New integrated impact assessment method

This graduation study contains two reports and a loose supplement. The main report is titled “Strategic Impact Assessment; a new impact assessment method using value engineering and system engineering elements.” The main report can be found from page 2 through to 64. An appendix to this report is the case study, titled “Strategic impact assessment golf resort St. Eustatius; Reviewing and improving the impact of a planned golf resort on the island of St. Eustatius.” This appendix is confidential and should be treated as such. It is included from page 65 to 166. The loose supplement is included as the last page of this document, on page 167.

Strategic Impact Assessment

A new impact assessment method using value engineering and system engineering elements.

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Preface

Large construction projects can potentially change the lives of many people. Due to the nature of these projects they are usually irreversible and not suited to be constructed temporarily to determine their impact. This means decision makers and stakeholders alike want to have reliable information about the impact of a project before any irreversible decisions are made.

An impact assessment is a document that aims to give a prediction of the impact that a project will have. There are several forms of impact assessments, for example the environmental impact assessment, the social impact assessment and the economic impact assessment. Currently each of these impact assessment fields generates their own report, which contains information about one impact aspect only. Questions are raised whether the current method of impact assessment delivers the information that is required to make well-informed decisions. As indicated the impact assessments are currently following an aspect-by-aspect approach, delivering detailed information on the specific fields, but neglecting cross links between the aspects. The resulting separate impact assessment reports may be contradicting or review different alternatives of the same project.

This report develops a method for impact assessment based on the construction management methods of value- and system engineering. Using these methods the aim is to develop an integrated impact assessment method that reviews all impacts in a single document, allowing the review of links between the impact fields. This study is performed as part of achieving a master degree for Civil Engineering and Management at the University of Twente in the Netherlands.

Using the developed integrated impact assessment method a case study was performed. The case study is available as a separate document, titled ‘Strategic impact assessment golf resort St. Eustatius’. It reviews the economic, social and environmental impact of a planned golf resort on the island of St. Eustatius.

The case study was performed on the island of St. Eustatius on request of the St. Eustatius Business Association (STEBA). The impact assessment is partially based on an earlier feasibility study performed by Rob Blokvoort and Tom Tiggeloven, both students of the University of Twente. I wish to express my thanks to the STEBA for providing me with the opportunity to perform this impact assessment and especially for the hospitality and warm welcome by STEBA president Mr. Koos Sneek and Mrs. Nora Sneek-Gibbs.

An impact assessment is not possible without information from the stakeholders. During the time on the island I have therefore discussed the impact with a large number of local businesses, (public) organisations and (government) agencies. I wish to thank these persons for the time they spend answering my questions and for the information they have provided.

Furthermore I want to thank my graduation committee, Ir. K.Th. Veenvliet, Dr.Ir. S.J. de Boer and Dr. Ir. M.J. Kolkman for their support and (constructive) criticism, which together improved the quality of this report. I also want to thank Mr. M.R. Stienstra for his assistance in finding the case study project.

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Executive summary

Impact assessment is an important tool to inform decision makers and stakeholders in advance about the impact their decisions will have. Within the field of impact assessment an aspect-by-aspect approach is currently used. For each impact, economic, social and environmental, a different team will write their own report. Links between the impact fields can therefore not be taken into account. The different reports often review different alternatives and may be contradicting. Based on the incomplete, inconsistent and sometimes contradicting information, decision makers currently have to draw their own conclusion about the overall impact of the project.

From the impact assessment community there are calls for a new 'integrated impact assessment' method. This method should deliver a single document, which reviews all the impact fields. The method should offer traceability, assuring that decisions made during the impact assessment process are made explicit and traceable. It should make second order effects visible, which are effects caused by the impact of the main project. Finally it should provide the links between the impact fields, making trade-offs between the impacts on different impact fields possible.

Based on the observed problems in the impact assessment community, this report asks the question: *How can the methods of system engineering and value engineering be integrated with the environmental impact assessment and can the resulting integrated impact assessment method be used to find and solve or mitigate the environmental, social and economic impact of a planned golf resort on St. Eustatius?* The question contains two phases. The first is a theory developing study, which develops the integrated impact assessment (IIA) method. The second phase is a case study, which applies the created method to find benefits and limitations.

It was found that the current impact assessment procedure has a large resemblance with a design process. Based on stakeholder requirements different alternative designs are created, which are reviewed for their impact. Within the field of construction management the design process also plays a prominent role. The methods of system engineering and value engineering are used to combine the expertise of different experts and work with the stakeholders to reach a design solution. It is therefore expected that the construction management methods can offer a new framework for the integrated impact assessment process.

The contribution to this new method from system engineering is that it offers a full framework for a design project. It covers the process from the stakeholder requirements to a finished design. A key point of system engineering is traceability, making clear how and why decisions are made. Value engineering is used as a method that provides a better understanding of the problem and aims to achieve consensus amongst the stakeholders over a common view of the problem. By better understanding the problem, more effective solutions can be found.

Combining system engineering, value engineering and the environmental impact assessment method leads to the new integrated impact assessment method. To be able to combine these methods, the link between system engineering and value engineering is created by use of a method by Gause and Weinberg, which transforms the functions developed by value engineering to system solutions, which are the input in the system engineering process. The resulting new integrated impact assessment method is shown in a diagram on the next page (figure 0.1).

Using the IIA method a case study was performed on the island of St. Eustatius. The case study reviews the economic, social and environmental impact of a planned golf resort. By reviewing the process of creating the case study and reviewing the result it is possible to, at least based on this case, find the benefits and limitations of the method.

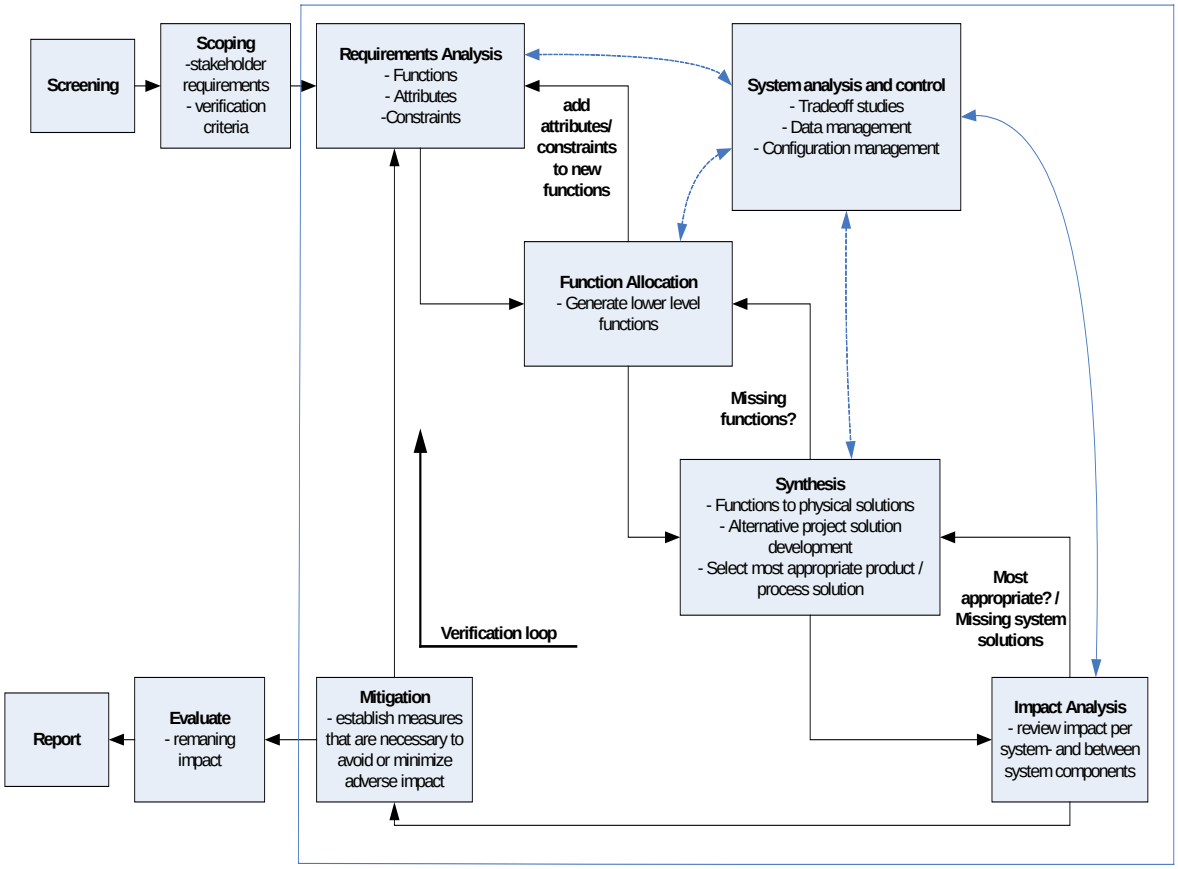


Figure 0.1 – new Integrated Impact Assessment method.

The results of the case study indicate that the IIA method is indeed able to provide traceability, can show links between impact fields, make 2nd order effects visible and can present all impacts in a single report.

The specific situation of the case study is that the project is located on a small island. This simplified the case study, as the golf resort affects the whole island and the available resources are relatively easy to determine. It was not possible to use a workshop approach on the island, whereby multiple team meetings would be planned. Instead, an interview approach was used, with a single workshop at the end of the study to review the results with the stakeholders. During this meeting it became clear that the interview approach missed some 2nd order effects.

1 Research plan

1.1 Background and objective

Within the field of the Environmental Impact Assessment (EIA) there are calls for a more integrated approach to impact assessment [MER-Commission, 2001]. Currently there is segmentation within the impact assessment field, whereby different teams of experts work on impact reports aimed at different impacts (social, economical, historical, environmental, etc). Decision makers will therefore receive several reports, whereby each report may come to different conclusions. The different reports do not show links between the impacts either. This means that decision makers now have to make decisions by reading between the lines to find links between impacts. They then have to draw conclusions from several separately performed studies which may very well contain conflicting information. An integrated approach should enable decision makers to make a decision based on a single document, that reviews the impact on all fields and also shows links between these impact fields.

The impact assessment process appears to be one where first, a preliminary design of the project is created after which this design is reviewed for its impact. Within the field of construction management, the methods System Engineering (SE) and Value Engineering (VE) are two methods that are used to determine the full set of functions of a project and systematically turn those functions into solutions. By using these two methods it should be possible to create a preliminary design that includes all impact fields and their links. The hypothesis is that reviewing this preliminary design for its social, environmental and economic impacts will give a good overview of the complete impact of a project.

Based on this background, the objective of this study is to develop an integrated impact assessment method by combining the above-mentioned methods. This integrated impact assessment method will then be used to execute an impact study on the island of St. Eustatius, in the Netherlands Antilles.

With a landmass of 21km^2, St. Eustatius is one of the smaller islands of the windward island group located in the northeastern Caribbean. The Quill, a dormant volcano, covers a large portion of the island. Even though in 2003 the BNP was the highest of the smaller islands, unemployment is at 6 – 10% and increasing [Staten Generaal 2003]. A large employer on the island is Statia Terminals B.V., which operates a large crude oil transshipment facility. Along with this facility, tourism and a medical school play important roles in the economy of the island.

The island promotes itself as an eco-tourism delight. The main attractions are the two national parks with rare flora and fauna as well as the good diving conditions due to the ample marine life and historic shipwrecks around the island.

To further promote the tourism sector, the St. Eustatius Business Association (STEBA), Tourism Development Foundation and the island Government are investigating the opportunity to develop a golf resort on the island. A study has been performed to research the economical viability of such a project. Further research is required to determine the environmental, social and economic impacts of a golf resort.

The objective of the research therefore is:

Objective:

To combine the (strategic) environmental impact assessment with the construction management methods of value engineering and system engineering, testing the resulting method by applying it to a planned golf resort on the island of St. Eustatius.

The methods of value engineering and system engineering are combined with the environmental impact assessment method. This results in the new integrated impact assessment method. The word integrated in this context means that, instead of looking at only one field at a time, this method will review all impacts. The expected advantages of this integration are:

- The decision maker gets a single report which draws conclusions based on all information.
- The method will show links between the different impact fields.
- Recognising links makes it possible to solve negative impacts more effectively and efficiently.

1.2 Problem formulation

The problem formulation determines, amongst other things, the scope of the research. In search of an appropriate project formulation the following has been taken into account:

Theory developing and case study
The research can be split up in two phases. The first phase is a theory developing study, which will develop a new impact assessment methodology, based on an evaluation of the problems with the current EIA method and relevant literature on VE and SE. When the theory has been developed, the research will switch to a case study, to test the method in a case situation. The characteristics of a case study [Doodewaard et al., 2000] are a small number of research objects, a labour intensive approach, more depth than width, qualitative data and research methods and research on location.

Integrated Environmental Impact Assessment
As indicated in the previous section, the environmental impact assessment community is looking for a more integrated approach to the impact assessment methodology. What is the current procedure and what is wrong with it that causes the call for an integrated approach?

Currently an Environmental Impact Assessment is a procedure that is individually performed. According to the best practice procedure [IAIA, 1999] it should be applied as early in the decision making process as possible.

Environmental Impact Assessment follows an 'aspect by aspect' approach [MER-Commission, 1998], which means that for every field of impact assessment, a different report is written. This results in an Environmental impact report, a Social impact report, an Economic impact report, etc. The lack of integration in this approach causes cross-links between different impact assessment aspects not to be taken into account. The approach therefore delivers an incomplete view of the impacts.

From two subsequent reports by the MER-Commission [1998, 2001], which will be discussed in detail in paragraph 2.1, it can be concluded that indeed there are problems with the current EIA procedure. The solution to this problem is mostly sought in integrating the various impact assessment studies and by getting the different experts to communicate with each other. The integrated assessment is thought to lead to a better-informed decision making process, which will lead to more fitting solutions regarding the mitigation of negative impacts.

Construction management methods
Within the field of construction management it is important to combine all the various fields of expertise in a single process. It is therefore interesting to see how methods used here can potentially benefit the integrated impact assessment. Two methods that are used in combination with each other to achieve integration in construction management are value engineering and system engineering. Environmental impact assessment (EIA) and the SE and VE methods essentially are creating a design in a process that requires an effort by participants from different disciplines. The difference is in the fact that with EIA the design is then reviewed for its impact. It is expected that the VE and SE methods can aid the EIA process by improving the way in which the design is created. The method will trace stakeholder requirements and decisions and will be able to show links between different elements of the design. As suggested by the MER-commission [2001] report, after combining these methods with the EIA, experimenting with the resulting method on a real project will show its potentials and limitations.

Environmental effects
Throughout the report the term “environmental effects” will be used. This term is intended in the wide sense of the word, as the effects something has on its surrounding. Environmental effects therefore include the biological, social and other relative effects that a project has.

Based on the previous considerations, the problem formulation for the project can be defined as follows:

> **Problem formulation:**
>
> How can the methods of system engineering and value engineering be integrated with the environmental impact assessment and can the resulting integrated impact assessment method be used to find, solve or mitigate the environmental, social and economic impact of a planned golf resort on St. Eustatius?

The first step will be combining the value engineering and system engineering methods with the environmental impact assessment. It is expected that using value- and system engineering methods will structure the process of an impact assessment. The assumption made is that this impact assessment method makes it possible to combine or integrate impact assessments on several fields (environmental, social and economical) into one study.

Integration
A possible definition of integration is ‘*The activity of combining data from multiple data sources to present a single collection of data*’ [IL1]. The word integrated within this report is used in this meaning. The multiple data sources are the three fields of impact (economic, social and environmental) which are combined ‘integrated’ in a single method and thus a single report. This makes it possible to review links between the data that are now lost because the data is presented individually.

To verify the assumption that this new impact assessment method can achieve the goal of integrating several impact reports in a single documents and contains links between the different impact fields, a case study using the created method will be performed. Based on the results of this study, the benefits and limitations as observed in the case can be reviewed. The impact assessment method will first have to find the problem areas within the case at which point solutions can be generated to solve or reduce these problems.

1.3 Research questions

The main research question is the problem formulation. This is the question that is ultimately to be answered. However, because this is a much too complex question to answer directly it has been divided into several research questions. When these questions have been answered, the problem formulation has also been answered. The research and thus also the research questions can be divided in two stages. Question one is a theory-generating question. Questions two through to five are questions that follow a design-oriented approach. This is appropriate for the research, as the research first aims to develop an integrated impact assessment method. Using this method a design problem will be solved.

