is not the only pressure potentially affecting the reef, besides the focus on the research related to the treatment plant it is advised to consider additional research on a 'whole ecosystem basis' in which the contribution of other pressures as well are included, such as run off via canals and overflows of salinas (salt pans) with nutrients and sediments (in rainy season), fisheries impact and the impact of climate change/acidification on the reef.

[7] Dr. Erik Meesters, Researcher, Ecologist, Marine tropical ecology, IMARES Wageningen UR (on 21 April, 2015)

2.2. COMPLEMENTARITY

2.2.1. Question complementarity

To what extent are SONA & USONA activities in the field coherent and not in duplicate or in conflict with activities financed by the project?

2.2.2. Answer to question regarding complementarity

Besides the activities based on the Delegation Agreement, SONA has managed the development funds on behalf of the Netherlands government, before and concurrent with the Delegation Agreement. In addition, SONA & USONA activities in the field have been related to the implementation of the contracts for house and hotel connections (EDF 10, € 5 million[8]) and obtained € 10 million from IenM for sewerage connections.

2.2.3. Conclusions and recommendations regarding complementarity

Conclusion. The implementation of house- and hotel-connections represents an absolute must and is a coherent contribution to the project activities. In fact, without sewerage connections the project cannot function and would not service any purpose. The activities of the Beneficiary as well as those of SONA and USONA are therefore coherent; there is no conflict with or duplication of activities financed by the project.

Recommendation. To *EUD* it is recommended to continue with complementary activities such as the cooperation with SONA and USONA as it increases the project scope.

2.3. APPROPRIATENESS

2.3.1. Question Appropriateness / implementation arrangements

What implementation arrangements are made? What are each other roles / responsibilities?

2.3.2. Answers to question regarding appropriateness / implementation arrangements

2.3.2.1. The Delegation Agreement

The Delegation Agreement, by which the European Commission delegated the authority of implementing the 9th EDF Programme to the EU member state body SONA, was signed on December 22nd, 2008 and ended on December 31st, 2014. The Delegation Agreement installed a system of indirect centralised management, by which the Commission delegates its budget implementing powers to a Delegatee to implement the project. The Delegatee is responsible for carrying out the tasks relating to the implementation of the actions described in Annex I of the Delegation Agreement. In performing the tasks entrusted to SONA, the implementing organisation USONA was made responsible for the overall administration and management of the activities, and carried out activities to the effect of concluding contracts for procurement, the signing of agreements, managing the agreements and making the appropriate payments. The SONA board, acting as an oversight body to guarantee that the implementation complied with the standards of the Delegation Agreement and SONA, supervised the activities of its implementing organisation USONA.

Based on its feasibility study, Dorsch prepared the Tender Documents for the Bonaire Sewerage and Sanitation System. After approval of these tender documents by both the European Commission and the Beneficiary, the Commission delegated to SONA the implementation of the project. The project was downsized after an unsuccessful international tender in 2009 to generate a budget feasible project. A negotiated procedure resulted in a Works Contract, which was signed in September 2010 with MNO Vervat International B.V. for the contract price of € 19,670,700 (excl. € 1,035,300 contingencies). The delay in the commencement of the works due to the total process of procurement was more than one year.

[8] Source: MoM Steering Committee Meeting 2009

The works started on October 16th, 2010 and on October 9th, 2012 the contractually defined 2 years and 13 days of implementation time had elapsed. At the end of December 2013, the overall physical progress of the works was around 99%, but testing and documentation was not ready by that date. Partial Provisional Acceptance was issued on June 30th, 2014. The main testing took place during 2014 and has still not been finalised with regard to the WWTP. During 2014, the Contractor carried out many repairs and, since no full provisional acceptance was issued, refused to assist the Beneficiary with the starting-up of the system. The Beneficiary, with guidance from the Supervisor's Representative, started up the system itself, which has been operational since September 9th, 2014.

The Delegation Agreement was not extended after 31.12.2014, but from the discussions held with USONA's representatives the evaluators understand that USONA will continue to be involved in the contractual issues still open with the Contractor.

The first important step is finalization of the amiable settlement and finalization of the works. In Appendix J we have reproduced the e-mail of USONA on the amiable settlement.

USONA's financial activities have been audited adequately.

2.3.2.2. The Financing Agreement

On May 8th, 2008, the Financing Agreement between the Commission and the (former) Netherlands Antilles was signed, ending December 31st, 2014. The delays in the performance of the Contractor forced the Island Authorities of Bonaire to request the Commission for an extension of the operational implementation phase of the Financing Agreement. This request was submitted on June 15th, 2012 and on November 27th, 2012 the Commission reacted positively. Rider 2 to the Financing Agreement defines a one-year extension of the operational implementation phase, ending December 31st, 2013. The period of execution of the Financing Agreement remained fixed to end on December 31st, 2014.

Further delays in performance of the Contractor forced the Bonaire Administration (TAO) to request (on November 1st, 2013) another extension of the period of execution of the Financing Agreement and the operational implementation phase. The Commission reacted positively and the period of execution of the Financing Agreement was extended to June 30th, 2015. The duration of the operational implementation phase was extended to June 30th, 2014. The one-year closure phase runs from June 30th, 2014 to June 30th, 2015. The Special Conditions in the Financing Agreement stipulate that the Beneficiary must commit itself to the set up an operating sewerage unit as a legal entity and to implement a tariff system to guarantee the necessary operational budget. As the fulfilment of the latter commitment needs time, the Dutch Government guarantees the funds for the first year(s) of operations and maintenance. Another important condition concerns the preparation of WEB, the management and operational organisation, for their task of operation and maintenance of the wastewater collection and treatment facilities. This activity was first put on hold during 2010 in view of the change of the constitutional status of Bonaire, which implicated changes in the policy and legal context. Initially, the new legal framework did not provide the basis for Bonaire to draft local island ordinances and by-laws on wastewater and irrigation & fertilisation and local wastewater levies. With the enactment of the VROM-BES law, this legal basis became available. Obligatory connection to the sewerage is laid down in one of the first island ordinances, issued by the Bonaire Administration in 2013.

2.3.2.3. Works Contract

The works contract tender (open internationally), based on the tender documents drawn up by Dorsch Consultants, was launched on January 2nd, 2009 with a Forecast Notice in the Official Journal and on the website of the European Commission. This was followed by the Procurement (Tender) Notice on March 4th, 2009. After a thorough evaluation of the bids, the tender was cancelled by SONA on August 17th, 2009. A cancellation notice was published in the Official Journal and on the website of the European Commission on September 9th, 2009.

After a process of redesign, a negotiated procedure with eligible candidates from the cancelled tender was initiated. The negotiated procedure resulted in the award of the works contract to MNO Vervat International B.V. on July 8th, 2010. The contract between USONA and the Contractor was signed on September 16th, 2010. The commencement date of the works was set to October 16th, 2010. The period of performance of 24 months therefore ended on October 16th 2012, followed by one-year maintenance period.

The Supervisor extended the period of performance during the implementation of the works by 13 calendar days. It is to mention that the Contractor has failed to complete the Works in accordance with the Contract on 29 October 2012.

A Partial Provisional Acceptance was issued on 10 July 2014 (See Appendix E and Appendix G for the map). The list of main units accepted is shown below:

- Vacuum station 1 is serving the central and northern part of Kralendijk. The station is equipped with three vacuum pumps; 1 vacuum tank with a volume of 10.35 m³; 2 booster pumps; including all mechanical and electrical equipment;
- Vacuum station 3 is serving the area along the coast towards Hato. The station is equipped with three vacuum pumps; 1 vacuum tank with a volume of 10.35 m³; 2 booster pumps; including all mechanical and electrical equipment
- Vacuum station 4 is serving the southern part of Kralendijk. It is equipped with three vacuum pumps; 1 vacuum tank with a volume of 10.35 m³; 2 booster pumps; including all mechanical and electrical equipment;
- Vacuum station 6 is serving the lagoon area south of Kralendijk and Belnem. It is equipped with six vacuum pumps; 1 vacuum tank with a volume of 10.35 m³; 2 booster pumps; including all mechanical and electrical equipment;
- Booster station 1 is equipped with 2 submersible booster pumps. The electrical components for monitoring are installed in the building of vacuum station 1. The standby generator guaranties the power supply in case of power failure or other calamities;
- The wastewater collection system is equipped with high-duty PVC pipes and fittings and others. 805 houses have been connected to collection chambers. In total, 386 collection chambers have been installed in Playa (Kralendijk & Hato) and 58 collection chambers in Belnem. 75 hotels and apartments are equipped with buffer tanks, which have been calculated that a four hours calamity incident can be covered. Note: In Appendix 5 of the Partial Provisional Acceptance is mentioned:

  > *The Supervisor and Supervisor's Representative also point out that frequent defects have occurred during the testing of the collection system. A general reservation is therefore made at this provisional acceptance that it cannot be certified that all vacuum lines are sustainable leakage- free.*

- Force mains:
  - From Booster station 1 to WWTP - DN 300 L=3100m;
  - From VS 1 to Booster station 1 OD 160 L= 20 m;
  - From VS 3 to Booster station 1 OD 160/200 L= 2000m;
  - From VS 4 to Booster station 1 OD 315 L= 1200m;
  - From VS 6 to Booster station 1 OD 250/200 L= 1600m.
- Irrigation pipe:
  - From WWTP / Irrigation Pumping Station to Kralendijk downtown; 3180 m HDPE pipe OD 125 mm SDR 11;
  - Distribution from the interconnection point OD 125 mm location Kralendijk to the north, suburb of Hato and to the south: OD 75 mm SDR 17, complete length 10,255 m.

  Note: In Appendix 5 of the Partial Provisional Acceptance is mentioned:

Contractual requirements for testing of the Irrigation system have been successfully completed. However, the hotel branches are still pending and therefore the Contractor has to verify whether this part of the Works meets the (qualitative) requirements of the Contract.

- WWTP: entire plant excluding:
  - TP 7 SBR basins and associated components;
  - TP 12 Water filter and associated components;
  - TP 14 UV system and associated components.

  Note: In Appendix 5 of the Partial Provisional Acceptance is mentioned:

  The Waste Water Treatment Plant has until now not been subject to a Performance Test according to amongst others Volume 3 section 7 of the Tender Documents. Therefore, the correct operation of the Waste Water Treatment Plant cannot be verified, as the required performance test has not been executed. For TP-07, TP-12 and TP 14 (only UV Part) the supervisor and Supervisor's Representative are holding reservations.

Further details are included in Appendix E.

Evaluators' opinion:

- The irrigation pipe has been accepted although the pressure tests for the entire system have failed. The issue is included in the dispute with the Contractor. It has to be proved that unaccepted material has been used. See pipe material test reports by KIWA;
- Parts of the WWTP have been accepted although a performance test of the plant has not been performed;
- Due to the fact that the Contractor has left the site, no further repairs have been made. Further details are included in § 2.4.14;
- The connections from the irrigation system to the hotels have also to be verified by the Supervisor Representative;
- There are no documents to prove to what extent the items from the '*Punch List*' included in the Certificate have been repaired.

With the letter dated November 4, 2014 (See Appendix F) the Contractor submits to the Contracting Authority a 14 days Notice in accordance with the Article 65 of the General Conditions *'Termination by the Contractor'*. The first argument used by the Contractor is that there is not sufficient wastewater available for the WWTP. Other arguments refer to:

- Rejection of the payment of IPC 20 with a value of € 1,005,402;
- Rejection of the payment of IPC 21 with a value of € 225, 246; and
- The alleged non-response to the Contractor's claims by the Supervisor.

2.3.2.4. Service Contract

The services tender (restricted) was launched by a Forecast Notice on February 9th, 2009. Following the 9th EDF procedures, the contract with Hydroplan GmbH was subsequently signed on December 18th, 2009 and the award notice published in the official Journal and on the website of the European Commission on January 15th, 2010. The commencement date was set on October 1st, 2010. The delays in performance of the Contractor forced USONA to adjust the available budget several times (seven Addenda were concluded) and to extend the period of the performance of the service contract. The latter issue was handled in Addendum 5, defining the extension of the period of performance of Hydroplan GmbH by 17 months, ending April 30th, 2015.

2.3.3. Question appropriateness / arrangements

To what extent are these arrangements appropriate to the project?

2.3.4. Answer to question regarding appropriateness / arrangements

According to the evaluators, the arrangements have been appropriate to the project. The arrangements have created an adequate legal and contractual frame, which should allow an adequate implementation.

2.3.5. Conclusions and recommendations regarding appropriateness / arrangements

Conclusion. The arrangements have been appropriate to the project. The reasons for the present situation are not the arrangements made, but the way in which some of implicated parties and especially the Works Contractor and the Supervisor Representative have fulfilled their duties. Further details regarding the factors responsible for the delays and are presented in § 2.5.6.

Recommendation. Not applicable.

2.4. EFFECTIVENESS

2.4.1. Question regarding effectiveness / prevention pollution

- How much pollution is prevented by the project?
- What is the daily load of Nitrogen (kg N/day) into the coastal waters after the project compared to the situation before? What is the improvement % N reduced?