1. What does the integrated environmental impact assessment method look like?
    a. What are the requirements for an integrated impact assessment method and is there a theory to support it?
    b. What are the basic characteristics of an Environmental Impact Assessment?
    c. What is Value Engineering and how does it improve integration?
    d. What is System Engineering and how does it improve integration?
    e. What should the procedure for the integrated assessment method be?

2. What are the requirements regarding the golf resort project?
    a. Who are the stakeholders?
    b. What requirements/ wishes do the stakeholders hold about the golf resort?
    c. What legislation is relevant?
    d. What is the situation at the proposed site(s) of the golf resort?

3. What does the provisional design of the golf resort look like?

4. What is the result of the impact analysis of the provisional design?

5. Which improvements can be made regarding the negative impact of the golf resort and what are the remaining effects?
    a. Which improvements can be made to reduce or solve the negative impact of system elements?
    b. What are the remaining effects (residue effects) of the golf resort?

1.4 Research approach

The research consists of two parts. First an integrated impact assessment method will be created. This part can be described as a theory developing research. The integrated impact method will be based on the current methods of EIA, VE and SE. To test this new method a case study is performed. In this project the case is a golf resort on the island of St. Eustatius. Using the integrated impact assessment method the impact of the golf resort will be reviewed and where possible negative effects will be solved or mitigated. Based on the case study the integrated impact assessment method will be reviewed for its benefits and limitations. A diagram containing an overview of the research approach is included in appendix I.

Chapter two will develop the integrated impact assessment method, which is the framework for the case study executed in chapter 3.

Chapter 2.1 will answer research question 1a through to 1c. It will establish the theory required to answer research question 1d, which is answered in chapter 2.2. Chapter 2.2 develops the framework for answering the case research questions (question 2, 3, 4 and 5).

Chapter 3.2 will answer research question 2. By interviewing the stakeholders and reviewing the legislation and situation on the site(s) of the planed golf resort the requirements and verification criteria are gathered.

Chapter 3.3 through to 3.5 will answer research question 3 and will go into the transformation from requirements to functions, attributes and constraints. Using function analysis, alternative solutions will be generated. Using system syntheses a system solutions will be found, resulting in a preliminary design.

Chapter 3.6 will review the impact of the preliminary design. Both the impact per system solution and the overall impact of the project will be reviewed. By doing this research question 4 will be answered.

Chapter 3.7 will determine which adverse impacts need to be mitigated or solved. This will require interviews or conversations with the people who will have the ultimate decision power in approving the project.

Chapter 3.8 will review the remaining impact and the significance of the remaining impact. Together with chapter 3.7 this will answer research question 5.

Chapter 4 will draw conclusions from the previous chapters. It will discuss the usefulness and limitation of the method and contain recommendations. Chapter 4 will also include a reflection on the research study.

2 Methodology

1. What does the integrated environmental impact assessment method look like?
    a. What are the requirements for an integrated impact assessment and is there a theory to support it?
    b. What are the basic characteristics of an Environmental Impact Assessment?
    c. What is System Engineering and how does it improve integration?
    d. What is Value Engineering and how does it improve integration?
    e. What should the procedure for the integrated assessment method be?

This chapter will answer research question one. Chapter 2.1.1 will review literature from the impact assessment field to determine the problems with the current method and the requirements for the new integrated impact assessment method. Chapter 2.1.2 will review the procedures of the current environmental impact assessment method. Chapter 2.1.3 and 2.1.4 will respectively review the system engineering and value engineering methods and determine the way in which they can improve integration. Chapter 2.2 provides the framework for the new integrated impact assessment method.

2.1 Theory

2.1.1 Requirements and theory for the Integrated Impact Assessment

As indicated in the previous chapter, the environmental impact assessment community is looking for a more integrated approach to the impact assessment methodology. What is the current procedure and what is wrong with it that causes the call for an integrated approach?

Currently an Environmental Impact Assessment is a procedure that is not linked to other impact assessment fields. A team of experts develops each impact report individually. The best practice procedure [IAIA, 1999] indicates an EIA should be applied as early in the decision making process as possible.

The Dutch commission for environmental impact assessment has delivered two articles about a more integral approach to Impact Assessment. The first article was written in their report *new experiences on EIA in the Netherlands* [MER-Commission, 1998]. In this report it is written that:

"*Until now, appraisers have largely used an aspect by aspect approach to the various specialistic topics and usually invite specialists to advise on the aspects. The product of this approach is a number of sectoral reports, often prepared at different moments in time, with conclusions and recommendations that must be interpreted and combined by the appraisers into a consistent project proposal of acceptable quality on all aspects.*" (page 27)

This shows that the lack of integration in this 'aspect by aspect approach' causes cross-links between different impact assessment aspects not to be taken into account. The approach therefore delivers an incomplete view of the impacts, which will lead to making decisions based on incomplete information. The incomplete information will make it impossible to do a trade-off between effects, which most likely reduces the value of the solution.

The EIA [MER-Commission, 1998] report mentions two approaches to integrate impact assessment. The first one is to synchronize the different sectoral studies and make sure that the

different experts get together and communicate. The second proposal is to generate a procedure to integrate the different sectoral studies. This, according to the paper, can be done at two levels. At a lower level the sectoral studies can be asked to review the same alternatives. This way the decision makers have a single set of alternatives with the impact they have on each sector. Still the aspects that are cross-linked between different studies are not included though. The higher-level integration would be a single study and report, which covers all the sectors and can thus also look at the relationships between them.

An update on the integration of impact studies was given in the report *further experiences on EIA in the Netherlands* [MER-Commission, 2001] by the commission for environmental impact assessment.

In this report it is still found that "*separate studies often use different principles and timetables and investigate different alternatives. The recommendations which emerge from these studies are far from consistent with each other, which saddles the project coordinator with the daunting task of drawing up a coherent and acceptable proposal for making decisions"*. (page 19) It also notes that "*second order effects such as the environmental effects of social changes caused by the projects, as well as other crosscutting issues are not studied. Which means that the quality of the resulting project proposal cannot be guaranteed"* (page 19).

With increasing attention for the impact of a project on a constantly growing number of fields, there is also the potential of an ever-growing number of experts and reports. This will only increase the problems for decision makers, as they will now have to come to a conclusion based on even more reports.

The report states there is ample reasons to believe that developing an integrated approach to impact assessment is desirable for the following reason: "*Decision makers are now confronted with sectoral impact studies for the environment, economics, safety and social aspects, especially in large infrastructure projects. The lack of sufficient rapport between these aspects can hamper decision makers, who need an integrated, coherent relationship between the various disciplines"* (page 21).

According to the report, "*more economic and environmental profit can be gained if the multiple objectives can be maintained flexibly while developing alternatives*" (page 21). An integrated Environmental Impact Assessment should therefore promote the evaluation of a project as a whole and prevent fragmented decision making about component aspects.

A mentioned added advantage of the Integrated Environmental Impact Analysis is that "*it contributes to an explicit discussion about the purpose of and need for a project.*" (page 22) The integrated approach thereby also enters the field of the strategic environmental assessment. "*By naming the various interests to be weighed against each other, expressing them in numbers and connection them with each other at an early stage it will be prevented that the purpose and need of a project and the economic feasibility of solutions are repeatedly brought up for discussion in the decision making process"*.

The 2001 report also goes into the subject of the method of development of an integrated environmental impact assessment. It states that experiments with the integrated approach "*offer the best opportunities for testing its potential and limitations"*.

From the two subsequent reports it can be concluded that indeed there are problems with the current EIA procedure. The problem with the current method is its aspect-by-aspect approach.

This approach delivers several impact reports but fails to show the links between the aspects in the reports. Decision makers therefore have to come to a conclusion based on incomplete or even inconsistent information. Within these reports implicit decision are usually made, which limit the options for the decision makers.

This means that a new integrated impact assessment is needed which will look at the impact of a project as a whole and take 2nd order effects and links into account. The goal is to provide the decision makers with a single document, which will give them a clear and consistent overview of the project impact. Decisions should be made explicit and traceable.

According to the MER committee [EIA, 1998] the theoretical framework for the integrated assessment should be based upon the system analytical model by Dalal [1992] to define sustainability. The model views the world in three subsystems:

- Economical; system of production, delivery and consumption of goods and services.
- Social; human society. Cultural characteristics, knowledge, norms and values and their expressions in laws, regulations, standards of social behaviour and institutional bodies.
- Natural system; biotic and a biotic renewable and non-renewable resources.

Overall sustainability, according to this model, cannot be determined. However by increasing the sustainability of each of the subsystems, an acceptable level of sustainability of the overall project can be provided.

An interesting statement in the objective of a Social Impact Analysis [IAIA, 2003] is that a social impact analysis is aiming for a situation where “development maximises its benefits and minimises its cost”. If seen in the light of the integrated Impact Analysis, cost can mean the economic cost, but it can also mean disappearing cultural values or a reduction of plant or animal species. Maximizing the benefits while minimizing the cost is also the very basis of value engineering, for example Thomas [2003] describes value in a formula: value = worth / cost. In other words, the objective of a Social Impact analysis is to maximise the worth and minimize the cost to create the highest value solution.

The above observation brings impact assessment in the domain of construction management and the methods of system engineering and value engineering. Using these methods, which will be described in section 2.1.3 and 2.14, the aim should be to maximize the value of the economic, social and environmental sustainability, to achieve a high value sustainable solution to the problem.

2.1.2 Environmental Impact Assessment

In January 1999 the International Association for Impact Assessment (IAIA) together with the institute of environmental impact assessment published the “best practice” principles for environmental impact assessment [IAIA, 1999]. The best practice principals are used as a guideline for the current method to execute an Environmental Impact Assessment. The EIA procedure should provide, according to this document, for:

Screening; to find out if the project should be reviewed for its environmental impact and if so, at what level of detail.

Scoping; to identify the issues and impacts that are likely to be important and to establish the terms of reference for the EIA.

Determining alternatives; to establish the preferred or most environmentally sound and benign option for achieving the project objectives.

Impact analysis; to identify and predict the likely environmental, social and other related effects of the proposal

Mitigation and impact management; establish the measures that are necessary to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system

Evaluation of significance; to determine the relative importance and acceptability of residual impacts that cannot be mitigated.

Environmental impact report; document clearly and impartially the impacts of the project, the proposed measures for mitigation and the significance of effects to and concerns from the affected public.

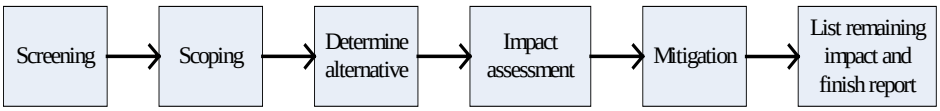


Diagram 2.1 – Environmental impact assessment (EIA) procedure

The EIA procedure is shown graphically in diagram 2.1. It follows what is called a linear "waterfall" model. A waterfall model takes one step at a time, but does not look back at previous steps. Such a model is best suited in an environment that does not change, or in other words where input, throughput and output are non-variable. While executing an impact assessment, it is not inconceivable that certain outcomes may cause rethinking of the requirements, or mitigation measures can require additional impact assessment. A waterfall model does not seem to be flexible enough to handle the changes in the environment.

2.1.3 Value engineering

Since not all readers are familiar with value engineering a short history and the basics of functions and the technical FAST and customer FAST diagram are discussed in appendix II. According to a definition by the Defence Authorisation Act, value engineering is "*an analysis of the functions of a program, project, product, item of equipment, building, facility, service or supply of an executive agency or contractor personnel, directed at improving performance, reliability, quality, safety and life cycle costs.*" [Kelly et al., 1998]

The aim of VE is both to get a better understanding of the problem and to achieve consensus amongst the stakeholders over a common view of the problem. This is important, because when the problem is well known and understood, a more effective solution can be found. The main question value engineering asks is therefore "what does it have to do?" VE can also give an insight in which parts of the problem are easily solvable and where a solution is difficult to reach. The next two paragraphs will describe some of the value engineering techniques.

2.1.3.1 Job plan

The job plan is a framework for undertaking value engineering projects. Male and Kelly [Kelly et al., 1998] determined the generic procedure that is followed world wide in a value engineering project. Their generic procedure follows eight steps, which are shown in figure 2.2.

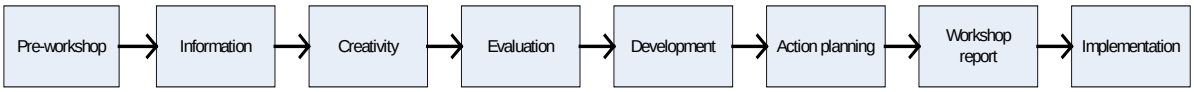


Diagram 2.2 – Job Plan

In short the job plan starts with pinpointing the problem. Pre-Workshop the information is gathered, during the information phase the exact (perceived) problem is specified. In a creative session solutions are generated. These solutions are reduced/ eliminated in the following steps, whereby each step delivers fewer, but more detailed solutions. During the action planning phase the most appropriate solution is selected. Below the eight steps of the job plan are described in more detail.

1. Pre-Workshop
   Information is gathered and an agenda is produced to determine the objectives and deliverables of the upcoming workshop. The workshop consists of the phases 2 through to 6.

2. Information phase
   During the information phase, participants of the workshop determine the needs of the client (whereby a distinction is made between actual needs, or 'wishes' that are not required but the client likes to have), the project constraints, the budgetary limits, time limits and the expected quality. Function Analysis plays an important role in this phase, including the Function Analysis System Technique "FAST".

   The FAST technique uses diagrams. The idea of a FAST diagram is to force a group to consider the functions and function interrelationships in such a way that creativity is focused. The Classic, Technical and Customer FAST are three types of FAST diagrams that exist. The technical FAST is most suited to review and improve elements of a design. An example of that could be a review of the irrigation system of golf resort. The Classic and Customer FAST are most suited to review the system as a whole. The Technical and Classic fast are mainly suited to determine what is to be done, while the Customer fast tries to establish a common understanding of what outcome is to be achieved. [Woodhead, 2001].

   The FAST diagram has the following functions:
   - It helps in describing the wishes, demands and needs in regard to the problem/ project
   - Classification and ordering increases understanding of the problem/ project
   - Shows the whole product/ design in a single diagram
   - Reduces uncertainty, so the product can be viewed upon in the correct way.

3. Creativity phase
   Brainstorm sessions are used to determine solutions.

4. Evaluation phase
   The solutions/ ideas found during the creativity phase are evaluated and accepted or

rejected. Male and Kelly [Kelly et al., 1998] mention a range of tools that can be used for the evaluation phase. These tools include determining if the solution is economically viable, technically feasible, functionally acceptable and acceptable to the client. Several methods are described to help answer the above questions, these methods include; silence means no, coloured dots, championing, big issues and decision matrices.

5. Development phase
   The accepted ideas from the previous phase are reviewed in detail, for their technical feasibility and economic viability.

6. Action planning phase
   The promising ideas developed in phase 5 are presented to the decision makers. Plans for implementing the solutions are generated and a document is signed which includes measures to be taken and responsibilities of persons in the process.

7. Workshop report phase
   The final report containing findings and actions is prepared and is validated by the participants.

8. Implementation
   Implementation of the agreed solutions.

The core of the job plan is the value management workshop. During point two through to six this method relies on a multidisciplinary team of specialists and stakeholders. Working together they first agree on the problem, they brainstorm solutions and work those into a final solution. The solution is reached in consensus, it is not necessarily 'the best' solution, but a solution that all parties agree to. By signing a document at the end of the process by the participating parties they all state to agree with the outcome, which can reduce arguments about the solution at a later point.

2.1.3.2 Requirements engineering

Gause and Weinberg published a book [Gause et al., 1989] containing techniques and methods to assess what people desire from a project. A part of this book contains techniques to determine the functions of a design and how to progress from functions, via attributes, constraints, preferences and expectations to a solution.

Team
Gause and Weinberg, as does the job plan, promote the use of teams. They first go into the subject of the group of people to include in the team. They state that ideally every known or potential user should participate in the requirements process. A 'user' is anyone who is affected; this therefore also includes those who loose from the project. A difference is made between users who are 'on the team' or 'on call by the team'. In the first case the user is continuously participating, while 'on call' means the user participates part-time, which is the far more common arrangement.