2.4.2. Answer to question regarding effectiveness / prevention pollution

According to the Works Contract the quality of the effluent should be as follows:

Parameter	Unit	Value
BOD_5	mg BOD/l	< 50
COD	mg COD/l	< 125
Suspended Solids	mg SS/l	< 5
E. Coli	MPN/100 ml	< 1000
Total Nitrogen	mg N/l	< 5
Phosphorus	mg P/l	< 5

Table 3 Quality of the effluent

The evaluators have received from WEB the analyses of the inlet and outlet flow from the WWTP for the period November 2014 - March 2015. The analyses have been made in the laboratory of WEB.

A summary table is presented below.

Flow	Parameter	Unit	Monthly average values -				
			Nov 14	Dec 14	Jan 15	Feb 15	March 15
Influent	N_{tot}	mg/l	55	69	74	82	77
Effluent	N_{tot}	mg/l	35	47	47	48	31
Influent	COD	mg/l	325	401	436	411	452
Effluent	COD		68	982	68	562	68
	Reduction		79%	(*)	84%	(*)	85%
Influent	BOD	mg/l	169	163	169	352	296
Effluent	BOD		(**)	(**)	(**)	(**)	(**)
Influent	Daily Volume	m^3/d	434	399	457	352	296

Table 4 Water analyse WEB Nov 2014- Mar 2015

(*) Problems faced in operation - lost of bio-mass

(**) Not determined

The analyses in April 2015 made by WEB show the following results:

Average values for the period 1- 20.04. 2015			
Parameter	**unit**	**Inlet**	**Outlet**
EC	µS/cm	983	645,8
pH		7	6,9
Temp	°C	22	22,5
N_{tot}	mg/l	80	26,3
COD	mgO_2/l	408	25,3
BOD_5	mgO_2/l	341	
Daily Volume	m^3/d	341	

Table 5 Water analyse WEB April 2015

Remarks:
The COD in the influent is around 400 mg/l, which is to be expected. The removal of COD is excellent. Although BOD_5 was not determined, the effluent standards for BOD_5 are normally fulfilled if those for COD are achieved. It is also to be mentioned that the values for April 2015 are better than in the month before at similar influent flows. The evaluators consider this as an indication that the WEB staff makes progress in operating the plant. However, the Nitrogen effluent standard for use in hotel gardens, put at 5 mg/l is not met. This is logical as the denitrification step is not operational yet.

One important issue is the minimum flow to be assured at the inlet for a proper operation of the SBR: the inlet flow is around 300-400 m^3/d. This is much lower than the design flow of phase 1. See discussion below.

A comparison table between the flows considered is presented below:

Flow	**Unit**	**According to the Works Contract § 3.14.1**	**Dorsch Feasibility study**			**Dorsch Findings Report**	**Flows measured by WEB (*)**
		Phase 1 excl. optional	**2007**	**2011**	**2017**	**Dorsch phase 1 2017**	**Oct 2014/ Apr. 2015**
Minimum daily flow	m^3/day	530				614	300-400
Average daily flow	m^3/day	820	885 / 1,290	1,042/ 1,488	1,131/ 1,595	821	
Maximum daily flow	m^3/day	1,020				1,018	

Table 6 Comparison of flows

(*) – 100% of the sewerage connections are connected. For details refer to section 2.4.8.

Remarks:
- For the time being, the hydraulic load entering the plant is only at about 80% of the minimum flow considered in the design data;
- The organic load (BOD load) is also reduced and creates considerable difficulties in operation of a treatment plant of the type selected: the SBR;
- Due to inadequate execution in the Booster station 1, sediments and scum cannot be transferred to the WWTP and by this, the BOD load reaching the plant is reduced. Further details regarding the Booster Station 1 are included in section 2.4.11

Evaluator's opinion. The N_{tot} load is at 39-35 mg/l. N_{tot} is reduced in the plant by 50%. The limit of N_{tot} = 5 mg/l is not reached because denitrification stage is not taken place. It must be mentioned that this limit is very

demanding. For example, the EU Directive for wastewater treatment indicates a limit of 15 mg/l N_{tot} for sewage treatment plants with a capacity of 10,000 - 100,000 PE (Population Equivalent or units per capita loading) which discharge in sensitive areas that are subject to eutrophication. To reach this limit will be difficult and expensive due to the need of injection of additional biomass in the system to reach the denitrification stage in the reactors. The process is sensitive and needs to start in the presence of an experienced process engineer. Under what circumstances the expected level of 5 mg/l can be achieved has to be determined by a special investigation. The WEB should investigate other sources of biomass that are less costly then methanol. The evaluators remind that, if the effluent standard cannot be reached, the whole irrigation system would become redundant, hotels would re-start to irrigate with untreated wastewater resulting in pollution of the marine environment.

The above-mentioned results represent the first 5 months of operation under unusual and difficult conditions, reduced flow and reduced biological load. Due to these circumstances, the treatment process has not reached the denitrification phase in which ammonium nitrate is transformed into Nitrogen thereby reducing the Total Nitrogen into the effluent.

The operation of the SBR basins in automatic mode is expected to have a positive impact on the N_{tot} levels.

2.4.3. Conclusions and recommendations regarding effectiveness / prevention pollution

Conclusions. At the moment, the WWTP does not function as designed. Nevertheless, the evaluators assume that around 85% of the pollution load can removed with the present installation in terms of COD and reaching the limit indicated in the Works Contract. The removal of Nitrogen is less than 50% and the effluent does not fulfil the standard and less pollution is prevented than designed.

As the irrigation system is not operational (see § 2.4.16) the effluent is discharged into a pond constructed adjacent to the WWTP. Given the distance to the shore, it is unlikely that the effluent discharge influences the coastal waters.

From the figures we learn that daily around 300 - 400 m^3 wastewater is pumped away from the coastal zone. This is the wastewater of around 2,600 - 5,000 persons. This is around 15 % - 25% of the total population. It is not known how many people are living in the sewered areas.

Hence, overall the evaluators conclude that, as far as pollution caused by wastewater, the project realises around 15 % - 25 % reduction of the overall pollution load on the island.

Recommendations. The evaluators recommend to *WEB* combining the database of water sales with the database of sewer connections. In this way it can easily be found out how much drinking water is used and how much ends up in the WWTP. For example, the present wastewater represents only 9% of the total drinking water production on Bonaire[9]. If there appears to be a large discrepancy between the water consumed and discharged into the sewers, it is recommended to investigate the causes: are people using the excess water for irrigation at home or are there on-site systems that are not connected to the vacuum system? It is clear that the design parameters used in the project area are not valid, but it is not clear which parameters: occupancy rate hotels, number of persons in a household? Per capita water use hotels and households? % Water used for irrigation at home? Or is the system leaking? Have people closed the valves again?[10] The evaluators heard anecdotes that there are households that close the valves to the vacuum sewers in order to irrigate their gardens. Hence, it is recommended to *WEB and OLB* to repeat / intensify the public

[9] According to the CBS, the water production on Bonaire in 2013 was 1.4 million m^3/year. Source: www.cbs.nl

[10] At present people can easily open and close the valves at the premises. USONA has suggested destroying the valves between the premises and the septic tanks so that people do not have an alternative anymore (Source: debriefing USONA, 29 April 2015. The evaluators find this a risky approach as, sometime in future during a major breakdown there might not be an alternative but to open the valves to the septic tanks again.

information campaigns explaining the benefits of the current system. It is recommended to *OLB* to enforce the laws and regulations that untreated sewage should not be used for irrigation.

2.4.4. Question effectiveness compared to alternatives

What is the effectiveness of the project compared to other forms of wastewater management and sanitation?

2.4.5. Answer to question effectiveness compared to alternatives


Urine diversion toilet flushing example

The problem that is to be addressed by the Sewerage and Sanitation System is the Nitrogen contamination in coastal waters around Bonaire, which results in declining reef quality. The biologist from Stinapa reiterated this (see § 2.1.2). Based on the studies from Dorsch, a vacuum sewerage system has been chosen. In the previous section is shown that only a part of the pollution load present in sewage is being removed by the chosen system. When realizing that almost 90% of the Nitrogen in wastewater originates from urine, see table below, a logical 'quick win' would have been to install urinals and urine diverting toilets. The collected urine could be used to produce struvite. With a population of 18,000 people at any given time, the annual struvite production could be 6,500 kg, worth € 6,500. If the urine would be collected once a week together with the household solid waste, collection costs could be minimized. A struvite installation can be made locally; only magnesium needs to be purchased.

The installation of these 'new sanitation systems', for instance in combination with waterless urinals and other water conservation measures could have contributed to an image of Bonaire being an environmental conscious island, which would have influenced tourism in a positive way. It is obvious that it would have needed a tailor-made, careful and considerable effort to introduce such a system on Bonaire to deal with cultural and social biases and that the level of convenience would need to be the same as the chosen sewerage system.

Table 2: Proposed default values for excreted mass and nutrients. Vinnerås *et al.*, 2006

Parameter	Unit	Urine	Faeces	Toilet paper	Blackwater (urine+faeces)
Wet mass	kg/person,year	550	51	8.9	610
Dry mass	kg/ person,year	21	11	8.5	40.5
Nitrogen	g/ person,year	4000	550		4550
Phosphorus	g/ person,year	365	183		548

Another form of wastewater management has been proposed in the Unesco-IHE study[11]: The alternative option described in this report follows a decentralized approach, in which existing infrastructure (package plants at a number of hotels, tanks at households) could as much as possible be used in combination with new infrastructure. For the hotels (or a cluster of hotels) the wastewater collected in the existing local sewer systems could be treated in upgraded or new package plants for wastewater treatment. The package plants would remove nutrients and could include disinfection for local reuse in irrigation. Commercially available package plants would be able to provide an effluent with better quality than from the SBR. Therefore, and because the septage would be kept separate from the wastewater, the nitrogen load to the gardens could be much less than in the chosen set-up. For households the existing cesspits could be upgraded to septic tanks. The septic tank effluent could be collected in a small diameter gravity sewer system. This sewer type would be

[11] Sewage Management in Bonaire, Evaluation of Proposed and Alternative solutions for reduction of Nitrogen Pollution to Coastal Waters, Prof. Huub Gijzen and Peter van der Steen, UNESCO-IHE Institute for Water Education, November 2004.

less costly than the vacuum sewers. The small diameter gravity sewer systems could be connected to package plants in a similar way as for the hotels. When the package plants are connected to vertical flow constructed wetlands, 80% of the remaining Nitrogen could be removed. This alternative options score better than the vacuum sewerage project design in terms of reduction of nutrient flux into the sea, cost-effectiveness and complexity of technology. Crucial for a successful implementation of alternative options are dedicated and well-trained organisations for operation and maintenance of the decentralized infrastructure. However, as these technologies are rather low-tech, they provide employment and local business opportunities for many. In terms of investment, the costs of small-bore sewerage are around 50 % of conventional sewer, say between € 5,000 - € 10,000 per household, costs in improved septic tanks € 1000 - € 2000 and installation of waterless urinals and urine diversion toilets € 500.

2.4.6. Conclusions and recommendations regarding effectiveness compared to alternatives

Conclusion. The project is expensive, vulnerable and complex compared to other forms of sanitation and does not generate many local business opportunities. Provided it is working as designed, it expected to have a high of convenience, as, as far as the user is concerned, it is a 'flush-and-forget' system.

Recommendations. As far as future wastewater and sanitation projects are concerned the evaluators recommend *to EUD and IenM* take alternative solutions seriously into account. As far as the *Local Entity of Bonaire* is concerned, the evaluators recommend starting developing local experiences with alternative sanitation systems for the majority of the population that does not have an improved sanitation system.

2.4.7. Question effectiveness / connections

How many houses and hotels have been connected at the moment and how many are being scheduled at the end of the project?

2.4.8. Answer to question effectiveness / connections

The current situation of sewerage connections realized is presented in the following table. In Appendix K the list of hotels connected is presented.

Sections	Total units According to contract	Total Units currently implemented	Valve open	Remarks
VS3-C	19	16	16	
VS1-C	14	14	11	
VS4-C	27	24	24	
VS6-C	17	16	13	The remaining units are problem units: Problem to reach septic tanks!
VS2-C		3	0	10th EDF connections
Grand Total COMMERCIAL	**77**	**73**	**63**	
VS3-P	33	37	37	
VS1-P	346	340	336	
VS4-P	303	289	287	
VS6-P	136	156	141	The remaining units are problem units: Owners not available!
VS5-P		122	0	10th EDF connections
VS2 -P		51	0	10th EDF connections
Grand Total PRIVATE	**818**	**995**	**801**	
TOTAL	**895**	**1068**	**864**	

Table 7 Sewerage connections

It is to mention that although the number of sewerage connections is higher than foreseen in the contract, the influent flow as well as the BOD load is considerably lower than foreseen in the Feasibility Study (see section 5.2).

2.4.9. Conclusions and recommendations regarding effectiveness / connections

Conclusions. As per 20 April 2015:

- 995 private connections have been implemented, where 801 house connections are in service;
- 77 commercial connections have been implemented, where 73 house connections are in service;
- In total 1, 068 connections have been implemented, where 864 house connections are in service.

Recommendations. In order to improve the effectiveness it is recommended to add as many house connections as possible.

2.4.10. Question effectiveness / vacuum system

What part of the vacuum system is in place / scheduled at the end of the project?

2.4.11. Answer to question regarding effectiveness / vacuum system

According to USONA Final Report Dec 2013 the system is realized to 100%. The system is shown in Appendix G. However, the system has several flaws, shortcomings and defects. In order to obtain a proper overview of what needs to be added and repaired in order to have a functioning system, WEB has hired RoyalHaskoningDHV to prepare a technical evaluation. The summary of the (Confidential) report is shown in Appendix I. As far as the vacuum system is concerned, RHDHV observes that: "*The vacuum collection system does not function as described in the works contract. The system is not robust and needs a lot of maintenance and repairs to keep it functioning. This leads to extra operation and maintenance costs (extra energy consumption, repeatedly changing of spares). The 'as built drawings', as far as they are available, do not represent the reality. The shape of the booster station is not optimum, leading to a floating layer that needs to be removed frequently. This leads to foul smell in the neighbourhood. There is insufficient buffering volume in those cases the Waste Water Treatment Plant (WWTP) is not capable to receive wastewater*". According to the TNO representative in charge of supervision of the project, these observations are partly made on wrong base data. According to the supervisor any flaws, shortcomings and defects that may be there at the moment will be repaired in due course. Also WEB assures that, at the expert from Vlovac (vacuum sewer manufacturer) is being hired and present in Bonaire, everything is undertaken to assure repairs. USONA mentioned that during the amiable settlement procedure it was revealed that the above average energy consumption is due to inefficient operation of the vacuum system: it is still set at 'off-factory' defaults whereas the pressure needs to be adjusted every time the number of connections changes[12]. According to the evaluators this is another illustration of the relative complexity of the selected system that needs attention from specialists that are not readily available on Bonaire.

USONA has asked Dorsch Consulting to prepare a Fact Finding Report submitted in March 2015, see Appendix H. The report reveals important shortcomings in the system and provides recommendations. The most important are:

As far as sewerage connections are concerned:

- *Dorsch:* House connection chambers are not watertight and there is a risk of flooding and damaging the control valve; an important number of chambers have the cover below the street surface. Consequently, the report recommends that all covers in roads, pedestrian walkways, other public areas, depressions and other flood-prone areas are to be equipped with proper watertight covers and separate ventilation pipes as specified in the contract drawings. All house connections that require an extension to reach the surface level have to be retrofitted with watertight fittings to protect the internal equipment from infiltrating

[12] Information USONA at debriefing 29 April 2015.

water. This must be done using the fittings supplied by the Manufacturer that are specifically designed for this purpose;

- *The evaluators* consider this aspect as important and also an example of poor performance of the Contractor as well as insufficient control from the part of the Supervisor. The required works are time intensive and costly. USONA and the Supervisor have to consider these costs in the dispute with the Contractor and make sure that sufficient budget is made available.

As far as vacuum lines are concerned:

- *Dorsch:* Regarding vacuum lines, Dorsch mentions the fact that the slopes of the pipes in some areas are not in accordance with the contract drawings. The report also mentions that the cover of the pipes in some areas is less than the 40 cm required. To reduce the energy consumption, Dorsch recommends to implement the constructional changes proposed by Flovac and to verify the pipe alignment on the as-built drawings by direct measurements;
- ***Evaluators:*** To the evaluators' opinion it is very difficult to correct at this stage the poor workmanship of the Contractor. The Supervisor failed to assure a proper control. The operator will have the difficult task to repair and, where possible, to correct. The reservation made in the provisional partial acceptance certificate would not help much. USONA needs to obtain the budget for the repairs during the defects liability period from the Contractor.

As far as division (section) valves are concerned:

- *Dorsch:* Regarding division (section) valves within the vacuum network, Dorsch states that the requirements according to EN 1091, as required according to section 5.7.1 of Volume 3 of the contract documents have not been met. EN 1091 requires division valves every 450 m as well as at the connection of a branch that is longer than 200 m, with the main line;
- The Dorsch report also mentions that the Contractor has not installed 4 air admission stations although they were included in the BOQ.

The *evaluators* agree with Dorsch as far as the section valves are concerned.

Regarding the air admission stations

Evaluators: To the evaluators' opinion the 4 air admission stations have to be installed and adequately tuned to provide the necessary air and improve the performance.

Regarding the Booster pumping station (BS) 1.

Dorsch mentions:

- *The wet well of the BS has an unfavourable construction (deviation of original contract) that leads to the pumps not being able to pump all sediments and scum to the WWTP and hardly any ventilation and cleaning of the air from the BS. This results in increased biological activity in the BS, odour complaints, increased maintenance by regularly removing the scum and sediments in the wet well, complicated maintenance of the valves. A drawing is attached to the report;*
- *The submersible pumps are mounted at a height above the floor of the sump that is more than recommended in the manufacturers' literature. The mounting height has been measured at 310mm to the rim of the pump inlet compared with 130mm recommended by the manufacturer. This will reduce the effectiveness of the pump scouring the wet well bottom at each pumping cycle;*
- *The level instrumentation installed in the wet well is a hydrometric type system, measuring level by the pressure sensed by a suspended instrument. This type of level measuring system in the wet well of a sewage pumping station is not the most advantageous choice. A better choice would have been a non-contact system such as an Ultrasonic system, which would allow measurement to the floor of the wet well and thus provide an enhanced degree of control. This ultrasonic level indicator was required in the contract according to the BoQ and section 4.4.4.10 of Volume 3 of the Contract Documents. Besides, the*

present installation is mounted too high above the floor of the wet well to give a proper range of control to operate the Booster Station Pumps.

Evaluator's opinion:

- The WEB staff confirmed the problems in the Booster Pumping station 1. As a remedial action, the wet well is cleaned from scum and sludge on a weekly basis using a hired vacuum tanker, as the pumps do not evacuate all sludge and scum. See Figure 3 for the situation before and Figure 4 for the situation after cleaning. Dorsch recommends pouring additional concrete to assure that the wastewater be drained to the pumps. The proposal could be right, but seems impossible to be implemented as the pumping station is under operation. At present it is also impossible to correct the position of the pumps to reduce the distance from the invert of the wet well to the suction pipe of the pump;
- The operator has changed the starting and stopping levels in such a manner that the pumps are working more frequently hoping the sludge would be pumped before it has time to settle. It seems that this measure was not efficient;
- According to the evaluators, the only remaining option to solve the problem would be to install a mixer in the wet chamber. The mixer should be properly designed (diameter of the blade, power, position) to assure the energy required in the wet well thus avoiding settling of the suspended matters;
- From experience the evaluators know that level measuring devices in wet chamber are frequently subject to disputes between design engineers, because the floating elements on the surface of the water can influence the accuracy of the measurement. An ultrasonic level-measuring device installed in a proper position is most probably a better solution. From a financial point of view, there should not be a problem as it is already included in the BOQ.

All problems revealed above are proof of poor performance of the Contractor and illustrate that the Supervisors Representative did not check the executed works properly.

Figure 5: Pump sump with scum layer

Figure 6: Cleaned pump sump

2.4.12. Conclusions and recommendations regarding effectiveness / vacuum system

Conclusions. The system has been implemented to a large extent, but not with the needed care and workmanship. These are reasons why at present the power consumption in the system is high[13] and there is a permanent need for maintenance and repair. Under normal conditions the Contractor should have covered the repairs during the defects liability period. At present WEB is waiting to get spare parts as they have not access to the spare parts purchased by the Contractor.

Recommendations. USONA and the Supervisor have to take care that sufficient budget is made available from the Works Contract to cover the cost for repairs and spare parts.

2.4.13. Question effectiveness / WWTP

Description wastewater treatment plant in place: quantity and quality of influent and effluent, efficiency treatment.

2.4.14. Answer to question regarding effectiveness / WWTP

The units composing the WWTP are presented below. In Appendix L the layout is presented.

[13] During the debriefing with USONA, it was learned that this issue was discussed during the amiable settlement procedure. According to Dorsch, excessive energy consumption could also be attributed to the fact that the vacuum pumps still need calibrating. At the moment they are still in the standard factory mode. As soon as a vacuum line is added, pumps needs recalibrating (Source: Mr. Thielemans, 29 April 2015)

TP-01 Operational Building
TP-02 Transformer Building & standby generator
TP-03 Flow meter Pit and Inlet structure
TP-04 Pumping Station 1 A (PS 1A)
TP-05 Storage Tank 1 (ST 1)
TP-06 Sequence Batch Reactor 1 (SBR 1)
TP-07 Sequence Batch Reactor 2 (SBR 2)
TP-08 Sludge Thickener
TP-09 Sludge Pumping Station
TP-10 Blower for SBR 1+2
TP-11 Storage Tank 2 (ST 2)
TP-12 Sand Filter
TP-13 Storage Tank 3 (ST 3)
TP-14 UV Disinfection and Irrigation Pumping Station
TP-15 Sludge Drying Beds

According to RHDHV, the "*WWTP has only 'partly' been made available to WEB. Hence, it cannot be operated completely. The installation is not complete and some parts do not function properly, such as the pre-treatment. The quality of the effluent does not meet the standards. The main treatment plant, the Sequential Batch Reactor (SBR) system does not function as it should and needs to be taken out of service / restarted frequently. Reasons are, amongst others: Severe under load: only 30 % of the design load; the automation system does not function and the methanol dosing cannot be used because of safety reasons. The main reason for the under loading of the installation is the fact that there is no vacuum truck discharge point into the installation (a measure to reduce costs), which should – according to the design – contribute 50% of the load. In addition several parts are subject to corrosion. In general the system is too complex for its size and many choices in the design are remarkable / unusual; the technical specifications are not always consistent and many items are missing; there is a discrepancy between the design and as-built situation*".

In the framework of the amiable settlement of the dispute, at the request of USONA, Dorsch has prepared a report on the status of the works.

Regarding the WWTP the report from *Dorsch* mention the following main aspects:

- The WWTP is presently operated in manual mode as the Supervisor / Operator is uncertain as to whether the PLC has a suitable automatic operation program loaded. The PLC is password protected and to date the Supervisor / Operator has not been given the password. Consequentially, the Supervisor with the Operator can only operate the WWTP in manual mode;
- Overall the WWTP, from an electrical and mechanical perspective, presents a neat and tidy appearance. From the civil perspective, the concrete works at the WWTP could have been constructed better. The *Evaluators* fully share this opinion;
- The C-source dosing system has not been used, but looks satisfactory, except for the lack of warning signs for methanol;
- The slope in the floor of the sludge drying beds is not constructed correctly. The floor undulates over the length. Also it is not clear whether the required slope to the drains has been achieved everywhere. Besides, the concrete already looks much older and worn than its age. The drains and their filter material have also not been constructed properly in all beds.

The observations of the *evaluators* are the following:

- The units are realized to 100%;
- UV Disinfection and Irrigation Pumping station are not in operation because the pressure line is not operational;
- The automation system is not operational. The Contractor has terminated the works and has not tested and handed over the system;
- In general the WWTP is in a good condition; especially as the mechanical equipment is provided from well-known suppliers;
- To assure water tightness, the leaking concrete structure has been injected with two-component epoxy and has been coated on the inner side with a polymer coating. At present no signs of leakages are observed, although some fine cracks are visible. These have to be monitored and actions should be taken, if needed;
- The piping is in good conditions; no defects or corrosions can be mentioned;

- On the water filter tanks corrosion is visible all over the tanks. For sure, the quality of the used stainless steel is not appropriate. According to the specification the steel should be AISI304. The quality of the steel delivered in reality is in accordance with the specification. The provision in the specification is wrong: the quality of the steel should have been higher, for example 316, but in the given situation protections measures such as proposed by the Paques (supplier) should be applied. The costs for the protection are in dispute between MNO and USONA;
- About the efficiency of the WWTP please refer to Chapter 5.1.1.

2.4.15. Conclusions and recommendations regarding effectiveness / WWTP

Conclusion. The system has been implemented but additional actions are needed to assure the complete operation as expected.

Recommendations.
To *WEB*:

- It is recommendable to assure the possibility to transfer wastewater from the existing AWZI plant to the new plant. This would increase the inlet flow and load and improve the working conditions of the plant. The transfer has to be coordinated by a process engineer to assure an appropriate flow is delivered avoiding negative impact on the process in the WWTP due the different water qualities;
- WEB should enter into a contract with a wastewater treatment expert (expert in SBR process) and assure technical assistance for a period of time on Bonaire for optimisation of the treatment process; The foreign expert should work together with and train a local young engineer on how to operate the plant in future;
- The WEB team should continue the training activities and the exchange of experiences with operators of similar plants;
- WEB should have an up-to-date a list of repairs, remedies and replacement which are needed;
- WEB should continue to cooperate with wastewater utilities in Holland that have experience with operation and maintenance of vacuum systems. An assignment of staff for a short period would also be beneficial.

To OLB:

- The financial resources from the Works contract should be made available if the contractor does not fulfil his obligations (unpaid works, retention money, performance security) and used to complete the works as soon as possible;
- In case the Contractor does not provide access to the automation system of the plant, WEB has to contact the supplier of the software directly and assure the implementation, testing and operation of the plant in automatic mode. This is an issue of high priority.

2.4.16. Question effectiveness / irrigation system

Description irrigation system in place and scheduled at the end of the project.

2.4.17. Answer to question regarding effectiveness / irrigation system

The irrigation system is realized at a percentage of 100 % according to USONA report.