Functions
The team will search for the functions of the project. For retrieving functions the following heuristic is advised:

- *Generate an initial list of potential functions*
- *Classify each function as evident (E), hidden (H) or frill (F).*
- *Using the classification, it should be tried to uncover unmentioned hidden functions.*
- *Functions with wording that implies constraints on solutions should be reworded to become problem instead of solution statements.*
- *Frill functions should be put on a "Get if you can list"*

Frills are functions that are 'nice to have', but cannot cost anything. Evident functions have to be as visible as possible and hidden functions are to be as invisible as possible. An example of a function can be 'provide water'. This will probably be a hidden function, as it is not important to show how water is provided. Provide accommodation is another function, which will most likely be evident as the accommodation is an important part of a resort. A frill could be 'improve airport'. While it may be nice to have a state-of-the-art airport, it is not necessarily required. An example of a constraint function could be 'develop golf-resort'. In this function it is already clear that the resort has to be a golf resort. This can be intentional, since another resort is not acceptable, but obviously limits the solution space. To make the functions traceable in the process, as promoted by system engineering, each function will be assigned a number.

Attributes
According to Gause and Weinberg (1989);
"Attributes are characteristics of a product that are desired by the client, they can be seen as adjectives or adverbs"

The procedure for finding attributes is as follows: (*According to Gause and Weinberg*)

- *Brainstorming a list of possible attributes*
- *Sort attributes from attribute details. Fill in the list with attributes for all details, and with the details suggested by all attributes.*
- *Assign each attribute to the appropriate function of functions*
- *Classify the attributes in Must (M), Want (W) and Ignore (I)*
- *Document the M and W attributes for further processing*

Attributes are characteristics of the product that are desired by the client. If a function would be 'provide water', attributes of such a function could for example be 'clean', 'reliable' and 'potable'. Attributes help to pinpoint what the client wants. If the water has to be potable, the quality has to be much higher then what would be required for irrigation. The attributes are classified as Must have, want to have or attributes that can be ignored. For tap water the attribute potable will be a must have. For shower water it could be argued that this is a want to have. For irrigation water, the attribute potable can be ignored.

Constraints

Number of power sources	0 – 95 %	95 – 100 %
2 or more		**SOLUTION**
1		

Reliability

Table 2.3

Gause and Weinberg [Gause et al., 1989] argue that constraints can be seen as borders. Within these borders there is the solution space. Constraints are derived from attributes classified as a Must. An example of a constraint would be 95% reliability. This means the reliability of the supply of irrigation water has to be between 100% and 95%. Another attribute could be 'multi powered'. The constraint in that case would be that at least one backup power source is required. The solution space would therefore be any solution that provides one or more backup power solutions and reliability between 95 and 100%. A graphic of the solution space is shown in figure 2.3. A similar solution space will be created for all 'Must have'-attributes.

In their method it is possible that no solution space exists. For example if the attributes of the holes state that they have to be at least 400 times 30m in size (216.000m^2 in total for 18 holes), but the total available space of the location is limited to 150.000m^2, there will not be a solution within the solution space. In this case the constraints may have to be renegotiated with one or more stakeholders(s), resulting in moving or lifting (some of) the constraints to create a solution space.

Preferences

According to Gauss and Weinberg any final design solution that satisfies every constraint is an acceptable solution. Some solutions may be more preferable then others though. This is why preferences should also be looked at. The methods that are used to determine the preferred solution should be made measurable, so designers can determine to what degree the preference has been satisfied. To determine the preferred solutions the method recommends so called 'what's it worth' and 'trade-off charts'. This means that in a graph the attributes are set out against their value.

In the search for alternative solutions and finding the most appropriate solution from within the solution space, two other tools can also be used. These are the technical FAST diagram and the SMART method. Both methods will be described below.

A technical FAST diagram is most suitable for reviewing and improving parts of a design. The technical FAST is explained in detail in Appendix II. The diagram reviews the functions of the particular part. Knowing all functions the part has to perform, it is possible to find alternative solutions, which cover the same functions. The goal is to find an alternative with a lower impact.

The technical FAST diagram consists out of the following parts [Veenvliet, 2004]:

- Scope
- Basic function
- Critical path functions
- Logic How/Why-question cycle
- Secondary required functions
- Causal function
- Supporting functions

Research has been performed by Green, which resulted in the development of the SMART methodology for value management [Green, 1992]. Green takes the multi attribute theory as a basis for selecting the most appropriate alternative. In short this means several options are reviewed against several criteria. Weight factors are used to determine the relative importance

of the attributes. The highest scoring alternative is considered to be the most appropriate option for the case. Because of the bounded rationality concept, Green [1992] argues, the most appropriate solution is not necessarily the best. The bounded rationality concept describes that only so many options can be considered; as it is impossible to explore all options it is not possible to find the “optimal solution”.

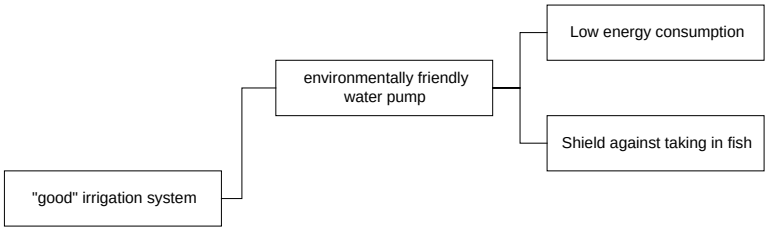


Figure 2.4 – Example value tree

The SMART method starts with creating an objective tree; this is basically the same process as creating a task oriented FAST diagram, however it uses design objectives instead of functions. An example of the value tree is given in figure 2.4. A design objective in this stage of the project could be a “good” irrigation system. The value tree exists out of “ends” and “means to an end”. One of the means for the “good” irrigation system could be an ‘environmentally friendly water pump’. The lowest order objectives are the attributes against which the design options should be evaluated. In case of the given example these are low energy consumption and a shield to prevent fish entering the pump.

These attributes are equipped with a weight to take into account their relative importance against the other functions. For example if the low energy consumption is found to be more important then the shield, it could get a weight of 0.7 against 0.3 for the shield. As said, the highest scoring alternative on the attributes is the alternative that is the most appropriate one for the project. By involving all stakeholders in the process of determining the weights of attributes, they will more easily accept the resulting alternative. The same applies for determining the score of an alternative, where these have to be determined subjectively. The score or value of an alternative on a certain attribute is between 0 and 100. Table 2.5 shows an example of the decision analysis matrix. In this example alternative 2 would be favoured above alternative 1.

	Low energy consumption	**Shield against taking in fish**	**Total**
Weight:	0.7	0.3	
Alternative 1	30	40	33
Alternative 2	20	80	38

Table 2.5 – Decision analysis matrix

System engineering

Definition System Engineering (SE):

Systems engineering is an interdisciplinary engineering management process that evolves and verifies an integrated, life cycle balanced set of system solutions that satisfy costumer needs.

System engineering fundamentals, system management college US department of defence, reader 854, University of Twente, page 3.

The system engineering process is shown graphically in appendix IV. The goal of System engineering, as can be deduced from the definition, is to create a solution (design) that satisfies the customer. The SE procedure starts with a requirements analysis, to find what the customer wants. The requirements are the input for function analysis and allocation. The function analysis is then used as input for the design synthesis. The process is iterative, in that steps made later in the process can influence earlier decisions.

SE is a layered process, which uses baselines. A baseline means that a certain part of the design should be known and will be frozen before the next stage begins. The Baselines follow the left part of the V-Model, as shown in figure 2.1. [Hull et al. 2002] At a certain stage the requirements of one level are frozen and will be used to determine the requirement in the next level. Each subsequent baseline, or step down in the left side of the V-model, freezes the previous steps and allows the work at a more detailed level. The right side of the V-model shows the testing procedure, where (a part of) the design is tested to verify it meats its requirements. A method to verify each requirement must be established and recorded during requirements analysis. It must always be possible to verify the requirement; otherwise the requirement is not a legitimate one [system engineering fundamentals, 2001].

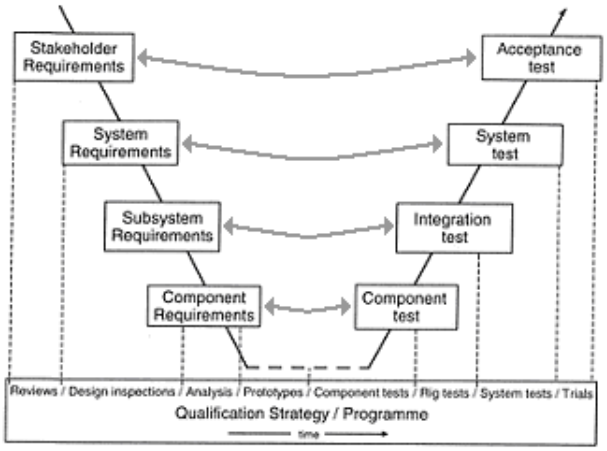


Figure 2.6 – V-model

SE requires all decisions to be taken visibly and traceable, this is done by assigning numbers to requirements, solutions resulting from the requirements and the verification procedures. Logging relations between requirements, solutions and verification in tables assures traceability.

So in short, system engineering can aid the integrated impact analysis by providing a method that will take into account the whole system and will provide traceability of the transformation of requirements into solutions and the verification procedures belonging to the solution.

2.2 Framework

During the review of the problems with the current impact assessment method (chapter 2.1.1) it was noted that integrated impact assessment should:

- Offer a single document which clearly and consistently states the project impact
- Trace the transformation from requirements to solutions, when decisions are made, they should be made explicitly.
- Take into account the 2nd order effects, which are the impacts resulting from changes caused by the project.
- Include the links between the different impact fields, which make trade-offs possible between for example environmental and economic effects.

How can value engineering and system engineering contribute to reaching these goals? In the theory section it was shown that System engineering delivers a full framework for design projects. Key point of System engineering seems to be traceability, making clear how and why decision were made.

Value engineering has its prime focus in the original question of 'what it has to do'. It is a good technique to discover the functions a design has to perform. The main tool, which is used in this method, is the FAST diagram (Function Analysis System Technique). The work of Gause and Weinberg can form a link between the methods. It can convert the functions found by the Value Engineering method to solutions, which can then be further processed in the system engineering method. The job plan, which is the main value engineering method, would also be able to convert functions to solutions. This method however relies primarily on a team approach and workshops. While the method by Gause and Weinberg also prefers a team approach, they do not exclude the option of interviews. Since a workshop approach is not feasible for this research project, the approach of Gause and Weinberg seems to be a more suitable one. There is however a negative side to the use of interviews instead of a team approach. In a team approach people can respond to and be stimulated by the other parties. This can promote creative solutions. The use of an interview approach will not facilitate this creative process. The effect of the choice for an interview approach will be discussed in more detail in the reflection.

The value engineering approach of the technical FAST diagram and the SMART approach by Green are methods that can be used to determine the most preferred solution where one is not immediately clear.

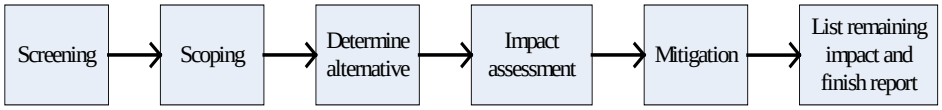


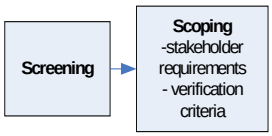
Diagram 2.7 – Environmental impact assessment (EIA) procedure

The current method for impact assessment was shown in the previous chapter and is repeated above in figure 2.7. In the next sections a new integrated impact assessment will be introduced. It is based on the current method, but the given theories will be introduced into this method.

2.2.1 Screening

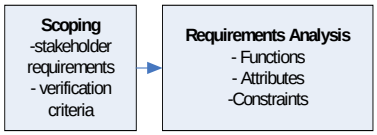
The need for screening remains, it will still be required to check whether an impact assessment is required and at what detail level. For larger civil engineering project it is expected an impact assessment will almost always be required though. An impact assessment can give an insight in the effects of a project, both positive and negative. If a larger project is not expected to have significant impacts on the economic, social or environmental field, it may not be worth executing the project at all.

2.2.2 Scoping



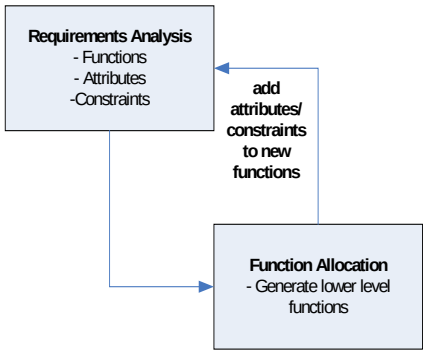
When it is determined an impact assessment is required, scoping should establish a list of stakeholders. Stakeholders are those people who are (expected to be) affected by the project. It should also be determined what the requirements and the verification criteria of the stakeholders regarding the project are. This is still more or less similar to the original impact assessment, with the exception that the likely impacts are not an issue yet. Reviewing the likely impacts is not required as the impact assessment process is already aimed at finding all impacts. It should be noted that the scoping phase can also be found in the value engineering job plan (the information phase) and is considered process input to the system engineering process.

2.2.3 Requirements analysis



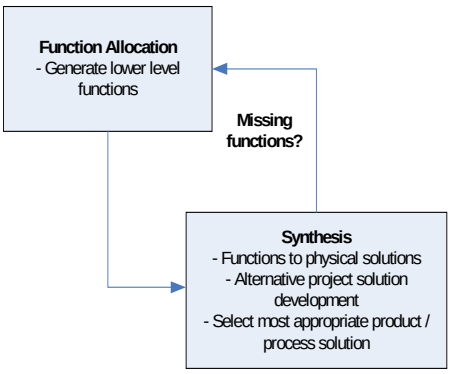
After the scoping phase, the current impact assessment starts with determining alternatives. It tries to establish possible solutions to meet the requirements that were given in the scoping phase. This is where the System engineering approach starts to become apparent. This method was created for the purpose of moving from requirements to design solutions. Value engineering, as indicated, is a method that can very well be used in combination with System engineering to determine the functions that the project has to accomplish. The requirements analysis therefore should convert the stakeholder requirements to functions. Using the methods of Gause and Weinberg, Attributes and Constraints are attached to functions, together generating a good understanding about what the design has to accomplish.

2.2.4 Function allocation



Using the FAST-method, which was explained in more detailed in chapter 2.1.3.1, the functions are grouped. Asking 'how' a function can be performed will generate lower level functions. When a lower level function is added, attributes and constraints should be attached, which requires an iterative process with requirements analysis.

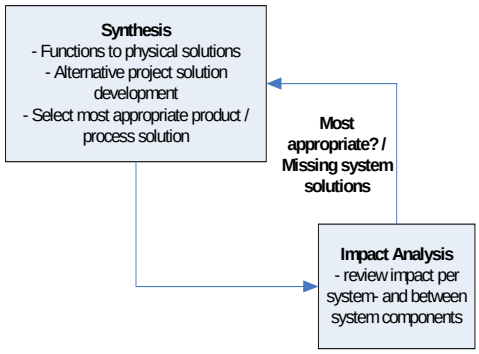
2.2.5 Synthesis



Function allocation delivers a list of functions that the design has to fulfil to satisfy the requirements of the project. Coupled to these functions are attributes and constraints. This makes it possible to determine the solutions space and find physical design solutions. There may be several solutions possible, alternative solutions can therefore be developed. Determining the most preferred solution, where alternatives are available, may not be possible before the next step; the impact assessment, has been completed. While stakeholder functions were included at the start, the synthesis phase may bring up other functions that are required. This could for example be a technical function, which is needed to support one or more stakeholder requirements. The synthesis and function allocation therefore is iterative.

The output of the synthesis phase is a design of the project, which may still include some different alternatives for certain solutions. The previous three steps together are replacing the 'determining alternatives' phase in the traditional impact assessment.

2.2.6 Impact analysis



The previous phase has delivered a physical design. The design consists out of many system solutions, which together form the complete project. These system solutions can individually be reviewed for their impact. To review the impact, the input and output of a system solution should be reviewed.

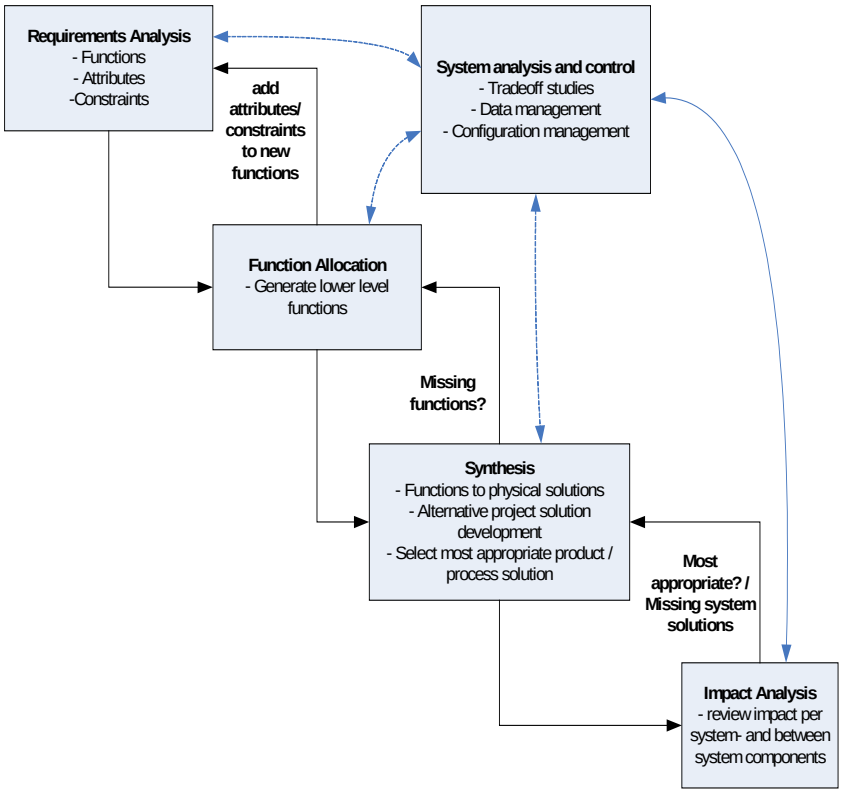
To explain the impact assessment by looking at in- and outputs, consider the system solution is photosynthesis. Photosynthesis is an important biologic/ chemical process within a plant, which provides energy for the plant. The chemical formula for photosynthesis is: 12 H_2O + 6 CO_2 + sunlight = $C_6H_{12}O_6$ + 6 O_2 + 6 H_2O. For the system solution photosynthesis to function it therefore requires an input of sunlight, carbon dioxide and water. The output of the system solution will be sugar, oxygen and water. Since water is both an input and output, the output can be kept within the system solution and reduce the need for water on the input side. In other words, because photosynthesis produces half of the water it needs, the required amount from its environment is reduced. By reviewing the input and output of the system solution the impact it has is now clear, it uses water, carbon dioxide and sunlight and produces sugar and oxygen. The produced sugar will for a large part be used elsewhere in the higher system solution ‘plant’. A plant may therefore not have the effect that it produces ‘sugar’, since the sugar the photosynthesis process produces will be used as input in another system solution within the plant.

The input of a system solution can be diverse things as labour, raw materials as petrol, gas, electricity, but also a thing as space. Examples of the output are money, waste, noise, etc. While in the example given above there is an exact formula that describes the required amounts, the in- and output may not always be measurable in a quantity. A qualitative output of a golf resort can for example be that it alters the appearance of a unique landscape.

It may be found that the impact analysis needs to review lower level system solutions that are not yet included in the provisional design. There should be a link back to synthesis to be able to add system solutions to be reviewed during the impact analysis.

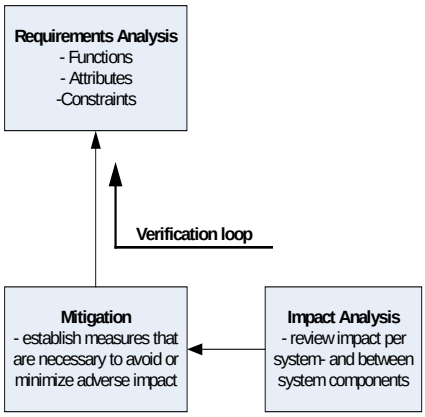
Where alternatives were available, the impact analysis should provide an insight in the impact of each of the alternatives. The alternative that is selected to be the most appropriate should be the one selected in the design synthesis. After some iterative steps, the synthesis therefore delivers the final design. The impact assessment delivers a list of the impact of each system solution. When the impacts of all system solutions are combined, the total impact of the provisional design is found.

2.2.7 System analysis and control



One of the perceived problems with the current method is the lack of traceability. To keep track of the process and to offer some additional tools system engineering offers system analysis and control features. Data management and configuration management are the main tools for tracing the whole process from requirements to design synthesis. These processes will be explained in more detail in the next chapter. Another important tool is the trade off study. By using the methods described in the theory, the technical FAST diagram or the SMART method by Green, a trade-off can be made between different alternatives. The trade-off can at this stage take into account the impact in determining the most preferred solution. The trade-off study contributes to a documented way of making design decisions, as it is made explicit why a certain alternative is selected.

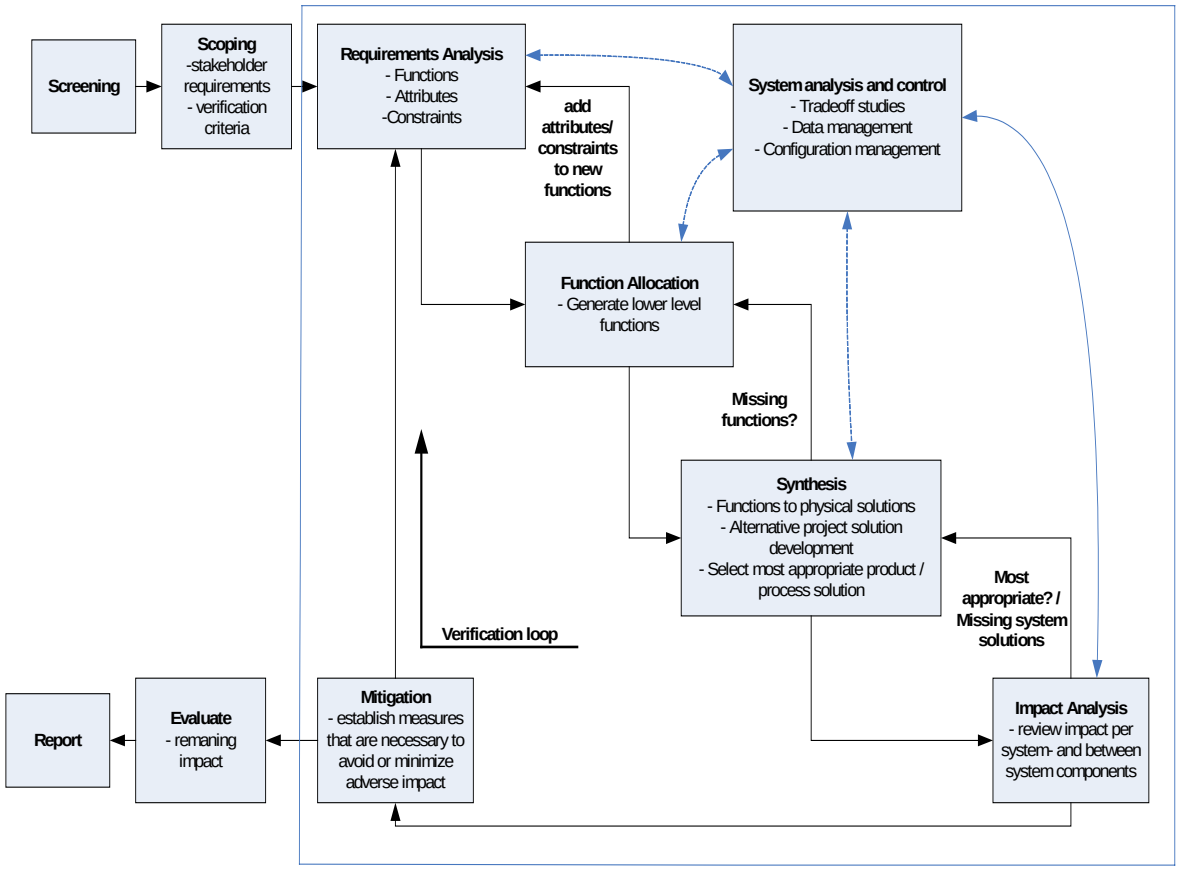
2.2.8 Mitigation



When the impact has been established, the impact assessment procedure indicates that measures should be established that are necessary to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system. Next to this somewhat negative perspective of 'fixing the bad' it may also become apparent that during mitigation opportunities exist to improve already positive impacts. Mitigation of the negative impacts is a must, optimizing the positive effects can however deliver additional value for the stakeholders.

When the mitigation measures have been determined, the impact assessment is in fact complete. The requirements have been transformed into a physical design solution. The impact of the design solution is known and the adverse effects have, where possible, been reduced or solved by use of the mitigation measures. It should now be asked if the final design, which results from the impact assessment, meets the requirements and verification criteria. If not the project requirements may have been too revolutionary or just not achievable. If a project is still wanted, it may be necessary to change (one or more) requirements. When requirements are changed, the process obviously (at least for the concerned requirements) starts again at requirements analysis.

2.2.9 Evaluate and report



While the impact assessment is not yet complete, the iterative process (within the block) continues. When verification shows the final design meets the requirements and verification criteria the evaluation phase can take place. During this phase the remaining impact, after mitigation, is written down. An indication should be given about the relative importance and acceptability of residual impacts that cannot be mitigated. Finally the impact assessment report has to document clearly and impartially the impacts of the project, the proposed measures for mitigation and the significance of remaining effects. The figure above shows the complete new integrated impact assessment method.

3 Case study

The full impact assessment report for the case study is included as a separate document. This chapter will examine the experience acquired during the research and explain how the method was used in this research.

The new integrated impact assessment method was used to determine the impact of a planned golf resort on the island of St. Eustatius, in the Netherlands Antilles. The project is intended to have an economic and social impact on the island. St. Eustatius is a small island (21km^2) in the northeastern Caribbean. For its income it is currently dependant mostly on an oil transshipment facility and tourism. There is however a yearly budget deficit of around US$6.1 million. The unemployment is also increasing, coupled with the fact that many young Statians who have to go abroad to study, will stay abroad since no jobs are available for them on the island. The golf resort is intended to solve (a large part of) the budget deficit and create jobs for Statians living on and off the island. The main goal of the golf resort project can be described as making the island self-sustainable.

This chapter will follow the steps of the integrated impact assessment method and answer research question 2, 3, 4 and 5.

3.1 Screening

Screening was not made a part of the research question, even though it is the first phase of the integrated impact investigation. To be able to do this research project, the case study project would have to meet the criteria that it is fit for an impact assessment. The need for an impact assessment was therefore established at the start of the research project and hence screening was not included as research question.

The golf resort project is situated on a small island. At first glance it is clear it will use a significant portion of the available land surface. A number of questions existed on the island, for example what the impact would be on to the Sea turtles, the Iguana's, on housing, etc. Next to these environmental and social worries another aim of the golf resort is to improve the financial position of the island, which is an economic impact. From this quick screening it is obvious that economic, social and environmental impacts can all be expected in the project.

3.2 Scoping

3.2.1 Stakeholders

2. Scoping of the impact assessment
    a. Who are the stakeholders

Scoping is about finding requirements and verification criteria. The requirements are used to determine what the customer wants, the verification criteria to verify whether those requirements are met. The main requirements can be found with the stakeholders. Requirements can also result from legislation and from the site itself. There are also requirements resulting from the design solutions and functions themselves, these cannot be determined until system solutions are generated though.

The stakeholders are those people that are affected by the project. It is important to trace and include all the affected persons as stakeholders. If they are not included from the start they will

show up later in the process. At that time it may be hard to include their requirements. Due to the specific situation of St. Eustatius the resort will affect most of the people on the island.

A distinction can be made between stakeholders that have taken the initiative for the project and stakeholders that will be impacted by the project. The first should be heard first to determine what the project is, or in other words to determine the scope of the project. It is possible to isolate some parties, or stakeholders, that have taken the initiative in the project. These stakeholders are the St. Eustatius Business Association (STEBA), the tourism development foundation and the St. Eustatius government. These parties have taken the initiative for social and economic development and can determine the scope of the golf resort. Because it was considered important to have representatives from all three impact fields (social, environmental and economical) from the start of the impact study, the main stakeholder on the field of the environment, the St. Eustatius National Parks Association (STENAPA), was also included in determining the scope of the project.

3.2.2 Stakeholder requirements

b. What requirements/ wishes do the stakeholders hold about the golf resort?

Since it was not feasible to organise a workshop with the stakeholders, an interview approach was selected to retrieve the requirements. Gause and Weinberg [Gause et al., 1989] distinguish between four elements that are important in exploring the requirements. These are the functions, attributes, constraints and preferences. As much as possible the interviews focussed on retrieving these four elements. The interviewed were stimulated to word their requirements in terms of functions.

Since the impact assessment is a continuation of the economic viability study, the requirements contained in this document were verified during the interviews with the stakeholders. During the interview the question “Who else is affected/ stakeholder” can create a “snowball effect” whereby via one stakeholder, others can be found.

In the initial requirements gathering phase three interviews took place. An interview with the Tourism Development Organization, the St Eustatius Business Association (STEBA) and with the main stakeholder regarding the environmental impact; St Eustatius National Parks Foundations (STENAPA). The government, a third party taking the initiative for the development of the project, is working closely together with the two other parties, for this reason an interview with the government was expected to deliver no additional information in this initial phase. Before interviewing other stakeholders it was first important to get information from these ‘key-stakeholders’ about what kind of project they want. Without, for example, an idea about the number of additional students that can be expected, talking to the schools is not very useful. The same applies to talking to the electricity company in regards to the amount of electricity that is required. In fact, without really knowing for sure that additional children will come to the island, the schools may initially not even be a stakeholder?

The initial interviews with the three parties focused on the requirements a golf resort project. By challenging the interviewed party to summarize their answer as a function and by asking ‘context free’ questions, it was possible to gather functions that the golf resort has to perform. For example, the tourism development foundation indicated the need of developing a beach, as not having a (Caribbean white) swim able beach is a constraint on the tourism development. The function for this requirement would be ‘develop beach’. An environmental function,

‘protect coral’, originates from the requirement that the coral should be protected because it is protected by law and important for tourism.

Next to finding the requirements for the project itself, another important item during the interview was the question what such a project has to accomplish, which goes above project level and ultimately showed the program goal that the project is to accomplish. The program goal for the island of St. Eustatius is to become self-sustainable. It was decided to use the constraints developed in the next phase as the verification requirements. When the final result of the impact assessment meets the constraints, it meets the requirements.

3.2.3 Legislation

c. What legislation is relevant?

The relevant legislation is the legislation that affects the project, usually by putting constraints on the solution space. Both by use of a literature study (reviewing the environmental and building laws) and by touching this subject during the interviews information was obtained.

St. Eustatius is part of the country of the Netherlands Antilles. Even though this country is a part of the Kingdom of the Netherlands it is not part of the European Union. This means European law is not a factor on the island.

The main relevant legislation for the development of a resort is the environmental legislation. By law, each island of the Netherlands Antilles has to have a national park, which is an environmental protection area. On St. Eustatius the government has appointed the STENAPA to manage the parks (more then one) for them.

From an interview with STENAPA it became clear that a part of the area where the golf resort is envisaged is protected. If the golf resort is to be constructed, the legislation will have to be changed, which requires the government to be informed over the consequences of such an action.

3.2.4 Local situation

d. What is the situation at the proposed site(s) of the golf resort

By visiting the site(s) of the golf resort, relevant information can be obtained about possible environmental worries. Stakeholders may be determined, as well as site specific constraints. These could be matters as the available space, the proximity of the ocean, etc.

The area where the golf resort is planned was examined both physically as well as on a map. The area is mostly undeveloped; there is only a road to the Zeelandia area. This means the entire infrastructure has to be developed together with the project. The local situation also poses some challenges due to the wildlife (sea turtles and iguana’s) and a beach that cannot be used due to a large undertow. This makes it unsafe for swimming.