According to the RHDHV report: "*The irrigation network has not been handed over and cannot be used because of a number of leakages. These leakages are probably caused by refill of the trench with large/sharp refill material and/or flaws in the pipe material. It is not sure whether the applied pipe diameter is large enough for the future discharge".*

The Dorsch Report mentions:

- *The supplied irrigation booster pump has a capacity of 39.6 m³/h or 11 l/s with 16.8 bar. The flow capacity of the pump is higher than the required capacity of 7 l/s with 6 bar from section 3.14.3 of Volume 3 of the contract documents. However, the capacity and quality of the irrigation pipes is lower than the required capacity and quality of PE 100 SDR11;*

- *The supplied OD125 pipe is a SDR17 pipe instead of a SDR11 pipe;*
- *The supplied OD75 pipes are, according to tests done by KIWA (coordinated by TNO), made from a lesser PE quality than the required PE100 quality. Therefore, the irrigation system cannot deliver the planned future flow of 10.6 l/s to the hotels;*

The following solutions can be considered to get the system to deliver 11 l/s:

- *Replace the OD125 SDR17 pipe with a OD125 SDR11 pipe, which was prescribed in the contract;*
- *Replace the OD75 SDR11 pipes with SDR11 or SDR 17 larger diameter pipes;*
- *Add booster pumps in the hotel branches that will provide sufficient pressure.*

***Evaluators'* opinion**

- According to USONA and the project supervisor, the pressure line has not passed the pressure tests. The quality of the installed pipe (length 8 km, diameter 75mm) is being verified by Kiwa (coordinated by TNO). Regarding the pipe OD 125 the evaluators have been informed that the pressure tests have passed.
- The entire irrigation pumping system is not properly designed:
    - The design flow is a rather small. It is not clear why it was not decided to use all effluent available; at least the average flow;
    - The installed pump KSB- Movitec VF- 9-1 has a Head of 171m for a flow of 11 l/s. The system is not economically designed with small pipes and needs a considerable pumping head to cope with the losses. Regarding the OD 75 mm sections it seems that the Contractor has not implemented the proper material. The diameter of the pipe as specified in the contract is too small. Considering 5 l/s for each section the velocity in the OD 75 pipe is around 1,2 m/s. This velocity is relatively high for this diameter and therefore losses are considerable;
    - There are no details available how the water will be distributed to the different hotels and how it will be avoided that the consumers near the main line are receiving more water while those at the end of pipe will receive less water or no water at all.

2.4.18. Conclusions and recommendations regarding irrigation system

Conclusions. It is obvious that the design is not appropriate: either the design in the Dorsch Tender Documents or one of the many design revisions is inadequate. As far as the Contractor is concerned this in an advantageous situation as the investments are relatively small due to reduced pipe diameters. However, for the operator there are considerable disadvantages, especially the high energy costs. Also the material of the pipe OD 75 is not in accordance with the requirements. USONA and the Supervisor need to sort out who is responsible and act accordingly.

Recommendations. The entire system including pumps for irrigation and pressure lines has to be redesigned properly. The provision of a tank with float valve and small booster pumps at the hotels should also be considered. All connections to hotels should include a water meter so that billing can be done in an efficient way.

2.4.19. Question effectiveness / factors non-achieving objectives

What are the major factors for non-achieving the objectives, if any?

2.4.20. Answer to question regarding effectiveness / factors non-achieving objectives

The objectives are currently partially achieved and the project is in a considerable delay. There are several factors that have contributed to the present situation. In the following sections we present our main findings.

2.4.20.1. Relatively unknown and relatively complex system

The selected technical solutions: a vacuum sewerage system and SBR are unknown in the Bonaire situation. The choice for vacuum sewerage was based on the fact that excavation in the rocky underground would be extremely expensive. However, it takes time and imported expertise to implement such a system, as it is

relatively complex compared to other systems. Neither the contractor, nor the subcontractor and supervisor had any experience with the system.

The choice for a rather complex treatment like SBR is not justified and unusual: normally the SBR is applied in an industrial environment where flows and quality of wastewater are well defined and with limited availability of land. Both factors do not apply on Bonaire: wastewater flow and wastewater quality are difficult to predict and fluctuate and there is a lot of land available to implement appropriate flexible wastewater treatment system.

2.4.20.2. Underestimation costs in the Feasibility Study

In the Feasibility Report, Dorsch has considerably underestimated the costs: the Dorsch Feasibility Study in 2002 estimated the Phase 1 investment costs of the Sewerage and Sanitation Project Bonaire to € 21.9 million, including € 1.4 million for supervision and € 0.264 million for vehicles (at price level 2008). Nine contracting companies bought the tender dossier (at a price of € 1200), of which ultimately 4 made an offer. The evaluation in July 2009 of the four received offers revealed a large gap of more than 9 million Euros between the available budget and the lowest bidder, Ashtrom b.v. As Ashtrom's bid was ruled not eligible for EDF financing by the Evaluation Committee, the effective gap between the available budget and the second lowest bidder MNO-Vervat b.v is around 13 million Euros, and was considered unbridgeable without additional funding.

As can be gathered from the table below, Ashtrom had the lowest bid, followed by MNO Vervat and Janssen de Jong, while the consortium Ballast Nedam and Wolter & Dros offered the highest price. Differences between contractors are significant. A thorough analysis has been made by USONA on every Bill of Quantities item to detect the reasons for such price differences.

Tenderer	Stated offer (in €)	Discount conditions in € (as stated in item 4 of the Tender Submission Form),
Ashtrom B.V.	31,451,052	--
MNO Vervat - International B.V.	35,764,187	--
Janssen de Jong Caribbean B.V.	47,615,268	--
Ballast Nedam B.V. and Wolter & Dros B.V.	47,908,486	250,000.-

Table 8 Offers Works Contract

A large variation between the tenderers' offers for the different bill items was found. The tenderers have all quoted very high unit prices for some items. In general, it can be stated though, that the cost estimate unit rates are quite often met by the tenderers' prices, but unfortunately these matching prices were not consistent in one single tender. The difference between the lowest and the highest bidder was more than 16 million Euros. The conclusions were evident: the price estimate by Dorsch was too low and the price settings of the contractors were relatively high. Minor non-conformities were detected, but each of them with the possibility to add necessary documents later.

A more accurate investigation regarding the unit rates in the area would have offered a realistic investment cost estimate and consequently the possibility to adapt the technical solution to the available budget. An important delay in the implementation of the project would have been avoided.

2.4.20.3. Overestimation of the wastewater flows

The Feasibility Study and the Tender Documents have used an overestimated the wastewater production rate with respect to water flow and organic load per person equivalent. The proof for this is the fact that at present with about 99 % of the house connections implemented and connected, the influent of the WWTP is below the minimum flow adopted in the design. As shown in Table 6 where flows are compared, there are considerable

differences between the documents studied and the current flows measured at the WWTP. The actual flows as presented in section § 2.4.2 are around 80% of the minimum daily flow and 50% of the average daily flow.

A more realistic approach would have led to design parameters that could have been achieved easily. This approach would also not have offered an excuse to the Contractor for not testing the WWTP. At the moment the Contractor claims he cannot test because of the flow is too small and the organic load too low. A more realistic approach would also have resulted in much lower investment, operation and maintenance costs.

Regarding the quality of the design, the evaluators consider that the design of Dorsch was flexible and allowed the desired modifications after the first failed tender procedure. The tender documents have asked for a Contractor's design, based upon article 19 ***Contractor's drawings and execution studies of The*** **General Conditions For Works Contracts Financed By The European Development Fund (edf).** Under 19.1 it is mentioned:

> *The Contractor shall submit to the Supervisor for approval at its own expense, all design and construction drawings and other documents and objects necessary for the proper execution of the contract,*

Unfortunately the Contractor has not immediately obeyed to this request and a lot of time was lost before the works on site could start.

2.4.20.4. Reduced number of bidders in the Works tender procedure

The competition for the Works Contract was very limited, as only 2 bidders have submitted offers. Under these conditions USONA had not very much choice in the selection of the Contractor[14].

2.4.20.5. Poor performances of Supervisor Representative

From the lecture of the different reports considering the quality problems, the delay in execution, the long list of Contractor' claims, it can be concluded that the Supervisor representative (Hydroplan) has not managed the Contractor properly. All defective works described in this report could have been avoided or corrected if the Supervisors Representative would have performed his job as expected.

The Supervisor has not recommended to the Contracting Authority the use of the appropriate provisions of the Works Contract regarding the situation the "*Contractor considerably fails to fulfil his contractual obligations*" (Art 70. financial penalties).

The evaluators consider that the USONA was aware of the situation on site but due to lack of experience to handle such situations and limited human resources, no any adequate remedial actions were taken. Refer also to § 2.5.9.

2.4.20.6. Poor performance of Works Contractor

The biggest responsibility for the current situation lays with the Contractor MNO Vervat, especially because of the poor quality of several works as well as the considerable delays in completion of the Works.

The following defective works can be mentioned here:

- Non-compliance with the minimum cover of the pipes and the sharp material that was included in the bedding of the pipes. This concerns the vacuum lines, the irrigation pipes as well as the force main;
- Leaking pipes in vacuum system;
- Storm water entering the vacuum system;
- Difficulties in operation of the Booster station 1;

[14] During the debriefing at USONA on 29 April, it was mentioned that also for smaller works, often very few international firms bid. Apparently, risks are deemed too high and/or very little spin-off is expected from works at small island communities. Source: Mr. Thielemans.

- Failed pressure tests of the irrigation pipe;
- Leakages in water retaining structures in the WWTP.

2.4.21. Conclusions and recommendations regarding effectiveness / factors non-achieving objectives

Conclusions. The general objective to assure the safeguard of the coral reef is at present only marginally achieved. The volume of nitrogen discharged into the sea has been reduced and the reduction will increase after all components of the project will work according to the design.

Recommendations. The evaluators recommend to WEB to investigate the reason for the relatively low wastewater flow by matching the database of water sales and connections to the sewerage, if necessary accompanied with house visits to see if valves are closed and/or untreated wastewater is used for local irrigation.

2.5. EFFICIENCY

2.5.1. Question Efficiency / management

What was the quality and capacity of the management of the Delegated Authority USONA?

2.5.2. Answer to question regarding efficiency / management

How is the financial progress compared to the physical progress in the field (in % value of works.

At present, the financial aspects of the Works Contract are as follows:

- Performances Guarantee over 10 % of the Contract prices in place and valid;
- Retention money - 10 % available;
- Advance Payment returned completely;
- Total amount of IPC approved and paid: € 16 million;
- Total value of certified works: € 19.271 million;
- IPCs not paid: IPC 20 with a value of € 1,005,402 and IPC 21 with a value of € 225,246;
- Works paid but not accepted: pressure pipe for irrigation - estimated amount € 1 million;
- The total Works accepted and paid to date are estimated at € 15 million;
- The financial progress of the contract to date: € 15million/ € 19.6 million = 76.5 %.

The physical progress on site is estimated at 95 %.

By the comparing the figure 76.5 % financial progress to 95 % physical progress, it can be concluded that the management by the Delegated Authority USONA has worked properly and that the Contractor was not overpaid.

Because the Contractor has ceased all activities on site, the Contracting Authority is entitled to the available amount and retention money to complete the outstanding repair and replacement works. This would be possible depending upon the results of the amiable settlement dispute. The decision is not know yet.

Regarding the non-financial aspects of the management by the Delegated Authority USONA, the evaluators would like to mention the following aspects:

- In § 2.4.20.5, the evaluators pointed out the poor performance of the project supervisor Hydroplan. According the evaluators, the project management could and should have taken more adequate actions to ensure a proper functioning supervision;
- Also regarding the 2 years delay in completion of the Works Contract, the evaluators are the opinion that USONA should have acted earlier and more active. The Supervisor has invited the management of the

Contractor from Holland[15] to present urgent and effective measures to limit the delays, but apparently this was too late and did not result in satisfactory results;

- The evaluators are also the opinion that the handling of the amiable settlement dispute from December 2014 until now takes a very long period. The fact that the action needs careful analysis is obvious, but it has also to be considered that urgent measures are needed to complete the missing works.

2.5.3. Conclusions and recommendations regarding efficiency / management

Conclusions. As the contract is executed within the available budget, the evaluators conclude that financially, the project is managed properly. However, as the works are not finished and as what is finished is partially working, the evaluators are the opinion that the Contracting Authority, SONA /USONA, has failed to undertake proper actions to avoid this situation. For more details refer to art. 2.5.9

Recommendations. Speed up the procedure of amiable settlement. The issue is for the moment of highest priority: the operator is working with an uncompleted system and might be tempted to make some changes that might be used by the Contractor to decline responsibility. The evaluators have not been involved in the amiable settlement procedure and therefore are not able to make specific suggestions.

2.5.4. Question efficiency / other donor contribution

What is the other donor contribution?

2.5.5. Answer to question regarding efficiency / other donor contribution

Due to the constitutional changes introduced on October 10th, 2010 a number of environmental responsibilities (for example building code and wastewater management) have been shifted from the Bonaire Administration to the Central Dutch Government. As a result, the Dutch Government provided € 10 million for the necessary house/hotel connections on private premises as defined in the Special Conditions to the Financing Agreement. The Dutch Ministry of Infrastructure and the Environment finances the connections of houses in this phase 2 under the ongoing connection project.

The Dutch Ministry of Infrastructure and Environment (IenM) has also committed itself to finance O&M as long as the fees collected from house connections and sales of irrigation water are insufficient.

In the past the Kingdom of the Netherlands has also financed a facility to receive, treat and dispose the contents of vacuum trucks that empty septic tanks (€ 850,000[16]). If Dorsch and/or the contractor would have taken this into account this could have led to a cheaper WWTP.

2.5.6. Conclusions and recommendations regarding efficiency / other donor contribution

Conclusions. There has been a considerable contribution from the other donor: the Kingdom of The Netherlands: € 5 million co-financing and € 10 million for financing sewer connections. In future a considerable financing is expected to assure O&M (€ 1- € 1.5 million per year). As IenM has guaranteed O&M costs, there is not much incentive for OLB to take all measures necessary to collect connection fees and sales from irrigation water.

Recommendations. The evaluators recommend to *USONA, EUD and IenM* that in future cases, existing contributions in investments are incorporated into the new works so that costs can be saved. The evaluators recommend to IenM to insist on adequate cost recovery by OLB.

[15] Information from OLB/USONA, May 2015

[16] Source: MOM first Steering Committee Meeting 2009. This is a 2008 commitment for temporary facilities.

2.5.7. Question efficiency / Delegation of authority to USONA

Did the delegation of authority to USONA provide relevant appropriate solutions to define and produce results?

2.5.8. Answer to question regarding efficiency / Delegation of authority to USONA

As the evaluators have identified 6 factors for not/partly achieving the projects objectives, the Steering Committee minutes of meetings have been studied to find out what relevant/ irrelevant and appropriate / inappropriate solutions USONA identified to influence these factors:

- Complex technical solution: the choice for vacuum sewerage and SBR has been made before USONA came on board, so for USONA this was a given fact;
- Underestimate of the costs in the feasibility study: Dorsch is a renown international firm and it is logical USONA trusted their judgment;
- Overestimation wastewater flows in the minutes of the first steering committee the works to handle the contents of the vacuum trucks, financed by the Kingdom of the Netherlands (€850,000) were regarded as 'temporary', hence there was no need for USONA to indicate to Dorsch in the Updated Feasibility Study to subtract the flow of the vacuum trucks;
- Reduced number of bidders: after USONA found out that there were only two bidders, with bids outside the financing scope, USONA decided not restart a bidding procedure as per EU 'D+3 rule', a risk would be created that the project could not be contracted on time;
- Poor performance of supervisor representative. The mere fact that up till 22 December 2013 a total of 971 official letters were written by Hydroplan to the Contractor as mentioned in the minutes of meeting of the 3rd Steering Committee Meeting, while the Contractor wrote 656 letters to the Supervisor's Representative is in the opinion of the evaluators not a proof of an efficient management, especially considering that the Contractor had always about 1 year of delay in completion of the Works. The subject matters addressed in the 656 letters are unknown to the evaluators. Other aspects regarding the performance of the Supervisor' Representative are included under chapter 9 Technical issues;
- Poor performance of Works Contractor is mainly reflected by the fact that at present the contract is 20 months in delay, that for parts of the Works the Provisional Acceptance was not issued yet and that significant issues have arisen during the defects liability period.

2.5.9. Conclusions and recommendations regarding efficiency / delegation of authority to USONA

Conclusions. If we study how USONA has handled the 6 factors that have led to not/partly achieving the projects objectives, the evaluators conclude that USONA had a difficult job to manage and had received very limited support from the Contractor as well as from the Supervisors' Representative.

Some of the factors having an impact on the present situation of the contract, such as the poor quality of the Dorsch Feasibility Study, could not be influenced by USONA.

The financial management of the contract has been handled properly, the Contractor is not overpaid and there are resources available to assure the completion of the Works.

However, as the works are not finished and as what is finished is partially working, the evaluators are the opinion that the USONA could have taken:

- Tougher measures regarding the Supervisor Representative Hydroplan, for instance by insisting on having staff with a more professional attitude; requesting the presence of Hydroplan management on meetings, analyse the option of termination of the service contract;
- Tougher measures regarding the Contractor MNO, for instance by using the leverage of IenM or use of financial penalties for serious breach of contractual obligations.

Recommendation. The evaluators recommend *to USONA* to speed up the procedure of amiable settlement.

2.6. QUALITY OF MONITORING

2.6.1. Question monitoring

To what extent did the program monitoring lead to adoption of relevant activities and intended results?

2.6.2. Answer to question regarding monitoring

As mentioned before under § 2.6.3, the program monitoring by USONA, especially the monitoring of the financial aspects, was efficient. Due to the adopted verification and control procedures the Contract was not overpaid and at present there are financial resources available to finalize the works.

Another aspect of monitoring is the monitoring of the effect of the project on the quality of the groundwater. According to the evaluators, this is an important issue. The Policy Advisor Environment and Nature Directorate of Spatial Planning and Development, Mr. Slobbe, has indicated that the Ministry of IenM has installed around 32 groundwater observation stations. Unfortunately funds are lacking to continue monitoring.

The qualities and quantities of the wastewater collected and treated, power consumption etc. are all monitored by WEB. This is done on a daily and sometimes hourly basis. Monitoring of the power consumption led to investigations into leaking vacuum pipes; monitoring of water quantity and quality led to constant improvement of WWTP process parameters.

2.6.3. Conclusions and recommendations regarding monitoring

Conclusions. According to the evaluators, all actors involved are taking up monitoring seriously.

Recommendations. The evaluators recommend *to OLB* to finance bi-annual measuring of groundwater quality so that the effects of the project can be assessed.

2.7. INDICATORS

2.7.1. Question indicators

What are the indicators of efficiency?

2.7.2. Answer to question regarding indicators

The list of indicators according to the Logical Framework (see Appendix M) of the project and our assessment are as follows:

Indicator	**Assessment**
Overall objective: Significant slowdown / stabilization of coral reef deterioration.	Unknown, too early to judge.
Project purpose:	
Health indicators.	Unknown, too early to judge.
Achievement budget.	Unknown, depends on amiable settlement with contractor.
Comparison WEB data with similar wastewater operations – use of benchmarking.	A comparison at this stage it is not possible because the WWTP is not operating long enough to generate reliable data.
Result indicators:	
Sewer system and wastewater treatment plant constructed.	99% constructed but not fully operational yet.

Indicator	Assessment
Vacuum network and pump stations constructed.	100% constructed and operational, yet with some defects.
Storm water system constructed.	Not constructed due to cost reductions.
Establishment of community services groups that participate actively in planning and implementation of the programme.	None as far as we know
The actual flow on daily basis treated against the design capacity (500m^3/d).	Less than 80% of design flow;
Number of times to exceed effluent quality standard.	The WWTP is not fully operational and Performance tests have not been performed.
Number of employees per unit of effluent produced.	Too early to define at this stage.
Number of employees per km pipe of the total network.	Unknown.
Costs per m^3 treated wastewater versus calculated costs.	Unknown as the project is not finished yet, claims of the contractor are to be expected and O&M costs are not known exactly.
Result activator activities: costs € 19.6 million and € 5 million co-financing.	Unknown as the project is not finished yet and claims are to be expected.

2.7.3. Conclusions and recommendations regarding indicators

Conclusions. More than 50% of the indicators cannot be assessed at the moment, mainly because the project is not 100% finished.

Recommendations. The evaluators recommend reassessing the indicators after one year of operation of the project and make prior arrangements with the beneficiary *OLB* on measurement and recording of the relevant data.

2.8. TECHNICAL ISSUES

2.8.1. Question technical issues

How have the technical problems experienced been dealt with?

2.8.2. Answer to question regarding technical issues

USONA is directly involved in dealing with technical problems. The most important technical problems were a combination of poor quality of the Works executed by the Contractor and inadequate supervision.

This is illustrated by poor quality of the concrete in water retaining structure and how this issue has been handled. As mentioned in the Hydroplan Draft Completion report, due to the poor workmanship of the Contractor the water retaining structures experienced considerable leakages. During a period of more than 6 months, different repair methods were tried. Eventually, at the Supervisor's request, two-component epoxy was injected and inside painting was applied, so the structures could pass the test for water tightness.

***Evaluators'* opinion**
The execution of water retaining structures requires a specific approach in design, selection of materials quality of cement and quality of concrete. The methodology of pouring concrete and vibration also play an important role. If all recommendations and technical rules would have been observed, the concrete should have been watertight and there would have been no need for further treatment. However, in the construction of the WWTP on Bonaire one or more rules have not been observed and the structure experienced considerable leakages. An experienced supervision Engineer should have intervened efficiently in disapproving inappropriate methods for execution of the water retaining structure and should have interrupted the works immediately, when they were not performed according to the required methodology. Most probably, the improper quality of the concrete was due to the fact that the Contractor had not sufficient and adequate vibrators when pouring the concrete.

The Supervisor has obviously not applied the provision of clause 42 of the General Conditions of Contract efficiently. This has led to 6 months delay, during which different remedial actions were tried in vain to repair the leaking concrete. It would have been better if a firm, specialised in repair works, had been hired. Such a specialised firm selects materials to be applied, proposes an adequate technology and does the work with its own staff. In such a situation the selected firm also guarantees the quality of the repairs. As this was not done, valuable time and money have been lost.

It is a strong indication that the Contractor has not the expected experience in pouring concrete in water retaining structures, but also in the opinion of the evaluators, the Supervisor's Representative had not the needed experience in supervising such works.

2.8.3. Conclusions and recommendations to question regarding technical issues

Conclusions. The technical issues observed are due to a combination of insufficient experience of the Works Contractor and the poor performances of the Supervisors Representative.

Recommendations. The evaluators recommend *to USONA* that in tender document qualification criteria as well as in award criteria, specific attention be paid to the particularities of the required works.

2.9. UNPLANNED RESULTS

2.9.1. Question unplanned results

Have any unplanned results arisen from the activities?

2.9.2. Answer to question regarding unplanned results

The following results from the activities were unplanned:

- Realization of new nature: as it is at the moment impossible to pump the treated effluent to the hotels for irrigation, it is being discharged into a pond next to the WWTP. This has attracted pink flamingos and turtles (See Figure 7);
- After many years of nuisance, the population of Bonaire realizes the benefits of connecting to the vacuum sewerage network. This has led to a stream of new clients that were originally not anticipated.

Figure 7: New nature next to WWTP

(Discharge of treated effluent)

2.9.3. Conclusions and recommendations regarding unplanned results

Conclusions. The project has led to a number of positive unplanned results such as new nature and a waiting list for clients for the network.

Recommendations. Not applicable.

2.10. IMPACT

2.10.1. Question impact

To what extent has the project contributed to the wider environment?

2.10.2. Answer to question regarding impact

Based on the interviews, Internet search, field visits, newspapers and magazines and the studying of the management reports, the project is well known. After years of complaints because of the nuisance during construction, everybody, including hotel owners recognize the project benefits, especially because it is not necessary anymore to have the septic tanks emptied every month and for some hotels every day. The project supervisor, Mr. Blom, even showed the evaluators a list of people waiting to be connected.

Hence, the people appreciate the convenience of the system. However, in the evaluators' view, the system has not led to a larger consciousness of environmental issues. This is a chance missed in this environment where every drop of water needs to be desalinated and where a clean environment is the base of the islands prosperity.

2.10.3. Conclusions and recommendations regarding impact

Conclusions. The project has a positive impact.

Recommendations. Evaluators recommend to the *OLB* to use the project benefits to boost the environmental awareness of the population and especially the hotel and resort owners and tourists.

2.11. SUSTAINABILITY

2.11.1. Question sustainability

Can the project results be operated and maintained after external funding has ended?

2.11.2. Answer to question sustainability

The project results are operated now and the results are satisfactory in the given situation as described in the present report.

Following aspects have been realized to assure sustainability:

- The legal frame for operating the system is in place. All households are obliged to connect to the sewer system. Law enforcement is a point of concern;
- The Dutch Government has assured topping up of finances to guarantee operation and maintenance in the future: on the long run people on Bonaire are to pay a fee that is comparable to the fee paid in The Netherlands and the difference is paid by the Kingdom of The Netherlands;
- An important issue is the completion of the works for house connections and to assure a more substantial flow and organic load to the WWTP.

2.11.3. Conclusions and recommendations regarding sustainability

Conclusions. The sustainability of the system is guaranteed, as long as IenM tops up the budget for O&M. Should IenM fail to do so for whatever reason, the project is in trouble.

Recommendations. The evaluators recommend to *OLB* to assure that the promises are legally binding and that as much local revenues are generated as possible. The evaluators recommend to *OLB* enforce the law that all households and hotels have to connect to the sewer system and **use** it. The present possibility to short cut need to be inactivated.

2.11.4. Question benefits

What are the benefits of the project and their continuation?

2.11.5. Answer to question regarding benefits

The benefits of the project are mainly represented by the reduction of the nitrogen discharged into the sea thereby safeguarding the coral reef.

The coral reef is the key aspect of the tourism of the island and therefore the continuation and optimisation of the WWTP and the sewer system is of utmost importance.

2.11.6. Conclusions and recommendations regarding benefits

Conclusions. At the moment around 15-25% of the nitrogen load into the sea is reduced and it is expected that this will have a positive benefit in the efforts to save the corals.

Recommendations. The evaluators recommend *OLB* o use the efforts of this project to influence the relative low environment consciousness of the community of Bonaire in a positive way: this project should be the start of a new beginning.