3.2.5 Conclusion

The results of the scoping process can be found in chapter II of the Strategic impact assessment, which is a separate supplement to this report.

The scoping phase is aimed at finding the requirements for the project. During the execution of the study it became apparent that there are two kinds of stakeholders. There are initiating parties, who can give the requirements for the project and explain what they want the project to become. The remaining parties are stakeholders because the project has an effect (impact) on them. To be able to determine which parties are affected by the project, it first has to be determined what the project is.

The requirements of the main stakeholders and requirements resulting from legislation and the local situation were determined by an interview method. The interview method in comparison with a team approach reduces the chance for innovative solutions. It was decided to use the constraints developed in the next phase as the verification requirements. When the final result of the impact assessment meets the constraints, it meets the requirements.

The requirements and their resulting functions were placed in a table (table 3.1), to provide traceability. A number is assigned to the function; this number will be used in the FAST diagram. The table also shows the stakeholder that brought in the requirement. The full list of requirements and functions is included in appendix V.

Requirement	Function	Function #	Stakeholder
The golf resort should add a large portion of rooms to the island.	Provide accommodation	0.1.1	Tourist Office

Table 3.1

3.3 Requirement analysis

3. What does the provisional design of the golf course look like?

Paragraph 3.3 through to 3.5 answer research question 3. Paragraph 3.5 includes a conclusion regarding this research question.

3.3.1 Functions

The scoping phase has resulted in a list of functions that the project has to for fill. Using the heuristic by Gause and Weinberg [Gause et al., 1981] more information about these functions can be found:

- *Generate an initial list of potential functions*
- *Classify each function as evident (E), hidden (H) or frill (F).*
- *Using the classification, it should be tried to uncover unmentioned hidden functions.*
- *Functions with wording that implies constraints on solutions should be reworded to become problem instead of solution statements.*
- *Frill functions should be put on a "Get if you can list"*

Step one, generating the initial list of potential functions was performed in the scoping phase. Additionally functions will also be found during the function allocation, which is the next phase after requirements analysis. This means the requirements analysis process is iterative.

To make the functions traceable in the process, as promoted by system engineering, each function was assigned a number. In a new table (table 3.2), the function is classified as evident, hidden or frill. Frills are functions that are nice, but cannot cost anything. Evident functions have to be as visible as possible and hidden functions are to be as invisible as possible. In the example below, the accommodation is an important part of the resort and a part that should be attractive and visible, which means it is classified as an evident function.

Number	**Functions**	**Hidden** **Evident** **Frill**	**Attributes (Must have, Want to have, Ignore)** **Constraints** **System solutions**
0.1.1	Provide accommodation (for golf resort)	E	

Table 3.2

3.3.2 Attributes

According to Gause and Weinberg [1981]; *"Attributes are characteristics of a product that are desired by the client, they can be seen as adjectives or adverbs"*

The procedure for finding attributes is as follows: (*According to Gause and Weinberg*)

- *Brainstorming a list of possible attributes*
- *Sort attributes from attribute details. Fill in the list with attributes for all details, and with the details suggested by all attributes.*
- *Assign each attribute to the appropriate function of functions*
- *Classify the attributes in Must (M), Want (W) and Ignore (I)*
- *Document the M and W attributes for further processing*

Attributes explain in more detail what the system solution is supposed to do. For providing accommodation the attributes are for example that the accommodation should be: Luxurious, discreet, have a theme, complete, 5-star+ quality and sustainable.

These are all attributes with the function provide accommodation. They explain in more detail what is expected of the accommodation. Not all these attributes may be as important as the other though. For example an accommodation that "has a theme" may be something that is possible, but is not necessarily wanted. For the impact analysis you could even argue that it can be ignored, because it has no real effect on the impact.

For this reason all attributes are classified either as **M**ust have, **W**ant to have or **I**gnore. The mentioned "theme" of the golf course can be ignored, so it is classified as such. A 5-star$^+$ quality is very important and is therefore a must have. A discreet accommodation is nice to have, but not a must, so it will be classified as a want to have. Want to have attributes are kept in mind in the process. Must have attributes are taken to the next level and ignore attributes are ignored.

For the function 'provide accommodation', this means the aim is to "*Provide sustainable accommodation facilities for the golf resort of a luxury, quality and completeness that is to be expected of a golf resort with a 5-star+ rating.*" The attributes are added to the table (table 3.3)

Number	**Functions**	**Hidden Evident Frill**	**Attributes (Must have, Want to have, Ignore) Constraints System solutions**
0.1.1	Provide accommodation (for golf resort)	E	Luxurious (W), discreet (W), two-stories (W), theme (I), complete (I), **5-star+ (M), Sustainable (M)** Provide accommodation facilities for the golf resort of a quality that is to be expected of a golf resort with a 5-star+ rating that is sustainable over a period of at least 50 years.

Table 3.3

3.3.3 Constraints

Gause and Weinberg (1989) argue that constraints can be seen as borders. Within these borders there is the solution space. Constraints are derived from attributes classified as a Must. During the case study a found constraint for providing the accommodation is the 5-star+ quality. This means that anything below 5-star$^+$ is not an option. The same applies for being sustainable for at least 50yrs. The solution space for these two constraints is displayed in figure 3.4.

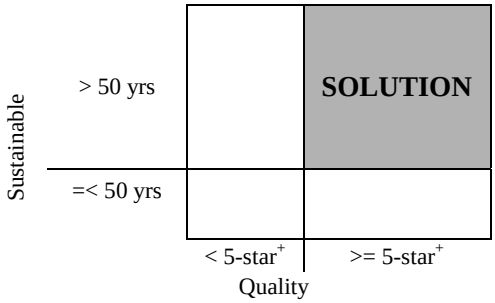


Figure 3.4

It is possible that no or a very small solution space exists. For example if the attributes of the holes state that they have to be at least 400 times 30m in size (216.000m^2 in total for 18 holes),

but the total available space of the location is limited to 150.000m^2, there will not be any solution within the solution space. In this case there is either no solution, or one or more stakeholders(s) will have to lift (some of) the constraints to create a solution space.

The 50-year sustainability is a practical way to determine sustainability. Sustainable is usually defined as something that is able to continue indefinitely without any negative consequences. 'Indefinitely' is hard to verify, by converting this requirement into sustainability for a number of years the designer can verify if the requirement is met. Constraints are, for traceability, added to the table (table 3.5)

Number	**Functions**	**Hidden Evident Frill**	**Attributes (Must have, Want to have, Ignore) Constraints System solutions**
0.1.1	Provide accommodation (for golf resort)	E	Luxurious (W), discreet (W), two-stories (W), theme (I), complete (I), **5-star+ (M), Sustainable (M)** Provide accommodation facilities for the golf resort of a quality that is to be expected of a golf resort with a 5-star+ rating that is sustainable over a period of at least 50 years. **Constraints:** • 5-star+ • Sustainable for a minimum of 50 years

Table 3.5

3.4 Function Allocation

To determine the relationships between functions and find missing functions a customer FAST diagram was created (see 'Customer FAST – Golf resort St. Eustatius'). The task, which is the start point of the FAST diagram, is a description of the actual need of the project. In this project the task was found to be a 'self-sustainable island'. This is the strategic goal, which is what the initiating parties ultimately want to achieve by executing this project.

The question 'how' can then be asked, in this case, 'how to create a self-sustainable island'. This question can be answered by some of the functions that were found in the requirements analysis, for example 'a self-sustainable island can be reached by creating a golf resort'. Because 'creating a golf course' is at a relatively broad description, lower level functions can be generated. Asking the question 'how can a golf resort be created?' can do this. The answer can be; by providing accommodation, eating facilities, health care facilities and a golf course.

In a FAST diagram a distinction is made between base functions and supporting functions [Veenvliet, 2004]. Base functions are essential to perform the task. Supporting functions are not necessarily required to perform the actual task, but help the project to be more acceptable or attractive. There are always four supporting functions, namely: guarantee easy, captivate stakeholders, satisfy stakeholders and guarantee reliability. By developing the FAST diagram, the full list of functions the design has to perform is known. Any functions that were added in this phase should be included in the requirement analysis to determine the function attributes and constraints.

3.5 Synthesis

The parties/ stakeholders that will judge the value of the final product can decide upon the preferred solution from within the solution space. The resulting system solutions will together form the provisional design of the golf resort. The provisional design will be presented using a block diagram, which will visually show the system and the main links between the different parts of the design. The provisional design should be just detailed enough to properly perform the impact analysis.

In case of the 'provide accommodation' function the system solutions were determined as follows. Similar golf courses of the 5-star^{+}-quality in the region have different staying accommodations, which consists out of hotel rooms, condominiums, time-share apartments and private villas. Interviews with main stakeholders determined that the preferred composition of the accommodation at the resort on St. Eustatius contains 156 hotel rooms and 40 condominiums. Because it is preferred the buildings are only two stories high the most suitable option would be to create blocks with hotel rooms, say a block with 6 rooms (3 on each floor). This means there would be 26 separate hotel blocks of two stories, 20 private villa's and 20 timeshare apartments. This means that the function provide accommodation will be provided by the following system solutions: 26 5-star^{+} and complete hotel blocks of 6 rooms, 40 5-star^{+} condominiums.

All system solutions together are placed in a preliminary design block diagram. The layout of this diagram is described in appendix VI. For the full diagram see the separate supplement 'Provisional design block diagram – Golf resort St. Eustatius'. The 'top level system function' can in impact assessment terms be regarded the program goal. The program for the island of St. Eustatius is to become a self-sustainable island. A program goal needs to be achieved by executing projects. Under the program goal there are therefore three projects: support business, sustainable development and increase government income. The system solutions as well are added to the table (table 3.6), together with the number under which it is included in the preliminary design block diagram.

Number	**Functions**	**Hidden Evident Frill**	**Attributes (Must have, Want to have, Ignore) Constraints System solutions**
0.1.1	Provide accommodation (for golf resort)	E	Luxurious (W), discreet (W), two-stories (W), theme (I), complete (I), **5-star+ (M), Sustainable (M)** Provide accommodation facilities for the golf resort of a quality that is to be expected of a golf resort with a 5-star+ rating that is sustainable over a period of at least 50 years. **Constraints:** • 5-star+ • Sustainable for a minimum of 50 years **System solution:** • 5-star+ hotel [1.0] • 5-star+ condominiums [2.0]

Table 3.6

3.5.1 Conclusion

The functions found in the scoping phase are expanded by use of the FAST diagram. The method by Gause and Weinberg converts the functions to system solutions. These are then used as input for the preliminary design block diagram (PDBD). By use of a single table, in which the whole process is shown, traceability is assured. The PDBD answers research question three ‘what does the provisional design of the golf course look like?’ This diagram contains all the system solutions resulting from the requirements found in the scoping phase. The PDBD and FAST diagram are included as supplements. The included PDBD also shows system solutions that were added as a result of the impact found during the impact assessment process.

The provisional design leaves some alternatives. For example it describes the need for a power plant. It is however not prescribed if this should be diesel generators, windmills, etc. In the next step the impact of these alternatives will be reviewed, after which a decision can be made for the preferred solution.

3.6 Impact analysis

3.6.1 Impact analysis of the provisional design

4. What is the result of the impact analysis of the provisional design?

Based on the PDBD created in the previous phase, the impact of the system elements is reviewed. Together the assessment of the impacts of these elements will answer the research question ‘What is the result of the impact analysis of the provisional design?’ The method indicates that the impact is reviewed per system element, as well as for the complete system.

There are many different definitions of impact, overall it can be said that the impact is larger or smaller depending on the amount in which a system element affects or influences the environment, society and the economy. Individual system elements can have an impact on each other; in fact, the impact of one system element can neutralize the impact of another. Keeping track and adding up the impacts of all the system elements can find the complete impact of the program.

Take for example the need for water; a golf resort requires a lot of water. This means that the impact of a golf course is that it uses a lot of water. Within the same program there is a reverse osmosis plant, which delivers this water. This means that at system level you will have two system elements, one with the impact that it requires a certain amount of water, the other element produces this amount. At program level this means that the requirement of water ‘outside’ of the project and thus the impact on water supply is 0. The need for water will still have social, environmental and economic effects though. For example a reverse osmosis plant will create jobs (social), it will have to be constructed, for which contractors will need to pay taxes to the government (economic) and there are some worries regarding salinization caused by reverse osmosis plants (environmental).

For each of the system elements the question asked should be what the input and output of the system elements are. The inputs are those resources that are required to construct and sustain the system element. For example to construct and sustain the accommodations there will need to be an input of labour, space, water and electricity. The output of the accommodations ‘what it creates’ will be, amongst other things, income for the resort and the government (tax), wastewater and solid waste, guests and transport demand to the island. Since the impact is cumulative towards the higher system solutions, the impact assessment of the system solutions should start at the lowest level solutions. The determination of the in- and output requires a vast amount of sources, for example interviews, reviewing similar system solutions, guidelines, calculations and common sense. The goal should always be to find the complete set of in- and outputs of a system element.

To give a good overview of the impact, it was decided to format the impact assessment in a table. The table first lists the system solution number, as shown on the PDBD. The next column shows the system solution name. The impact assessment for the system solution is given in the next column. The final column will be described in the next chapter and deals with the steps to be taken to mitigate adverse impacts.

Number	System solution	Description	Mitigation required?
1.1.1.3.1	**Doctors office**	Currently there are two general practitioners, a dermatologist and dentists on the island. This is an overcapacity, no additional persons are needed when the number of people on the island increases by a 1000. [Queen Beatrix med. center] In times of need (for example in the case a hurricane would hit the island), the hospital can rely on the help of the medical school, which adds at least 12 doctors. Some of the students are trained nurses, which can also help in the case of emergencies. ***Impact:*** • None	

Figure 3.7

An example of an impact assessment for the system solution ‘doctors office’ is given above (table 3.7). In this case, the increase in people on the island, as generated by other system solutions, is shown to have no impact on the doctor’s office, or hospital. This was determined by interviewing the hospitals head nurse and one of the general practitioners.

Care should be taken with the data gathered during interviews. The impact assessment is written to determine the effects of a specific project. During the interviews the focus should be kept on the effects that the specific project will have. An example of how challenging this can be was encountered while interviewing hospital officials. On a small island the hospital is unable to offer full medical support. Obviously they wish to be able to offer this, so one of the things they would like to do is increase their lab, so blood tests no longer have to be transported to hospitals on other islands and thus results can be received faster. How certain is it that the stated need for an improved lab is really affected by the golf resort though? Will it be build regardless of the resort or will it not be build even when the resort is build? This is not always a simple question to answer. Interviewing more then one person per organization may provide a better understanding and partially solve this problem.

It may not be immediately clear what the preferred system solution is. This may not only depend on the preferred ‘technical’ solution, but also on the impact of the solution alternatives. For example irrigation or water supply using the existing reverse osmosis plant on the island may be a technologically preferred solution versus a new build water plant. When the impact is regarded it will however show that using the existing plant cannot supply the full amount of water and will pose a threat to the water supply of the island in dry periods. During the impact assessment it therefore proofed to be required to execute some specific ‘trade-off’ studies. This means possible system solutions are set next to each other and investigated for their impact. Another example of an instance where such a study was required is electrical power. The system solution ‘generate electricity’ delivered several solutions that were all reviewed for their impact, based on the results a solution was selected.

In three instances during the impact assessment it was found to be necessary to add system elements. These system elements are construction, telecommunication and the harbour facilities. Two reasons were found for these functions not being included.

Telecommunication stands for high speed Internet and the ability to get a (mobile and fixed) phone connection and was added as a requirement during an interview to determine the impact of accommodation. This requirement was missed during the initial gathering of requirements in the scoping phase. By adding ‘provide telecommunication’ as a function and starting the process from the requirements analysis phase for just this function, telecommunication could be added as the system solution ‘telecommunication infrastructure’. No problems were encountered in coping with this new requirement from the impact assessment phase.

The need to construct the resort is obvious and should therefore have been included as a system solution of the resort. To add harbour facilities however was not caused by missing this in the requirements or function allocation phase. It was not expected that the harbour facilities would pose a problem or changes would be required. During the examination of the impact of construction it however became apparent that a lot of heavy material and equipment would need to be moved to the island. At this point there was a reason for concern regarding the harbour facilities. The harbour facility therefore offers an example that it should be possible to add system solutions from the impact assessment phase.

3.6.2 Conclusion

Per system solution the impact was investigated. This required a vast amount of sources including interviews, comparisons with similar projects, literature studies and common sense. The impact is the in- and output of a system solution. If a system solution has no impact at all there will be no in- and output.

During the execution of the impact assessment it became apparent that system solutions were missing. Two causes were found for this. The first was some missing requirements, which should have been included from the start in the scoping phase, but were not included at that time. A second cause was a larger than expected impact, which required a system solution to be added. Due to the traceability in the process and everything being on paper (in diagram or table form), adding functions or system solution even at a later stage in the process proved to be no problem.

3.7 Mitigation

5. Which improvements can be made regarding the negative environmental impact of the golf resort and what are the remaining effects?
    a. Which improvements can be made to reduce or solve the negative environmental impact of system elements?

As it is the stakeholders who are making the decisions, the results of the impact analysis were discussed with these persons. Where negative impacts were found several options exist:

- The solution space is too large and the constraints have to change, thereby changing the solution space (up to having no solution space left, which would mean an impossible project).
- They prefer another solution within the solution space, which has a smaller negative impact
- They accept the negative impacts if compensating (mitigating) measures are taken.
- They accept the negative impact. (They increase the solution space, by lifting one or more constraints, so the new solution space includes the solution)

The process continues until all adverse impacts are solved or mitigated or until it is concluded no further action can be taken. In that last case the remaining impact can be reviewed.

During the impact assessment it became apparent where problem areas exist regarding the negative impact of the project. Where a negative impact exists it should be attempted to mitigate (reduce) this impact by taking measures. To determine which measures should be taken, interviews with the involved stakeholders were required. Other sources for mitigation can also be used, for example looking at similar projects and the solutions used there, literature or common sense. It was found that during the interviews to determine the impact of the various system elements in many cases mitigation measures would already be discussed.

The mitigation measures are listed in the same table that contains the impact assessment of the system elements. This guarantees traceability between impact and mitigation measures.
For added readability and to highlight the mitigation measures, they are also summarized at the end of the report.

After mitigation has taken place in a fact the impact assessment is completed. It is known what the project will look like (provisional design), what its impact is, which measures can be taken to reduce the negative impact and what impact remains. The question can therefore now be asked if the outcome of the study meets the requirements. As indicated in 3.2.2 to determine if the outcome meets the requirements, the outcome is compared with the constraints. When this is done it is determined that there are several points where the requirements are not yet met. For example the accommodations and providing energy are proving to be unsustainable. In the first case sustainability is not achieved due to the inability to process solid waste in a sustainable way, in the second case due to the use of non-renewable fuels. Some other requirements are also not met. It is up to the decision makers and stakeholders to determine the consequences of not meeting the requirements.

3.8 Evaluate

b. What are the remaining environmental effects of the golf resort?

The remaining impact (residue impact) is listed together with the mitigation measures at the end of the impact assessment document. The decision maker will have to determine if the residue impact is acceptable or remains a concern.

It may not be possible to find mitigation measures for all the adverse impacts, or it may not be possible to mitigate negative impacts completely. In the case study, no mitigation measures were found that could solve problems regarding waste disposal. Depending on the opinions of the stakeholders about the severity, the remaining impact was classified as significant or not significant. It is up to the decision maker to determine if the project can go on, further study or measures are required or the project should be cancelled due to the remaining impact.

On completion of the impact mitigation a group session was organized. During this session the impact assessment was presented, as well as the mitigation measures and the impact that remained at that time. After the presentation, a group discussion, under the supervision of a moderator, was held about the impact. During this discussion several questions were raised that could be answered with the impact assessment.

The only worry not covered by the report was the question whether the report presented enough about the 2nd order effects. While for example the effect of the additional people on the island due to an increase in population and tourists was taken into account, this increase in people on the island can potentially also spark another increase in people who are needed to support the increased population. It was determined that the effect of this increase on the hospital and the schools in terms of jobs does not exist. Some questions remained about the effects on supermarkets and some other facilities and services though. It is important to note that the effects on, for example, the supermarkets can be included in the method. In the closing round attendees mentioned that while at first sceptical, they now understood the reason for having the project (the program) and could see how this could become a success.

The results of verification, which showed that the design does not meet all requirements was discussed in this meeting. No mitigation solutions were found. The inability to deliver green energy to the resort, while not meeting the requirement was not seen as a large problem. This negative impact will be accepted. The solid waste issues however were not regarded acceptable. The parties have indicated they will further investigate the problem. Further investigation could result in additional requirements being added to the impact assessment process, after which an acceptable solution may be found. Due to time constraints this however did not take place.

3.8.1 Conclusions

Based on the impacts found during the impact assessment phase, measures to reduce ‘mitigate’ the impact were determined. Verification of the impact assessment, combined with the mitigation measures, revealed that not all requirements are met. It is up to the decision makers to determine if further research and measures are required, if the impacts are accepted as they currently are, or if the project with these impacts is not wanted at all. During a group session, where the results of the impact assessment were discussed, it became apparent some negative impacts will require further research. The stakeholders and decision makers will accept some other impacts that do not meet the verification criteria.

4 Conclusions and recommendations

The conclusions and recommendations in this section refer to the new integrated impact assessment method. The conclusions and recommendations regarding the impact assessment of the golf resort are included in the impact assessment report, which was included as a loose supplement.

4.1 Conclusions

The main question posed in this report is the problem formulation. The problem formulation is:

How can the methods of system engineering and value engineering be integrated with the environmental impact assessment and how can the resulting integrated impact assessment method be used to find and solve or mitigate the environmental, social and economic impact of a planned golf resort on St. Eustatius?

The report described the combination of the system engineering and value engineering methods with the impact assessment. This combination resulted in the new integrated impact assessment procedure (page 29).

Using the integrated impact assessment procedure an impact assessment was executed. The following conclusions can be made based on the executed impact assessment:

- The procedure allows for assessing all impacts at the same time and in one report, in this case the economic, social and environmental impact.
- The reviewed system elements and the main relations between these elements are presented in a single diagram, which offers a good overview and good tool in discussions.
- Due to tracing the requirements throughout the document, it becomes clear what impact is caused by which requirements.
- The generation of a customer FAST and preliminary design block diagram force the generation of a single ‘start point’. The start point is the reason for executing all the underlying projects, which in impact assessment terms makes it the strategic goal. Next to showing the start point, the program level also indicates why the project is needed.
- The impact assessment gives the opportunity to find the relations between impacts. This way the client does not get one report, which states that the beach is used for tourism, while another report states it is used for sea turtle nesting. The two reports are not able to tell the consequences of dual use. By examining both impacts within a single report the consequences of shared use can be reviewed and should this be negative, the report can also bring up solutions. In the specific case it was actually solved in a way where it generated a benefit to both the tourists and the sea turtles.

4.2 Reflection

4.2.1 Relevance of the thesis

The thesis looks at an existing problem in the field of impact assessment and applies proven methods from the field of construction management to mitigate the perceived problems. The method was then tested on a project on the island of St. Eustatius.

The island of St. Eustatius is relatively small; it only measures 7 by 3km. As indicated in the report this means that a large project as a golf resort will have an effect on the whole island. With the project situated on an island, the scope can more easily be determined, as well as the stakeholders. The effect will also be easier to consider, as there is a physical border after which either the effect stops, or import and export become issues. If the project is not located on an island, or a much larger island, it will most likely be harder to determine where the effect stops and which stakeholders to include. While this may not necessarily make the thesis less relevant, the size of the island is simplifying factor.

The question also has to be asked whether the situation on the island did warrant an impact assessment. The golf resort project on St. Eustatius is a large project that was expected to have a potential significant impact. With the impact investigation completed it is indeed clear that there were impacts on all the fields. For example fitting the golf resort in with the environment, the high use of water and the increase in population.

By executing an impact assessment it was possible to clearly present the consequences ‘impact’ of the golf resort, versus the benefits and the goal that the project aims to achieve. It was also possible to mitigate many negative effects. Since the method shows links between the different impact fields, potential problems like the use of the beach by both tourists and sea turtles, could be turned into benefits for both.

In conclusion and looking back on the impact assessment study it is clear that all three impact fields, environmental, economical and social were present in the case study. It can therefore be said that indeed the project did warrant an impact assessment.

4.2.2 Making of the thesis

In creating the impact assessment, getting all parties together to determine the requirements was not feasible. The requirements were gathered by use of individual interviews with the stakeholders instead. There are some disadvantages in using an interview instead of a team approach. In a team approach, stakeholders may influence each other and ‘in a creative process’ come up with important other requirements that individually were not brought up. In an interview approach there is also an added chance for conflicting requirements.

Because the parties that are looking to start the golf resort are still looking for investors, the investors, who will be key stakeholders were not yet available for an interview. By keeping the design at a ‘high level’ and not in depth, a lot of room was left for specific requirements by the investor. An investor may however have different ideas about the number of rooms required, the size of the golf course, etc. By not including this party in the investigation, there is a larger chance for deviation between the results of the impact assessment and the reality.

In creating the preliminary design of the golf resort, a function to form approach was selected. This means that the question is asked what “it has to do” before the question “what it physically

looks like", which would be the first question if a form to function approach is used. The function to form approach has the advantage that it allows for more creative thinking, people do not have to think in terms of real objects, but can express what they truly want something to be. Thinking in functions first also allows an easier switch to higher functions, to determine what the actual need 'problem' is. The actual need within impact assessment is the program level, that what ultimately has to be achieved. Having the ultimate goal of the project clear at an early stage helps to get a good overview.

During the impact assessment it may not always be possible to find exact numbers. There are for example no exact numbers of Statians living outside St. Eustatius. It those cases it may be necessary to find indicators. The number of Statians living in the Netherlands, for example, was determined by looking at the total size of the group of Antilleans living in the Netherlands and taking the size of the population on the islands as an indicator for dividing the group in the Netherlands.

After determining the impact and mitigation measures there was a group discussion with (a large part of) the stakeholders. The discussion was preceded by a presentation of the impact assessment. During the (thorough) discussion, which was led by a moderator, no new impact issues came to light. With the impact and the project goal known, parties participating in the discussion indicated they had much more confidence in the project.

During the meeting the mitigation measures were acknowledged. The impacts for which no solutions was found during the study did not get solved during the meeting either. Further attention is needed regarding these subjects (mainly waste management). While the golf resort will, under the current conditions, make things worse, it is important to note that the problem of waste management is already an issue.

The bulk of the work in doing the impact assessment is the actual determining of the impact per system element. For the impacts that require interviews or information from third parties, waiting times may be long. In most cases it is however possible to continue with determining impacts on other system solutions while waiting for information or an interview.
An issue found during executing the impact assessment is that there is no certainty that all impacts are taken into account. How can be guaranteed in the direction of the client or the stakeholders that the opinions of all stakeholders have been included and all relevant effects have been reviewed? A more thorough review of this question will be continued in the next section.

4.2.3 Usefulness of the integrated approach

An important question to ask is obviously if the integrated approach to impact analysis as executed in this report is actually useful. Does it solve (some of) the problems that were found in the current practice of impact assessments and that were stated in the process of getting to a problem formulation at the start of this report?

The main problems that the new impact assessment method was to solve are:

- Offer a single document which clearly and consistently states the project impact
- Trace the transformation from requirements to solutions, when decisions are made, they should be made explicitly.
- Take into account the 2nd order effects, which are the impacts resulting from changes caused by the project.

- Include the links between the different impact fields, which make trade-offs possible between for example environmental and economic effects.

The developed impact method did indeed offer a single document, which covers the economic, social and environmental impact. In an attempt to present it clearly and consistently the impact is presented in a table, together with the mitigation measures. The same mitigation measures together with the remaining impact are again given at the end of the document.

Decisions made in the impact assessment are for example the conversion from functions to system solutions, which solution is the preferred one and which alternative has the preferred impact. The conversion from functions to system solution is a process, which is described and tracked in a table. This ensures that the decisions are traceable and can be checked. When a selection has to be made from alternatives this was also substantiated. An example of this is the selection for diesel powered electric generators, which was selected on its cost and the disability of wind energy to provide a constant amount of electricity.

Second order effects are the effects that occur due to changes created by the impact of the resort. For example the construction and operation of the resort itself does not have a direct effect on schools. Because personnel are required to run the resort, the population on the island will increase. This causes a larger demand for schools. By use of the customer FAST and PDBD the method forces a single start point. This single start point can be considered the program level, or strategic goal. By considering all that has to be accomplished to reach this goal, second order effects will be taken into consideration. A worry during the group session, held at the end of the study, was whether the report examined the 2nd order effects deep enough. It was mentioned for example that the effects on the supermarkets were not included. While it would have been no problem to include this effect in the method, the effects on supermarkets were never thought of during the interviews. This shows the disadvantage of an interview method versus a team approach. In the last setting stimulation by other parties may cause parties to come up with new ideas that in an interview approach do not come up.

The method also allows links between different impact fields to be included. An example from the study where a link, or in this case conflict between impact fields were found is the usage of the beach. From an environmental standpoint the beach is required for the nesting of sea turtles. From an economic standpoint, the beach is required for the guests of the resort. By including this link, it became a subject in the mitigation measures. In a standard impact report a decision maker may have just received two reports, one stating that Sea turtles, which are protected by law, use the beach, another report stating that for economic reasons (to attract tourists), the resort should have a beach. During mitigation it became apparent that some simple measures would allow the beach to be used for both the guests and the sea turtles. In fact, because the resort will clean the beach from waste washed ashore, the beach will even become a safer place for the sea turtles.

From the four points above it can be concluded that indeed the method solves the four mentioned problems encountered in the current impact assessment method.

Another question to be asked is whether or not the impact assessment is complete and how it is possible to be certain about this. Appendix III compares the new integrated impact assessment method with ‘the seven samurai of system engineering’ by Martin [2004]. From this comparison it becomes clear that indeed the new integrated impact assessment method follows, at least on the main points, the holistic systems thinking as described by Martin. This ensures that the ‘whole picture’ is taken into account.

4.3 Recommendations

As indicated in the reflection the developed integrated impact assessment method seems to solve the main problems indicated in the two MER-Commission reports [1998,2001]. It could only be tested in this single case study though. Due to the nature of the study some elements that could improve the results could not be tested.

Team approach
It would be interesting to use this method in a team approach. The team approach has two meanings. Firstly the team should include impact assessment investigators from all disciplines. This can provide information if the method can indeed create deliberation between the experts. Secondly next to the experts, the stakeholders should be involved more often, either by including them in the team or by use of a job plan method, whereby they would be part of the workshop. From the single meeting of a majority of the stakeholders in this research project it became clear that in a team approach people do stimulate each other and impacts may be discovered that are not found using interviews. The team approach is expected to deliver a more complete picture of the system solutions and therefore allow a more complete impact assessment.

Further case study
The case selected for this study took place in a 'controlled' environment. The island of St. Eustatius is small and it is clear that a large project like a golf resort will have an influence on the whole island. It is also clear where the impact stops, people whom do not live on the island are unable to work there, as commuting is not feasible. It is also clear that items that are not locally produced will need to be brought in (imported) by either boat or aircraft. When a case study would be executed in a more standard situation, for example somewhere on the mainland of Europe, it may be much harder to determine where the impact of a project stops. It would therefore be interesting to execute such a study to determine if the method is suited for such a situation. If a case study is performed in such a situation it is expected that determining the available resources becomes harder.

Further integration between the design process and impact assessment
The new integrated impact assessment method provides a single report containing the different impact fields. To achieve this, first a design is created, after which it is reviewed for its impact on the three impact fields (environmental, social and economic). The new integrated impact assessment method uses VE and SE, which were taken from the field of construction management. Since both the design phase of a project and the impact assessment are creating a 'provisional' design of the project, there may be double work. Between the two designs there may in fact be differences. It may be possible to use VE and SE as the binding factor to combine impact assessment and the design process. By making impact assessment a part of the design process it may be possible to reduce the time and minimize double work during the design phase. Another advantage could be that whenever the design is changed, the environmental, social and economic effects can easily be determined. Further research would be required to determine if the listed advantages are achievable, what the negative sides of such integration would be and whether it is possible at all.