2.11.7. Question sense of ownership

Is there a sense of ownership amongst the beneficiaries?

2.11.8. Answer to question regarding sense of ownership

From the study of the reports, informal talks to hotel owners, as well as from the minutes of the steering committee meetings it can be concluded that the private consumers and the hotels see the benefits and hence it can be concluded that there is a sense of ownership. This is also illustrated by the 'waiting list' for new connections. Within a few months, the beneficiaries will be approached to start paying their monthly fees and this will be an important moment in time to judge whether there is indeed a real sense of ownership.

2.11.9. Conclusions and recommendations regarding sense of ownership

Conclusions. Now that the period of construction nuisance is over and WEB does an excellent job to keep the system running, the beneficiaries have a positive attitude towards the project results. The proof of the sense of ownership will be the moment the people that are connected start paying the fees.

Recommendations. The evaluators recommend *OLB* to start a campaign indicating the benefits of the system and the obligation to pay fees.

2.11.10. Question favourability economic and financial factors

Are the economic and financial factors favourable?

2.11.11. Answer to question regarding favourability economic and financial factor

The economic and financial factors are, like in all other countries not very favourable. The local authorities count on the support from the Netherlands Government. It should be noted that the project is one of the most expensive ones in the world, both in investment (around € 9,000 per capita/tourist (€ 45 million / 5,000 persons), or around € 27,000 per household assuming 3 persons in a household). The running costs are around

€ 300 per capita/tourist, around € 900 per household per year (€ 1.5 million/ 5,000 persons), around 200% of the expenditure The Netherlands.

2.11.12. Conclusions and recommendations regarding favourability economic and financial factor

Conclusions. Economic and financial factors are not very favourable given the extreme high cost of the chosen vacuum system in combination with an SBR.

Recommendations. *To USONA and OLB* is recommended to insist in future on lower cost solutions that are compatible with the local economy and finances.

2.11.13. Question WEB's institutional / management capacity

Has WEB the institutional / management capacity?

2.11.14. Answer to question regarding WEB's institutional / management capacity

The WEB is operating without problems the energy and water supply on Bonaire and therefore the operation of the WWTP and the sewer system should not create special difficulties. Due to the specifics of the wastewater treatment and the sewerage system, WEB has to assure skilled personnel like a process engineer or mechanical staff for the operation and maintenance of the vacuum sewer system.

Initially, WEB was acting as the Supervisor of the Project. In 2011, WEB stepped back from its role of the Supervisor of the Project. In 2013, WEB started again to participate in the Project with a team of 4 persons as the future Operator. In January 2014, the entire team was established as Operator. The Organisation Chart below indicates the staff structure in the operational team.
(Source: Hydroplan, 2015)

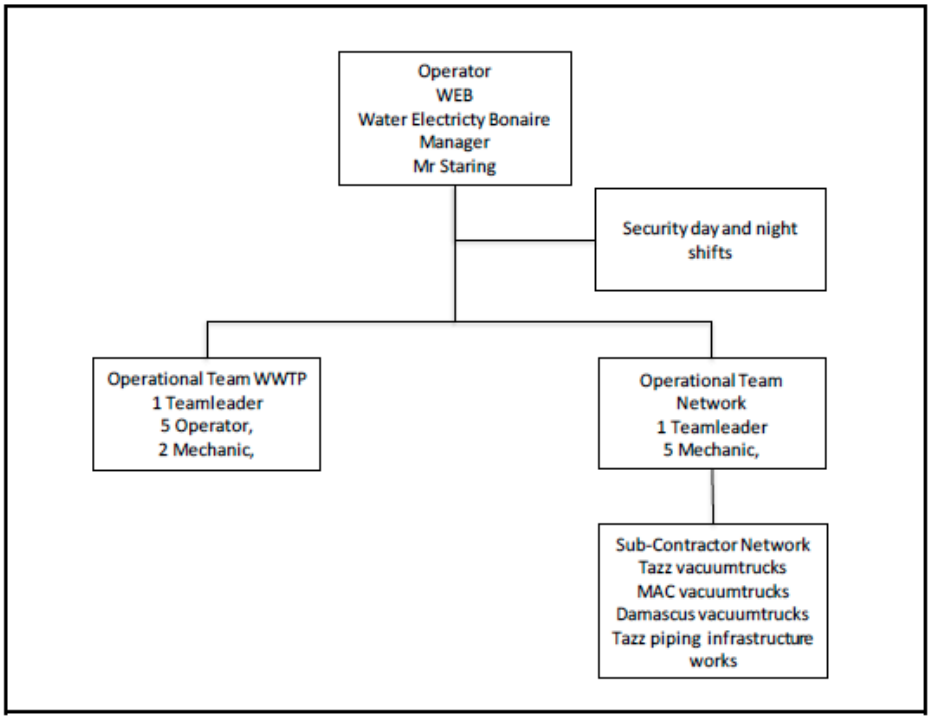

Figure 8 WWTP - WEB - Organization chart

2.11.15. Conclusions and recommendations regarding WEB's institutional / management capacity

Conclusions. From what the evaluators have seen and experienced, WEB has the institutional and management capacity to run the project.

Recommendations. It is recommended to *OLB* to keep WEB on the job.

2.11.16. Question WEB's technical capacity

Has WEB the technical capacity?

2.11.17. Answer to question regarding WEB's technical capacity

WEB is operating without problems the energy and water supply on Bonaire and therefore the operation of the WWTP and the sewer system should not create special difficulties. However, wastewater treatment and the vacuum sewerage system require special skills, that need to be developed.

2.11.18. Conclusion and recommendation regarding WEB's technical capacity

Conclusion. The O&M of a vacuum system and especially the WWTP requires special skills, usually not present in a drinking water and electricity utility. It will cost time and money to develop these skills.

Recommendation. WEB should increase its technical capacity with additional staff and should enhance the professional capacity of the available staff by training and change of experience with similar WWTP, especially in the field of process management.

2.12. EU SPECIFIC CRITERIA

2.12.1. Question EU specific criteria

What is the EU added value?

2.12.2. Answer to question EU / added value

Without the EU this project would not have been realized. Hence, the EU has contributed to the reduction of pollution due to sewage and indirectly to the protection of the coral reefs that bring tourists to the island.

2.12.3. Conclusion and recommendation EU added value

Conclusions. The added value of the EU is to make the investment in the system possible. Without the EU this project would not have been possible.

Recommendations. The evaluators recommend to *EUD* to continue investments in the protection of the environment but to assure that conditions in terms of appropriateness and sustainability are better taken into account before investing. The choice for vacuum technology and SBR do not fulfil these conditions.

2.12.4. Question EU / crosscutting issues

Were crosscutting issues taken adequately into account in the identification/formulation documents and to what extent were they reflected in the implementation of the project and it's monitoring?

2.12.5. Answer to question regarding EU / crosscutting issues

The evaluators have not been able to identify any crosscutting issues such as gender and climate change. As far as other crosscutting issues such as poverty reduction and social inclusion are concerned, the evaluators found that during implementation the contractor has hired many local sub-contractors who employed local workers. In this sense, the project has reduced poverty. The sewerage connections are in an area where properties are expensive; hence it benefits the richer segments of the society. It is interesting to note that these 'rich' have received the connections for free, whereas the 'poor', outside the sewerage area, need to

invest themselves in septic tanks. On the other hand, if the project is successful, the coral saved and tourism continues there will be a 'trickling down' effect.

As far as the creation of local jobs is concerned, this is limited to some extra positions at WEB. The claim that the sewerage system has an economic spinoff is not true, as non-sewered options would also have contributed to sustainable diving tourism and its economical spinoff.

2.12.6. Conclusion and recommendation EU / crosscutting issues

Conclusions. As far as poverty reduction and social inclusion are concerned, the evaluators found that the poor might benefit indirectly from the project. However, in direct terms like connection to the sewerage, the effects are counterproductive: the rich receive sewerage for free whereas the poor have to pay for non-sewerage solutions.

Recommendations. The evaluators recommend that in future the *EUD* insists on al overall sewerage and sanitation plan that improves sanitation **for all** segments of the society in a fair and equal way.

2.12.7. Question EU / optimization current investments

How can the utilization of the current investments be optimized?

2.12.8. Answer to question EU / optimization current investments

The current investments can be optimized by:

- Adding as many house connections as possible to the existing system within the service areas;
- Improving all other on-site sanitation systems on the island: assuring that all cesspits are converted into septic tanks systems, that all septic tanks are watertight and produce an effluent that fulfils strict environmental criteria such as reduced nitrogen load. In many cases that would mean additional treatment of settled septic tank effluent in secondary treatment. It is recommended that the EU safeguards its investments into vacuum sewerage by supporting additional connections.

In addition:

- WEB should enter into a contract with a wastewater treatment expert (expert in SBR processes) and assure technical assistance for a period of time on Bonaire for optimization of the treatment process;
- WEB should have an up-to-date a list of repairs, remedies and replacements which are needed;
- The financial resources from the Works contract should be made available if the contractor does not fulfil his obligations (unpaid works, retention money, performance security);
- The WEB team should continue the training activities and change of experience with operators of similar plants;
- In case the Contractor does not grant access to the automation system of the WWTP, WEB has to contact the supplier of the software directly and assure the implementation, testing and operation of the plant into automatic mode;
- Effort should be made to increase the wastewater flow into the WWTP and avoid stagnation and settling of solids in the collector pipe to the WWTP as in this situation the biological process starts before the plant and the BOD load is reduced;
- WEB should continue to cooperate with wastewater utilities in Holland, which have experience with operation and maintenance of vacuum systems in order to learn them their experiences. An assignment of staff for a short period would also be recommendable and in the interest of the project.

2.12.9. Conclusion and recommendation EU / optimization current investments

Conclusions. There are many options to optimize current investments.

Recommendations. The evaluators recommend adding as many connections as possible and paying attention to the non-sewerage properties. In addition WEB need to be strengthened in its skills and knowledge so that it can operate the new system in a successful way.

2.12.10. Question EU / stakeholder participation

What was the level of Stakeholder participation in the management and implementation of the project (including other donors, the local governments of the island, TAO's and EU Delegation/HQ, etc.), and the level of local ownership.

2.12.11. Answer to question EU / stakeholder participation

According to the MoM of the Steering committee (2009) the topic has been debated with the hotels, dive shops, NGO's and environmental groups for the last 15 years through the SGR. In this body, the interest groups are represented. In fact, everybody was the opinion that a structural solution was necessary, since the coral reef is a valuable asset to the island.

The list of institutions / organizations involved is impressive:

At a Central level:

- Stichting SONA as Contracting Authority and Delegatee body for the European Commission;
- USONA as implementing body, acting on behalf of Stichting SONA;
- Territorial Authorizing Officer (TAO) of former Netherlands Antilles for the period 2008-2010 and TAO Bonaire;
- European Commission - AIDCO, Brussels;
- EU Delegation in Guyana;
- Until 2011: the Ministry of Infrastructure (Verkeer en Waterstaat) and the Ministry of Spatial Planning and Environment (VROM). From 2011 onwards: Ministry of Infrastructure and the Environment (IenM) of The Netherlands (co-donor).

At Island level:

- The Executive Council of Bonaire;
- WEB, the Water and Power Company of Bonaire;
- Dept. of Physical Planning and Management, Bonaire; DROB;
- Dept. of Agriculture and Fisheries, Bonaire; LVV;
- Garbage Collection Company of Bonaire: Selibon;
- Dept. of Hygiene, Bonaire, DGH;
- Other Stakeholders / working groups:
  - ALIANSA: Nature Alliance, Bonaire;
  - BONHATA: Bonaire Hotel Association;
  - BHG: Bonaire Hospitality Group;
  - STINAPA: National Parks Foundation, Bonaire.

2.12.12. Conclusions and recommendation EU / stakeholder participation

Conclusions. Stakeholders have been participating fully in the project.

Recommendations. Given the question marks regarding sustainability and appropriateness of the solution at hand, in future stakeholders should be added that could come up with non-conventional solutions.

2.12.13. Question EU / coherence strategy urban development

Is the project in coherence with EU strategy in Urban Development?

2.12.14. Answer to question regarding EU / coherence urban development

Considering the strategy in Urban Development, the preservation of blue and green infrastructure and preservation of agricultural land and the promotion of local production it can be considered that the project having as objective the safeguard of the coral reef and consequently to contribute to the development of tourism on the island is in coherence with EU strategy in Urban Development.

2.12.15. Conclusion and recommendation regarding EU / coherence urban development

Conclusions. In itself the project is coherent with the EU strategy on preservation of blue and green infrastructure.

Recommendations. Not applicable.

2.12.16. Question EU / EDF visibility actions

What EDF visibility actions were undertaken?

2.12.17. Answer to question EU / EDF visibility actions

The EU visibility is given a lot of attention through placards, signs, project cars, newsletters, project documentation, radio and television, leaflets etc. The Contractor put up large billboards, clearly showing the EU as the principal project donor. Three billboards were placed at strategic spots on the island and are still present. See Figure below 9. OLB placed a billboard in the centre of Kralendijk (Figure 10). During 2013, several local media announcements had been made regarding the progress of the works, especially since connections have been implemented on private properties. The donor logos are always present on the flyers, specially prepared for the house connection information[17]. Also in the colophon, EU is mentioned, see Figure 11. Officials, the public and the press were present at the start of the construction ceremony during which EU visibility was ensured through EU signs, the EU flag, speeches and press releases and media coverage on TV, social media and in local newspapers. The Commission has expressed its desire to have a commemorative plaque installed on the site of the treatment plant. This issue is being addressed by USONA when the official opening ceremony is taking place.