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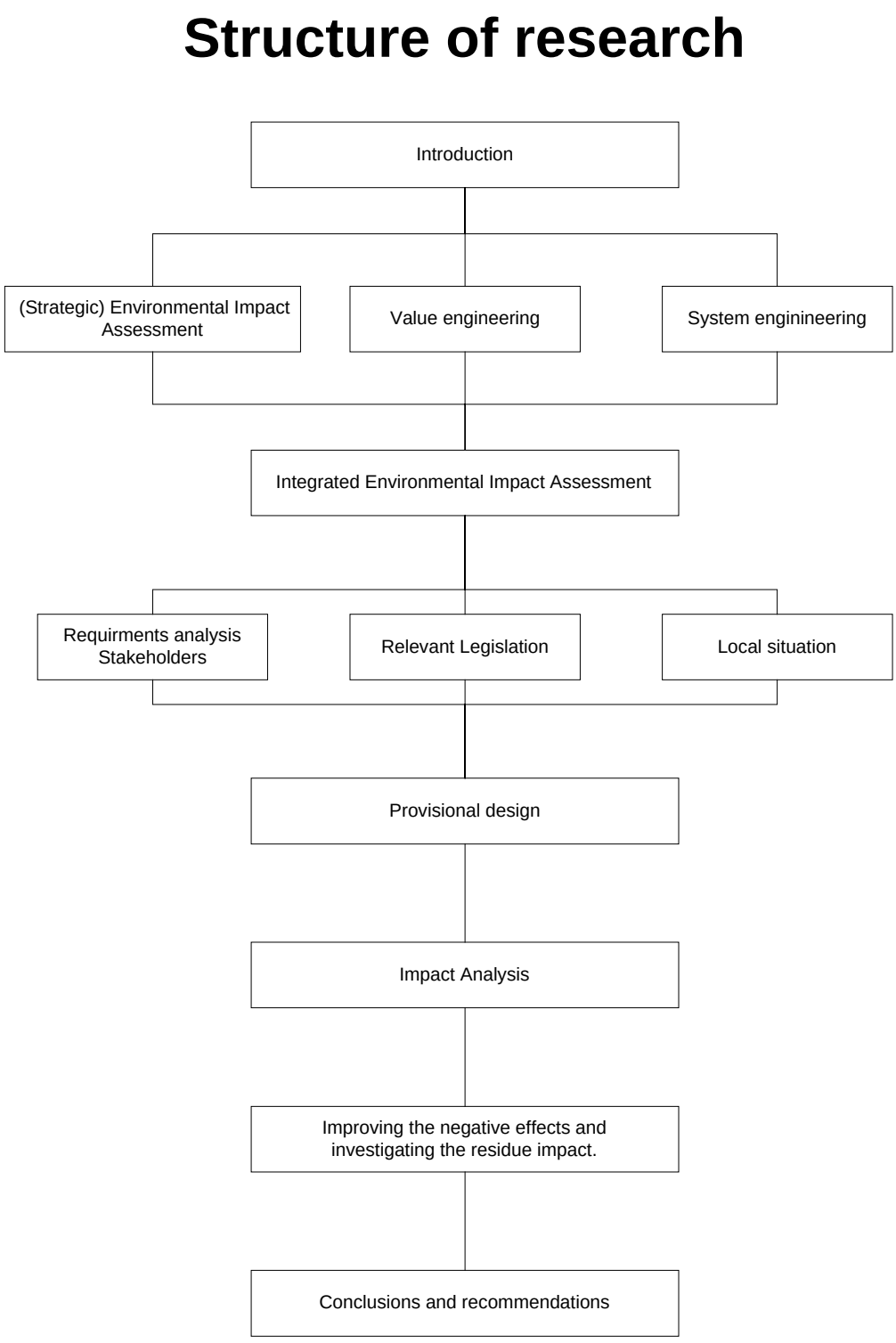
Loose supplements:

‘Strategic impact assessment golf resort St. Eustatius’

‘Customer FAST – Golf resort St. Eustatius’

‘Provisional design block diagram – Golf resort St. Eustatius’

Appendix I – Structure of the research



Appendix II – Value engineering, the main principles.

Value engineering is used extensively in this study. Since not all readers may be familiar with this method the main principles of functions and the technical and customer FAST are explained below.

Historically

Larry Miles developed the theory of value engineering, also called value analysis or function analysis, in the 2nd world war. Due to wartime shortages in materials new ways had to be found to provide products, which offered the same functions, but used different (available) materials. By being able to understand what a product has to do, it's function; successful new products could be provided.

After the war the method was further developed. It shifted to a dynamic development process that aims for an increased acceptance of the design results by the stakeholders and a decrease of the cost of a design. [Bryant 1998]

The two main lines of thought in Value Engineering are:
- A clearly described problem is solved half already.
- Communication between the stakeholders is the key to establish the problem.

Functions

The main question value engineering asks is 'what does it have to do?' Answering this question will aid to define and better understand the product that to be developed. In the VE method, the answer to the question will be given in the form of functions. The essence, according to Miles [1989] is that the only thing a customer wants is a function. The functions that the customer wants done are the heart of the problem. Miles states that a customer wants only two types of functions, in varying degrees in different products and services. These are use functions and aesthetic functions. Use functions are the actual functions that need to be performed, the aesthetic functions are there to please. By bringing a problem back to its core; the functions it has to perform, a creative process becomes possible.

A function is normally built up of two words, an *active verb* and a *measurable noun*. Examples of functions are *provide accommodation*, *create golf-resort* and *create beach*. According to Bryant [1998] using this two word description has several advantages:
- People are forced to specify an exact wording of the problem; this helps in focusing on the exact problem at hand.
- By focusing on the core, the solution space for alternatives is kept as large as possible, which helps in the creative phase.
- Functions that are similar to each other are easy to identify and combine or eliminate.
- The method promotes full understanding by all team members regardless of their knowledge, educational, and technical backgrounds.

FAST (function analysis system technique) diagram

The idea of a FAST diagram is to force a group to consider the functions and function interrelationships in such a way that creativity is focused. The Classic, Technical and Customer FAST are three types of FAST diagrams that exist. The technical FAST is most suited to review and improve elements of a design. An example of that could be a review of the

irrigation system of golf resort. The Classic and Customer FAST are most suited to review the system as a whole. The Technical and Classic fast are mainly suited to determine what is to be done, while the Customer fast tries to establish a common understanding of what outcome is to be achieved. [Woodhead, 2001] To determine all system elements of a project, which is what the impact assessment requires, the Customer FAST is the most appropriate FAST diagram form. To improve the performance of separate system elements, for example during mitigation, the technical FAST can be used. There is not a single correct FAST diagram. A group uses the diagram to consider functions and their interrelationships, different groups will create different FAST diagrams.

The Customer FAST consists out of the following elements:

- Scope border
- Task
- Basic Functions
  - Primary function
  - Secondary function
- Supporting Functions
  - Primary function
  - Secondary function

The layout of the customer FAST is shown in figure II.1. The start point of the diagram is the task. This is the reason for the project, the reason for executing the project. The task is the highest order function in the diagram and forms the scope. An example of a task can be 'Self-sustainable Island' or 'Create golf-resort'. In the first case the scope of the project is substantially larger. The task is performed by basic and supporting functions, basic and supporting functions are different names for the original use and aesthetic functions mentioned by Miles [1989].

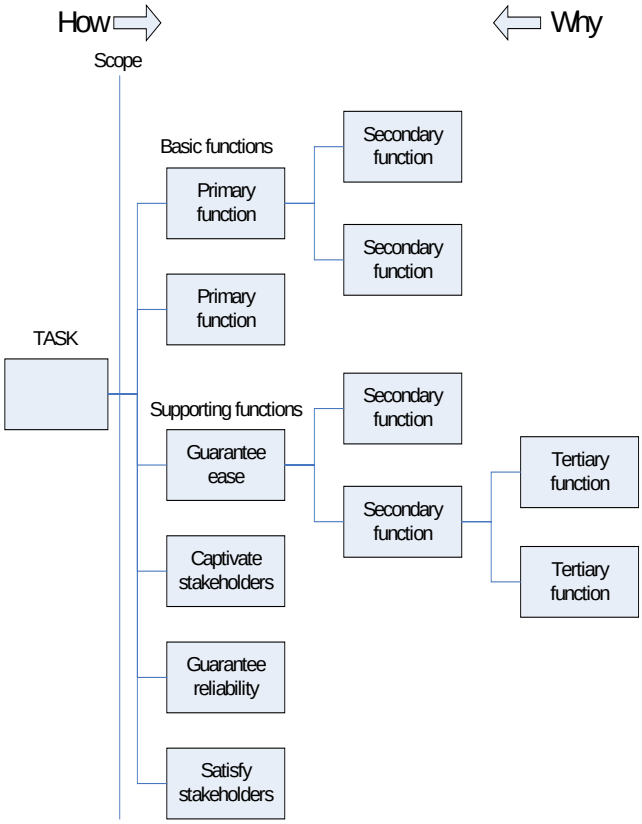


Figure II.1 Customer FAST [Veenvliet, 2004]

The logic behind a FAST diagram consists out of asking the questions 'HOW' and 'WHY'. When the question is asked 'How to develop a self sustainable island?' lower level functions can be found. A possible answer to this question could be 'by creating a golf resort'. Create golf resort would then be a primary function in the diagram. By asking the question 'How to create a golf resort', a secondary function can be found, etc. To check the logic behind the 'How' answers, the WHY question should be asked. Why should a golf resort be created? To answer is to develop a self-sustainable island, which means in this case the logic is valid.

In the customer FAST a distinction is made between Basic (Use) functions and Supporting (Aesthetic) functions. The supporting functions always have four primary functions; guarantee ease, captivate stakeholders, guarantee reliability and satisfy stakeholders.

As indicated the Customer FAST is used to establish a common understanding of what is to be achieved. The Technical FAST is used to determine in which alternative ways the same

functions can be performed. It is most suitable to review, for example during mitigation, a specific part of the project to come up with alternatives. The Technical FAST consists out of the following elements:

- Scope border
- Basic functions
- Critical function path
- Logic HOW-WHY questions
- Secondary functions
- Causative function
- Supporting functions
  - Caused by/ simultaneous functions
  - Always present functions
  - Design functions

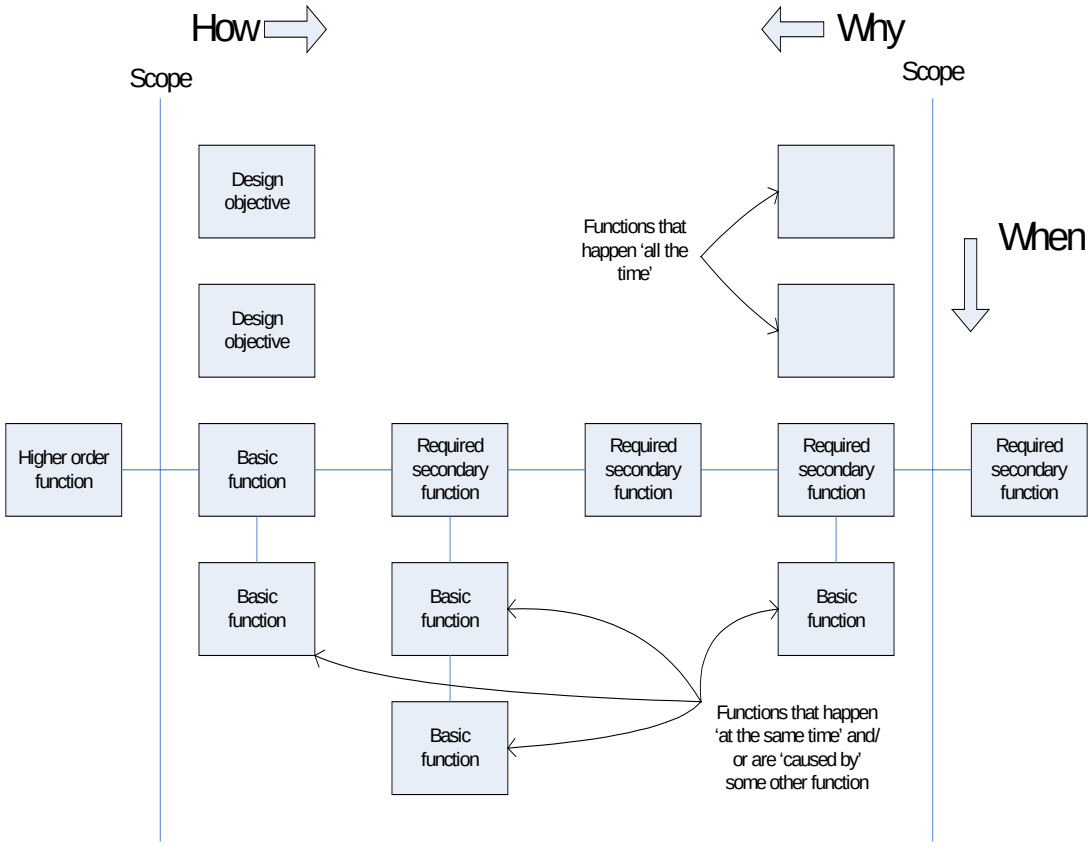


Figure II.2 Technical FAST [Snodgrass, 1986]

An overview of the technical FAST is given in figure II.2. The technical FAST diagram has two scope borders. On the left of the scope border is the higher order function, which is comparable to the task from the customer FAST. It explains why the part of the project is needed. On the right of the scope the causative function can be found. The causative function explains the reason of the value study. A possible causative function can be 'study alternative'. The primary function, as well as the secondary functions are between the higher order function and the causative function and are build up using the same 'how' / 'why' question used with the

customer FAST. Below the secondary functions and primary functions there are functions that occur at the same time. For example if a function is ‘Desalinize water’, at the same time the function ‘Utilize electricity’ would be valid, as the desalination process causes the utilization a lot of energy.

Finally there are two types of functions, which are noted separately. These are design objectives and functions that happen ‘all the time’. An example of an always-present function would be ‘minimize environmental impact’. A possible design function can be ‘minimize (energy) consumption’.

Appendix III – The seven samurai of system engineering

In his paper Martin [2004] indicates there are seven different systems that must be acknowledged and understood when using system engineering. Between the seven systems there are fifteen interactions. When these seven systems and their relations are considered, the paper states, there is a better chance for understanding the whole picture.

In figure III.1 the 'holistic view' as created in the paper by Martin is displayed. Can the new impact assessment method as developed in this report be recognised in the holistic view?

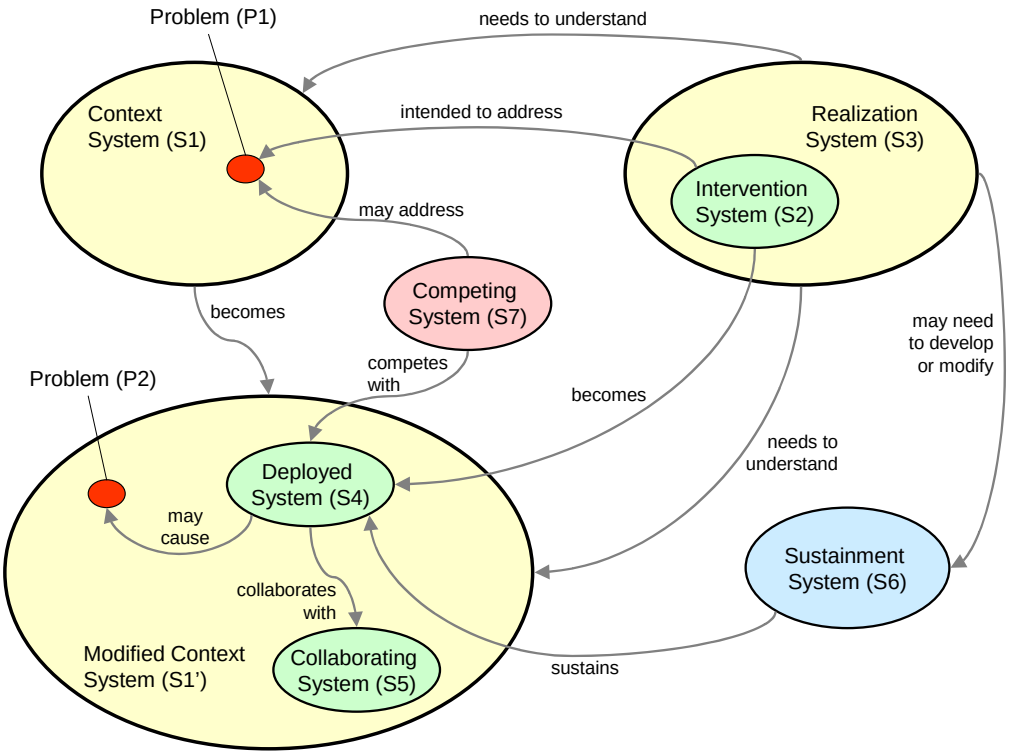


Figure III.1 – Holistic system view as found in the seven samurai of system engineering by James N Martin.