Figure 9: Billboard in Kralendijk north

Figure 10: Billboard in the centre of Kralendijk

[17] Source: Final Report USONA, 2015

Figure 11: Colophon folder connection to sewerage

In Appendix O part of the communication tools and activities during 2013 and 2014 is presented in Dutch. From this we learn that following tools were used:

- Press releases: 2 in 2012, 8 in 2013 and 4 in 2014;
- Briefing of the press and excursion on 10 December 2014;
- Design and use of a Motto/logo: "*clean water for now and later*" that later was changed into: "*A clean Bonaire for us and our children*";

- Newsletter Awa Awe: 6 per year;

- Radio programs and radio spots;
- Television: monthly 5 minutes prime time TV that was repeated and television panel 7 Oktober 2013;
- Radio panel 18 December 2014;

- The 'theme of the month' was discussed in day advertisements in the 'Extra's;
- Internet: as loading up the OLB website did not go up to the wishes, a dedicated website was created in June 2014: www.kloaka-bonaire.com;
- Social media: there is a Facebook page, Twitter and Youtube: Kloaka.Bonaire;
- Leaflets in Papiamento, Dutch and English on how to connect to the system;

- In the framework of the campaign "*Attention what to flush*" and "*keep medicines separately*" special leaflets were distributed home to home in Bonaire in Papiamento and Dutch;

- Direct mail: on 6 February 2013, 75 businesses and 990 households in the service area received a letter in which the project was announced and explained. On 29 November 2013 all households and businesses received a letter on what to flush into the system (Paga tunu kiko bot a spula). In August 2013 all households and businesses received a letter on the deadline for free connections and in October 2014 on the connections in Belnem;
- **Open day:** On Saturday 14 December, 2013 the doors of the WWTP were opened;

- **Festival "Open the tap"** on 24 May 2014 where the community of Bonaire was invited on the Wilhelminaplein to celebrate the start of the utilization of the sewerage and WWTP;

- Quizzes**:** on 19 November 2013 a quiz was organized regarding wastewater by "*Young Bonaire*" on the occasion of 50 years WEB;
- Flyer teams: On special occasions flyers are being distributed;
- Article Makubeken: in August 2013, an article was published in Makubeken, a quarterly house-to-house magazine;
- Bill boards: in December 2013, on several places billboards were erected;
- Posters: on the occasion of the open day at the WWTP, posters were produced;

2.12.18. Conclusions and recommendations EU / EDF visibility actions

Conclusions. The EU visibility is given proper attention through placards, signs, project cars, newsletters, project documentation and reports.

Recommendations. Not applicable.

3. OVERALL ASSESSMENT

3.1. OVERALL ASSESSMENT

3.1.1. Scope of Works

The main expected results of the project are the implementation of a sewer system and of a wastewater treatment plant in Bonaire. By this it is expected to reduce the amount of Nitrogen discharged into the sea, thus safeguarding the coral reef and assuring the survival of the most important attraction for the tourists on Bonaire Island.

The Feasibility Study for the sewer system, for the WWTP as well the Tender Documents has been prepared Dorsch Consulting of Germany.

The technical solution adopted includes a sewer system based on vacuum system and a WWTP using SBR treatment process.

3.1.2. Implementation arrangements

To assure a proper implementation, the following arrangements were made:

1. The Delegation Agreement, by which the European Commission delegated the authority of implementing the 9th EDF Programme to the EU member state body SONA, was signed on December 22nd, 2008 and ended on December 31st, 2014. The Delegation Agreement installed a system of indirect centralised management, by which the Commission delegates its budget implementing powers to a Delegatee body to implement the project;
2. The Financing Agreement between the Commission and the (former) Netherlands Antilles was signed on May 8th, 2008. Due to delays in implementation, the Financing Agreement was extended to June 30th, 2015. The duration of the operational implementation phase was extended to June 30th, 2014. The one-year closure phase runs from June 30th, 2014 to June 30th, 2015;
3. The Works contract between USONA and the Contractor MNO Vervat International B.V was signed on September 16th, 2010. The commencement date of the works was set on October 16th, 2010. The period of performance of 24 months therefore ended on October 16th 2012, followed by one-year maintenance period. The agreed Contract Price is € 19,670,700 (excl.€ 1,035,300 contingencies);
4. The Service Contract for Supervision with Hydroplan GmbH of Germany was signed on December 18th, 2009. The commencement date was set on October 1st, 2010. The delays in performance of the Contractor forced USONA to adjust the available budget several times (seven Addenda were concluded) and to extend the period of performance of the service contract. The latter issue was handled in Addendum 5, defining the extension of the period of performance of Hydroplan GmbH by 17 months, ending April 30th, 2015;
5. The Beneficiary (now Public Entity / Openbaar Lichaam of Bonaire) has chosen the following participants:
   - The Supervisor is TNO, represented by Mr. Michael Franklin Blom (TNO);
   - Operator WEB (Water- en Energiebedrijf Bonaire N.V.).

3.2. CURRENT STATUS OF THE WORKS

The works started on October 16th, 2010 and on October 29th, 2012 the contractually defined 2 years and 13 days of implementation time had elapsed. The Supervisors Representative granted a time extension of 13 days.

Partial Provisional Acceptance was issued on June 30th, 2014 with a delay of 610 days. The Works of the WWTP are not included in the Partial Provisional Acceptance.

The Beneficiary, with guidance from the Supervisor's Representative, started-up the system, which has been operational since September 9th, 2014.

WEB is operating the system since then, although the Contractor did not complete several works yet.

A summary of the implemented sewerage connections is presented in the table below

Sections	Total units Acc contract	Total Units current implemented	In service
Grand Total COMMERCIAL	77	73	63
Grand Total PRIVATE	818	995	801
TOTAL	895	1068	864

Table 9 Summary house connections

The WWTP is operating in manual mode only while the denitrification, filter station and UV treatment are not in operation. Hence, the effluent cannot be used for irrigation.

In November 2014, the Contractor gave a 14 days Notice to USONA claiming 'Termination by the Contractor' and left the site.

USONA initiated an amiable settlement procedure with is not concluded yet.

At present the financial aspects of the Works Contract are as follows:

- Performances Guarantee over 10 % of the Contract prices in place and valid;
- Retention money - 10 % available;
- Advance Payment returned completely;
- Total amount of IPC approved and paid is of about € 16 million;
- IPCs not paid: IPC 20 with a value of € 1,005,402 and IPC 21 with a value of € 225,246;
- Works paid but not accepted: pressure pipe for irrigation - estimated amount € 1 million;
- The total Works accepted and paid to date are estimated at € 15 million;
- The financial progress of the contract to date: € 15million/ € 19.6 million = 76.5 %.

The physical progress on site is estimated at 95 %. By comparing the two figures 76.5% and 95 % it can be concluded that the management has worked properly and that the Contractor was not overpaid

The absence of the Contractor and the dispute with the Contractor creates considerable difficulties, mainly for the operator WEB who misses the assistance, which a Contractor normally provides during the defects liability period.

3.3. CURRENT PERFORMANCES OF THE SYSTEM

The plant and the sewer system are operated by WEB although only a partial provisional acceptance was performed. For the time being the hydraulic load entering the plant is only at about 80% of the minimum flow considered in the design data; The COD is around 400 mg/l, which is to be expected. The removal of COD is normal and as far as COD and BOD is concerned the effluent quality is all right. However, the Nitrogen effluent

standard for use in hotel gardens, put at 5 mg/l is not met. This is logical as the denitrification step is not operational yet. From this point of view the performances of the system are considered as acceptable taken into consideration that the above-mentioned results represent results of first 5 months of operation under difficult conditions, reduced flow and reduced biological load.

After all recommendations made are implemented the performances will improve considerably and almost all parameters of the effluent could be reached. The limit of 5 mg/l Nitrogen is a very difficult task and for sure related to considerable operation costs.

3.4. MAIN FINDINGS

The main findings of the evaluation are:

- The proposed Works are relevant for the protection of the coral reef;
- The arrangements have been appropriate to the project, creating the adequate legal and contractual framework for the project that could have led to the expected results;
- From the point of view of the effectiveness, the objectives are currently partially achieved. Important is to mention that the Works Contract is in a delay of 24 months and not yet complete;
- The factors, which have contributed to the present situation are as follows:
  a. Performance of Works Contractor. The main responsibility for the current situation is the Contractor MNO Vervat, especially because of the poor quality of several works as well as the considerable delays in completion of the Works;
  b. Performances of Supervisor Representative. From the lecture of the different reports considering the quality problems, the delay in execution, the long list of Contractor' claims, it can be concluded that the Supervisor representative (Hydroplan) has not managed the Contractor properly.
  c. The Contracting Authority, USONA, has concentrated their effort on not exceeding the Contract Price and not approving unjustified requests for payment but has failed to assure the implementation on time of the Contract. The lack of experience and insufficient staff most probably have generated this situation.
  d. Relatively unknown and relatively complex system. The selected technical solutions: a vacuum sewerage system and SBR are unknown on Bonaire. The choice for vacuum sewerage was based on the fact that excavation in the rocky -underground would be extremely expensive. However, it takes time and imported expertise to implement such a system, as it is relatively complex compared to other systems. Neither the contractor, nor the subcontractor and supervisor had any experience with the system. The choice for a rather complex treatment like SBR is not justified and unusual: normally SBR is applied in an industrial environment where flows and quality of wastewater are well defined and with limited availability of land, which is not the case here;
  e. Cost estimation in the Feasibility Study. In the Feasibility Report, Dorsch has considerably underestimated the costs. In the first tendering, all offers were about 50 % higher than the budget. A more accurate investigation regarding the unit rates in the area would have offered a realistic investment cost and consequently the possibility to adapt the technical solution to the available budget. An important delay in the implementation of the project would have been avoided;
  f. Overestimation of the wastewater flows. The Feasibility Study and the Tender Documents have overestimated the wastewater flow and the organic load. The proof for this is the fact that at present with about 99 % of the house connections implemented and connected, the influent flow to the WWTP is below the minimum flow adopted in the design. A more realistic approach would have led to design parameters that could have been achieved easily. This approach would also not have offered an excuse to the Contractor for not testing the WWTP. At the moment the Contractor claims he cannot test because of the flow is too small and the organic load too low. A more realistic approach would also have resulted in much lower investment, operation and maintenance costs;
  g. Reduced number of bidders in the Works tender procedure. The competition for the Works Contract was very limited, as only 2 bidders have submitted offers.
- With respect to the quality of the financial project management by the Delegated Authority USONA, the evaluators are the opinion that the management has worked properly and the contractor was not overpaid;

- With regard to non-financial aspects, the project management by the Delegated Authority USONA should have had a more active and a stronger position towards the poor performance of the Supervision Representative and especially towards the Works Contractor. It is also noted that the progress of the amiable settlement is very slow. The fact that the action needs careful analysis is obvious, but it has also to be considered that urgent measures are needed to complete the works;
- As complementary activities such as house/commercial connections have been implemented, other donors have had an important contribution to the implementation and operation of the project;
- Other donors have also contributed to the implementation of the project: Apart from the € 5 million share in the sewerage and WWTP costs, the Dutch Government provided € 10 million for the necessary house/hotel connections on private premises as defined in the Special Conditions to the Financing Agreement. The Netherlands Ministry of Infrastructure and the Environment (IenM, formally the ministries of Verkeer en Waterstaat en VROM) finances the house/hotel connections in Phase 2 of the ongoing connection project. IenM has also committed itself to finance operation and maintenance (O&M) as long as the fees collected from house/hotel connections and sales of irrigation water are insufficient to cover O&M;
- The sustainability is assured by the following:
  a. The legal frame for operating the system is in place. All households and commercial enterprises are obliged to connect to the sewer system, although law enforcement by OLB is a point of attention;
  b. The Dutch Government has assured topping up of finances to guarantee operation and maintenance in the future: on the long run people on Bonaire are to pay a fee that is comparable to the fee paid in The Netherlands and the difference is paid by the Kingdom of The Netherlands (IenM);
  c. An important issue is the completion of the works for house/hotel connections and to assure a more substantial flow and organic load to the WWTP;
  d. The WEB operates the energy and water supply on Bonaire efficiently and therefore the operation of the WWTP and the sewer system should not create special difficulties. Due to the specifics of the wastewater treatment and the sewerage system, WEB has to assure skilled personnel like a process engineer for the WWTP and mechanical staff for the operation and maintenance of the sewer system. A point of attention is that WEB needs to increase its technical capacity with additional staff and should enhance the professional capacity of the available staff by training and change of experience with similar WWTP.

Summary

The system is not 100% completed and is partially accepted. This situation can to be solved only after the amiable settlement procedure is finalised, either by completing the works under GC 64 of the Works Contract or per settlement. This issue should have first priority. Even under these conditions the system is working in an acceptable way and the effluent from the WWTP is also acceptable considering the small flow and reduced load.

Besides the completion of the Works according to the design and the contract, the operator WEB has to execute many improvements and repairs. The most important are:

- The reduction of power consumptions;
- Implement measures to avoid deposits in the Booster station and in the pressure line to the WWTP. These measures have to assure that all wastewater is pumped to the WWTP and will eliminate the need to clean the wet well of the pumping station weekly. Pumping the water including the present deposits would also mean that the BOD load is higher and that the WWTP will work better;
- Create the possibility to transfer the wastewater from the AWZI to the new WWTP. Taking into account that the discharge of vacuum tanks into the WWTP was in the initial design, it can be assumed that this will not influence the treatment process in a negative way. The additional flow and load will most probably influence the treatment process positively. The process of transfer of the wastewater should be initiated after the process engineer is in place, so that he can coordinate the process. It would be also of an advantage if the plant would be operating in automatic mode.

3.5. RECOMMENDATIONS FOR OPTIMIZATION OF THE SYSTEM

The current investment has to be optimized by measures to be undertaken by WEB as well as by the Beneficiary (OLB).

Regarding *WEB*:

- WEB should enter into a contract with a wastewater treatment expert (expert in SBR process) and assure technical assistance for a period of time on Bonaire for optimization of the treatment process. The foreign expert should work together and train a local young engineer on how to operate the plant in future;
- The WEB team should continue the training activities and exchange of experience with operators of similar plants;
- WEB should have an up-to-date a list of repairs, remedies and replacements which are needed;
- WEB should continue to cooperate with wastewater utilities, which have a long experience in operation and maintenance of vacuum systems in order to share skills and knowledge. An assignment of staff for a short period would benefit the project.

Regarding the Delegated Authority:

- The financial resources from the Works contract should be made available if the contractor does not fulfil his obligations (unpaid works, retention money, performance security) and used to complete the works as soon as possible;
- In case the Contractor does not give the access to the automatic system of the plant, WEB has to contact directly the supplier of the software and assure the implementation, testing and into operation of the plant in automatic mode;
- The pressure pipe for irrigation has to be put into operation. If the pipe installed is not in accordance with the specifications it has to be replaced and the costs to be covered either by the Contractor or with money from the Contract deducted from the Contractor. Any other solution proposed would be a compromise and should be avoided;
- Adding as many house connections as possible to the existing system within the service areas;
- Improving all other on-site sanitation systems on the island: assuring that all cesspits are converted into septic tank systems, assure that septic tanks are watertight and produce an effluent that fulfils strict environmental criteria such as reduced nitrogen load. Most 'septic tanks' are in fact cesspits where raw sewage leaks into the soil. Hence, the building code needs adjustments[18].

3.6. LESSONS

From the evaluation of the project the following lessons can be concluded:

- The base data regarding existing population and growth rate, water consumption, wastewater production, organic load should be intensively analysed. Overestimation leads, next to increased investment costs, also to considerable operational difficulties if the minimum flow and biological load are not assured. In addition, the Works Contractor uses the fact that the minimum parameters are not reached to claim additional costs or terminate the Contract;
- The data base for the confidential costs estimation should be based on the real prices in the area;
- The Technical solutions for example treatment process should be adapted to the local conditions in order to minimize investment costs as well as the operational costs. The introduction of modern processes that are difficult to maintain and operate need to be justified before eliminating conventional processes that offer a better chance of successful operation under difficult conditions;
- Even though a well-known international consultant prepares a project, the local authorities should analyse, ask details about the implication of what is offered. More involvement from this side is needed;
- The Contracting Authority should intervene strongly and efficiently from the first sign of poor performance of the Supervisor or especially of the Works Contractor trying to avoid big delays.

[18] Information USONA and OLB May 2015.

4. CONCLUSIONS AND RECOMMENDATIONS

As far as conclusions and recommendations are concerned, the evaluators distinguish between conclusions and recommendations that contain transferable lessons for future similar projects and conclusions regarding the current Bonaire project.

4.1. CONCLUSIONS

As far as the current project Sewerage and Sanitation Project is concerned the conclusions are:

a. The system is not completed and not fully operational yet. It is also underutilized as some parts were overdesigned. This leads to underperformance, especially when it concerns the WWTP;
b. The project has made an excellent start in achieving the objective of protecting the coral reefs from Nitrate pollution. However, Nitrate from sewage is only one of many sources. Hence, the current solution is only part of the beginning.

As far as conclusions are concerned that contain transferable lessens for future similar projects, the evaluators refer to the major factors for only partially achieving the project objectives that are identified being: Relatively unknown and relatively complex system; Underestimate of the costs in the feasibility study; Overestimation wastewater flows; Reduced number of bidders; Poor performance of supervisor representative; and Poor performance of works contractor.

When clustering, these factors lead to the following main 3 conclusions:

c. The project was technology driven and could have been better prepared. Signals from parties that were questioning the choices made were neglected and the local situation could have been better investigated (prices, actual water consumption, wastewater production);
d. The choice amongst the bidders for the project was restricted to only two who did not really have experience with the technology at hand which caused a lot of problems;
e. The execution of the works and the initial supervision leave a lot to be desired. Only when it was too late parties were selected that had both the expertise and skills to work in the Bonaire conditions.

Ad conclusion a: the system is not completed and not fully operational yet.
There remain many households and commercial entities that would like to connect the system. The households and commercial entities that are connected produce a wastewater volume that is much less than anticipated. Parts of the vacuum lines are not air- and water tight yet and lead to unnecessary energy consumption. The state of the booster station leaves a lot to be desired and the WWTP does not treat the wastewater up to the chosen standard. The quality of the effluent is not fit for distribution and if it were fit, the irrigation line is defunct. In addition, the evaluators doubt whether the chosen effluent standard is a realistic one, given the technology that has been adopted (SBR). Hence a lot of work needs to be done to complete and operationalize the system. USONA and WEB have hired several consultants (Dorsch, RoyalHaskoningDHV) to advise them on what measures to take. Some of the advices contradict each other and some of the advices mix the 'nice-to-haves' with the 'bare minimum to operationalize the system'.

Ad conclusion b: the current solution is only part of the beginning.
The objective of the project is the safeguarding of the coral reef. It is a fact that the release of Nitrate is an important factor. Nitrate is released by human waste, but there are many other sources: surface water runoff, fertilizers, solid waste, animal waste, etc. The current project has laid an excellent base to protect the coral reef and should give a boost to other activities that are needed.

Ad conclusion c. the project is technology driven and during the design and implementation signals from outside were neglected.

- In the Feasibility Study, the solution chosen to deal with human waste management has been vacuum sewerage. As far as the Bonaire conditions are concerned, this system is relatively high-tech, rigid,

extremely expensive in construction and operation and maintenance, difficult to construct and cumbersome to operate and maintain. During the feasibility study and afterwards, many stakeholders have questioned the appropriateness of this solution and even today OLB is hesitating to take the responsibility for it. The situation at the moment shows that the 'criticasters' had a point: the system could only be constructed thanks to grants from the EU and The Netherlands and it can only be operated, maintained and sustained thanks to grants from The Netherlands. Both technically and financially it is not a system that could have been implemented and operated independently from external assistance. WWF, the World Wide Fund for Nature had executed an alternative study to identify solutions that could technically have been more appropriate to the local conditions, flexible, less costly in construction and operation and maintenance, more easily to construct. Hence, it seems that the study process was technologically biased and that the stakeholders were not adequately heard and consulted. *So the sub-conclusion here is that the project has failed to be open to other opinions and less technological solutions*;

- A logical point in time where it still was possible to come to another solution was after the bidding, when it was clear that Dorsch had underestimated the costs of the project by more than 50% (for details, see § 2.4.20.2). Hence, it seems that by this time the project objective had changed from 'protecting the coral reef' to 'constructing a vacuum sewerage system'. *So the conclusion here is that a logical moment in time to reassess the project was wasted and that the overall objective seemed to have gone lost*;
- Apart from the choice for vacuum sewerage, the evaluators criticise the choice for an SBR. Usually this is based on shortage of land and chosen in an environment where quality and quantity of wastewater is fairly well known and where there is not sufficient land available. There are many wastewater treatment technologies that can better handle variations in influent. It is also not clear and, in the views of the evaluators not logic, that in the design of the WWTP the existing AWZI where wastewater from septic tanks is being treated has been neglected other than skipping the inlet structure for receiving vacuum trucks. Hence, the question is whether the consultants have been taken the local conditions well enough into account and whether the supervisors were critical enough when studying the conclusions and recommendations of the consultants. *So the conclusion here is that the chosen technology for wastewater treatment did not take into account the local conditions and uncertainties about the future wastewater flow*.

Ad conclusion d. The number of bidders was restricted to two.
During the bidding period, only three bids were received and one bid was not eligible. To comply with the 'D+3 rule' negotiations with the two companies that finally submitted a bid were opened. MNO Vervat was selected, a company that has experience in road construction but not in vacuum sewerage. It is beyond doubt that all procedures were followed properly, but even so the fact remains that the selected contractor has failed to do a good job and that the current situation can to a large extent be blamed on the contractor. *So, the conclusion here is that a number of two bidders restricted the choice.*

Ad conclusion e. Execution of the works and supervision failed.
The available reports indicate without doubt that the contractor has failed to do good job and the evaluators are the opinion that the Supervisor should have been more active. The following pictures, taken from the Dorsch Fact Finding report of January 2015[19], illustrate these conclusions. Remark from the evaluators: the irrigation pipe does not clearly indicate that this is not a drinking water pipe. In future, people willing to connect to the drinking water can easily get confused and connect their drinking water to reclaimed water.

[19] Dorsch Consultants, Fact Finding Report, March 2015

Figure 12: Masonry on top of vacuum pit that could lead to infiltration of storm water (Source: Dorsch, 2015)

Figure 13: Lack of distance between pipes in trench (Source: Dorsch, 2015)

Figure 14: Pipes in one trench, too close to each other (Source: Dorsch, 2015)

4.2. RECOMMENDATIONS

As far as the current Sewerage and Sanitation Project is concerned the recommendations are:

- Target group: *Public Entity Bonaire, WEB, USONA, EU and the Ministry of IenM in The Netherlands*. The evaluators recommend undertaking everything that is possible to complete and operationalize the system. In terms of completion:
  - Add as many connections as possible;
  - Repair leaking vacuum pipes and optimise pumping stations, refurbish vacuum pits in such a way that there is no storm water entering the vacuum sewers. In addition, order enough spare parts to be able to repair any broken parts in time;
  - Solve the problem of deposits in the Booster pumping station 1 and eliminate weekly cleaning with vacuum tanks;
  - Complete and optimise the WWTP:
  - In order to do this it is indispensable to *investigate the cause for the low flow*. The evaluators recommend to WEB combining the database of water sales with the database of sewer connections. In this way it can easily be found out how much drinking water is used and how much ends up in the WWTP. If there appears to be a large discrepancy, it is recommended to investigate the causes: are people using the excess water for irrigation at home or are there on-site systems that are not connected to the vacuum system? It is clear that the design parameters used in the project are not valid, but it is not clear which parameters: occupancy rate hotels, number of persons in a household? Per capita water use hotels and households? % Water used for irrigation at home? Or is the system leaking?
  - Assure the transfer of wastewater from AWZI plant to the new WWTP;
  - Repair the defects at the WWTP;
  - Investigate the best way for denitrification. Once the methanol dosing has been installed, this could be a significant extra operational cost. The evaluators recommend to investigate other, less costly methods;
  - Install a new irrigation line and start distributing irrigation water so that the hotels can harvest the fruits of the project and so that income can be generated to cover part of the O&M costs;
- Target group *Public Entity of Bonaire*:
  - Monitor the effects of the project on the quality of the groundwater by sampling twice a year (dry season and wet season) from the 32 installed groundwater 'stations'. The stations were financed by The Ministry of IenM and were used in the past to investigate the microbiology, nutrients physicochemical[20]. The evaluators recommend to find funds (around € 10,000 per year for two rounds) and recommence the sampling so that there is an objective method to assess the effect of the project;
  - Take all other actions needed to harvest the benefits of the investment by eliminating as many Nitrogen sources as possible. The evaluators recommend to improve solid waste management, convert cess pits into septic tanks, seal all septic tanks and install post treatment on the on-site sanitation systems for denitrification such as vertical flow constructed wetlands, ban the import, sale and use of chemical fertilizers, reduce the influx of excrements of goats and donkeys into the ocean etc. etc.

As far as transferable lessens for future similar projects are concerned the recommendations are as follows.

- Target group: *staff that prepares Terms of References for studies in the Caribbean:* The situation on small islands as Bonaire demand a careful approach: the environment is delicate and the community is rather small. Interventions from outside can have other effects than anticipated. Hence, the evaluators recommend for the future that a process be assured where the consultants that are hired incorporate non-technological aspects and are open to inputs from all stakeholders involved. As far as future

[20] Source: Frank van Slobbe, MSc Policy Advisor Environment and Nature Directorate of Spatial Planning and Development Public Entity of Bonaire

wastewater projects are concerned in areas where there are no systems yet, it is also recommended to design solutions that are capable of coping with many uncertainties and unknowns: quality and quantity of domestic and non-domestic wastewater, urban growth, spatial planning, economic development, local skills and experiences etc. In short the process need to be designed in such a way that it is appropriate to the local conditions;

- Target group: *USONA and WEB*. When supervisors are hired to assess the quality of the work of the contractors, assure that they are active in the field and do not accept work that is not up to the quality that is required. Assure that the supervisor is familiar with the way of working and the attitude in the region.