Both start to review the problem and its context 'scope'. The context of an engineering project can be the available space, legislation, available number of people, the accessibility, etc. The paper states that it is important to find the cause of the problem, so the problem can truly be completely solved. It should also be asked if the found problem is a symptom of a deeper problem. In the impact assessment method, value engineering and the tool of the FAST diagram is used to discover the true problem(s) that need to be solved. The context (S1) is handled in determining the scope.

Using the tools supplied by system engineering, the system solutions are generated. The intervention system, or solutions, in this case is a golf resort. The golf resort is to (partially) solve the problem of not being a self-sustainable island. This makes the golf resort and the system solutions belonging to this project the intervention system (S2).

For the golf resort employees are required, services need to be offered to the guests, policies need to be changed. In other words, other system solutions are required to realise the golf resort. In the holistic system thinking this is described as the realisation system (S3). The

impact assessment indeed needs to and does review the context system, for example the question can be asked how many local employees can be found, which reverts back to the context. The realization system should also look at how the project will change the context (S1'), so it can anticipate, for example more teachers may be necessary due to an increase in inhabitants on the island in the new context.

The intervention system will ultimately be build, which turns it into the deployed system (S4). The deployed system will be different from the intended intervention system. This is taken into account by not going into very high detail levels in the impact assessment. By keeping the impact assessment at a somewhat higher level, there is room for changes in the design without any big effects on the impact of the project.

Next to the system developed for the golf resort there may be collaborating projects that affect the impact of the golf resort. For example, if a foreign investor would build a power plant for the resort, the local energy company would not be able to supply this power to the resort. The potential, mainly economic, benefit for the island of being able to deliver electricity to the resort will in that case be lost. Since the profits that a foreign company makes will not stay on the island, this means that the total economic impact on the island will be lower than envisaged. On the other hand, if the plan for a boat service to the nearby islands works out, this may complement the golf resort and may attract golfers from nearby islands (S5).

The sustainment system includes water, electricity, maintenance, etc. These things are, probably other than with a mechanical engineering project, very much part of the realization system. Still, within the realization system it is possible to recognise sustainment systems (S6).

There are almost always alternatives that can be considered. With an impact assessment, an important alternative to consider is doing nothing. Alternatives will address the original problem (P1) and will vary in the level at which they succeed to compete with the deployed system (Competing systems, S7).

From the analysis above it becomes clear that the impact assessment follows, at least on the main points, the holistic systems thinking as described by Mr. Martin. This ensures that the 'whole picture' is taken into account.

Appendix IV – The System Engineering Process

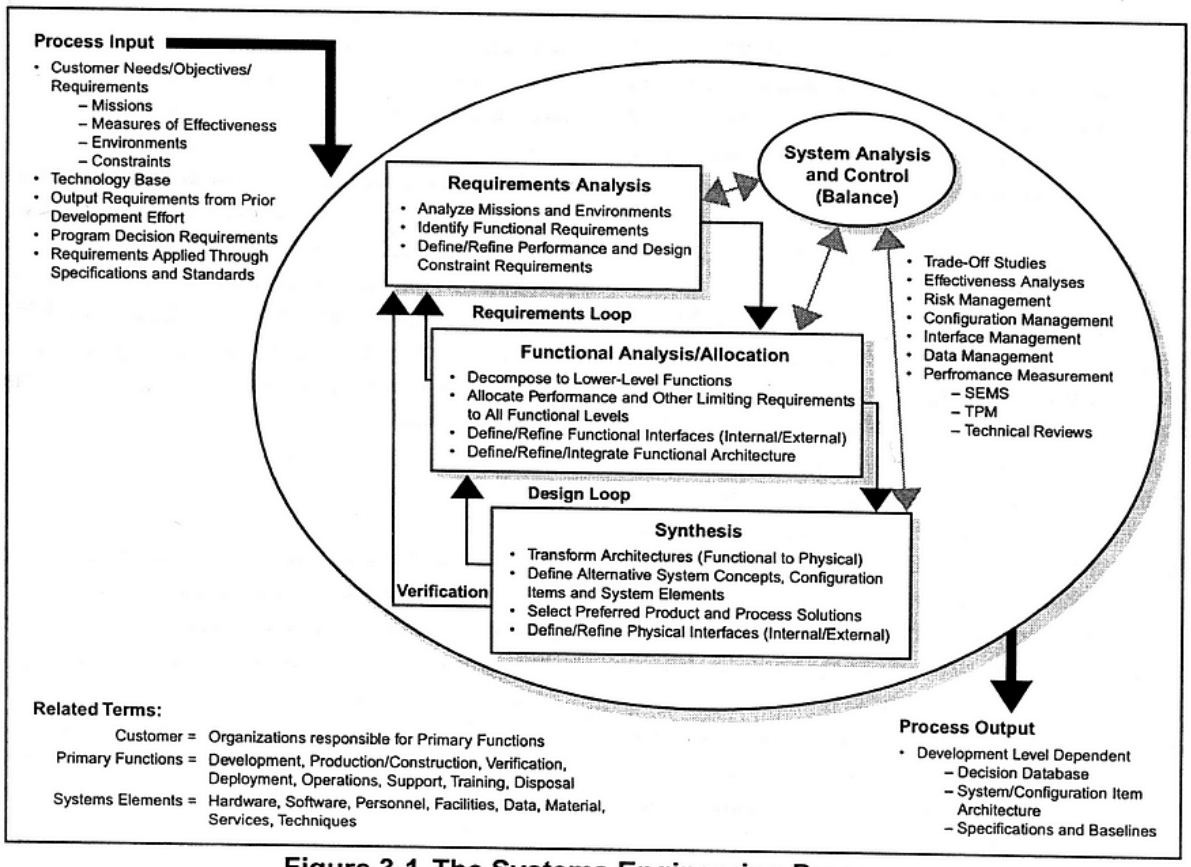


Figure 3-1. The Systems Engineering Process

According to the system engineering fundamentals [2001], the system engineering process is a top-down comprehensive, iterative and recursive problem solving process, applied sequentially through all stages of development, that is used to:

- Transform needs and requirements into a set of system products and process descriptions.
- Generate information for decision makers.
- Provide input for the next level of development.

Figure 3.1, above, shows the system engineering process. The main system engineering activities are requirements analysis, functional analysis and allocation and design synthesis. These activities are controlled 'balanced' by the system analysis and control techniques. The figure shows that system engineering needs the project requirements as an input. During the process it converts the requirements to system elements/ solutions. The process output is a design plus the information about the decision that determined why the requirements where converted into this specific design.

Appendix V – Requirements and functions

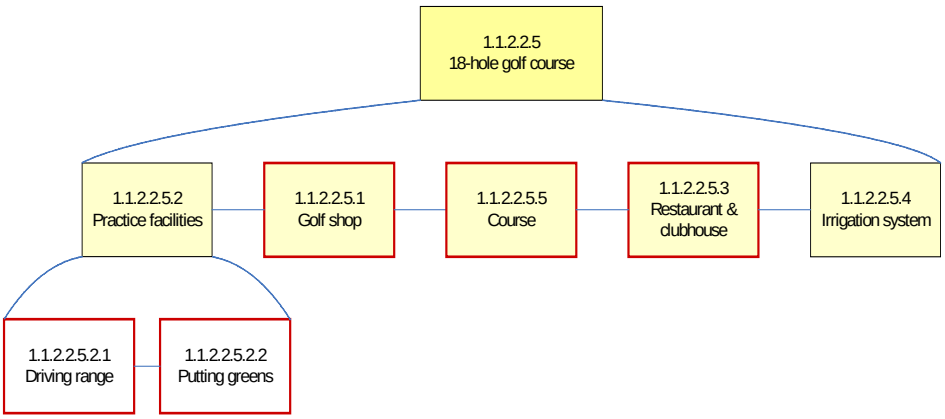
Requirement	Function	Number	Source
St. Eustatius should aim to become an exclusive destination, comparable with St. Kitts now.	Exclusive location	Attr.	TO
The golf resort should add a large portion of rooms to the island.	Provide accommodation	0.1.1	TO
The golf resort would have to decrease the social employment function of the local government.	Attract workers	0.2.1	TO
The golf course management should have a reserve for marketing, taking the load of the government to do marketing for the island	Promote Island	0.1.5	TO
The goal of the golf course is to have spin of effects increasing the islands economy and the social position	Increase economy Increase society	0.1.6	TO
Care should be taken which people are going to work on the golf resort; people from the nearby islands, Dutch Antilles and Europe/ USA are no problem. Low educated people from for example the Dominica's with big families will have a large social impact.	Offer employment	0.2.1	TO
The unique things compared to other islands are the quietness and a lack of crime, these should be maintained	Maintain quietness Maintain crime-free status	- 0.2.2	TO
Having a beach would lift a constraint that is currently tempering the tourism development.	Create beach	0.1.2	TO
Because not all persons may like golf (partners of golfers), other attractions should be offered as well to keep those people happy.	Develop attractions	0.1.3	TO
The accommodations should be aimed at a tourist that wants luxury and quality in a discreet way.	Create exclusive golf resort	0.1.1	TO
To support upper class tourists, the airport terminal and apron should be renewed. A VIP room would perhaps attract the very top of the market.	Upgrade airport	01.4	TO
The beach from the waterline to the dunes is protected and should not be used due to sea turtles.	Protect Seaturtles	0.3.4	ST
Venus Bay houses the protected Iguana delicatissima, it is rare and only exists on 4 islands. The trees (which ones) are important for the food of the iguanas and should be protected.	Protect Iguana delicatissima	0.3.1	ST
The water next to Venus Bay and Zeelandia is important for fishery, there are also corals nearby which should be protected.	Protect Coral Protect Fishery	0.3.2 0.3.3	ST
Care should be taken with effluent water from a desalination plant, not to damage corals or impact fishery.	Protect Coral Protect Fishery	0.3.3 0.3.2	ST
Eustatius should aim to promote itself as the island of Archaeology, diving, history, hiking and yachting.		Altr.	ST
In protection of the sea turtles a golf course next to the dunes can keep the water edge dark and protect it against more harmful development	Limit seaside lighting	Constr.	ST
The Netherlands wants St. Eustatius to be more independent by providing their own income	Self-supporting island	0.2.3	BA

The local residence have to agree with the project	Satisfy locals		BA
The buildings have to fit in with the current style, this means a maximum of 2 floors	Fit surrounding	0.3.5	BA
Offer employment for 600 to 700 people and thereby also increase the tax revenues	Offer employment Increase tax revenue	0.2.1 0.1.6.3	BA
Increase the total government tax revenue due to the taxes that the golf course has to pay	Increase tax revenue	0.1.6.3	BA
Double the islands economy by direct and indirect effects of the golf resort	Double economy	Verif.	BA
Decrease unemployment on the island	Decrease unemployment	0.1.6.2	BA
Make it possible for Statians that had to move abroad because there wasn't any work for them can return to the island	Provide work (to Statians)	0.2.1.2	BA
Increase the facilities and service levels on the islands	Increase facilities Increase service	0.2.3.1 0.2.3.2	BA
Make sure the project fits in with the environment, as this increases the popularity of the golf resort with tourists.	Fit (golf course) in environment	0.3.5	BA
The project should provide it's own power, if possible using renewable energy sources.	Provide power	0.1.1.6.2	BA
A requirement resulting from the legislation however is that the project should show clearly the environmental impact on Venus Bay, enabling the government to make an informed decision about whether or not to change the law to allow a golf resort.	Inform government Change Law		LG

BA : Business Association
LG : Legislation
ST : Stenapa
TO : Tourist Office

Appendix VI – Preliminary Design Block Diagram

The system solutions are placed in a block diagram to give an overview of the system solutions and their main relationships. The diagram is setup somewhat similar to the customer FAST, although in this case it contains system solutions and not functions. An example and part of the actual block diagram created for the case study is shown in figure VI.1



VI.1 Preliminary design block diagram

In the Customer FAST a lower level function is found by asking the question how. The logic can then be checked asking the question why the lower level function exists. The answer should be the higher level function. In the above diagram the 18-hole golf course is a system solution. The system solution is build up out of several other, lower level, system solutions. A golf shop, irrigation system and course are elements of the 18-hole golf course. The practice facilities consist out of two elements, a driving range and putting greens.

To find the lower level elements of a system solution, the question can be asked, which system solutions make up this system solution? A question to check the answer could be, is this system solution an element of the higher order system solution? Coupled to the example the questions could be: Which system solutions make up an 18-hole golf course? To check one of the answers, a restaurant and clubhouse, the questions can be asked if a restaurant and clubhouse are an element of an 18-hole golf course. Indeed on most luxury golf courses a restaurant and clubhouse can be found, so in this case this is a valid lower level system solution.

The system solutions are all numbered to provide traceability. Note that each subsequent lower layer starts with the number of the system solution it belongs to, but adds an additional number layer. The highest order system solution in the above example is 1.1.2.2.5, the next layer starts with this number, but an additional number is added at the end: 1.1.2.2.5.**x**. The diagram should have just enough layers ‘detail’ to execute an impact assessment. It is not necessary to work on all details. A putting green for example consists out of grass, a hole, a flag, etc. These are details that are not relevant for the impact assessment. The system element ‘putting greens’ is detailed enough.

The Diagram should always have a single system solution at the very start, which is the program level system solution. In the case project the program level system solution, or strategic goal of the project, is a self-sustainable island. All the system elements within the program are necessary to reach this goal.

Strategic impact assessment golf resort St. Eustatius

Reviewing and improving the impact of a planned golf resort on the island of St. Eustatius.

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June 2006

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Preface

Sustainable development should play a major role in any program or project. The study that lies before you reviews the economic, environmental and social impact of a program aimed at making the island of St. Eustatius more self-sustainable. The main project reviewed to reach this program goal is the development of a golf resort. This report reviews the economic, social and environmental consequences when such a project is executed.

The impact assessment is part of a larger project, which reviews the possibility of using the construction management methods of system- and value engineering in Impact Assessment studies. This study is performed as part of achieving a master degree for Civil Engineering and Management at the University of Twente in the Netherlands.

The impact assessment has been performed on request of the St. Eustatius Business Association (STEBA) and is partially based on an earlier feasibility study of a golf course in St. Eustatius, performed by Rob Blokvoort and Tom Tiggeloven, both of the University of Twente. The impact assessment was executed on the island of St. Eustatius. I wish to express my thanks to the STEBA for providing me with the opportunity to do this impact assessment and especially for the hospitality and warm welcome by STEBA president Mr. Koos Sneek and Mrs. Nora Sneek-Gibbs.

An impact assessment is not possible without information from the stakeholders. During the time on the island I have therefore discussed the impact with a large number of local businesses, organisations and (government) agencies. I wish to thank these persons for the time they spend answering my questions and the information they have provided.

Comparing the possible effects with observed effects and situations at similar resort in Anguilla, which is currently being constructed and St Kitts, which is in full operation, was very helpful. I wish to thank the government of Anguilla and the resort management at the Marriot resort in St Kitts for their assistance and unselfish help in providing me with information about the way these resorts and construction projects are run and the impact that they have.

An impact assessment can and does not give a final answer whether a project or program should be executed. It is a document that provides information about the expected impact of a project. It is up to the stakeholders to form an opinion about the impact of the project and up to the government to promote discussion between stakeholders. The stakeholder opinions on the impact should be heard and taken into consideration before a final decision is taken about the project. I sincerely hope all stakeholders will find this report a helpful and reliable source of information in determining their standpoint regarding the project.

This document is an appendix to the report ‘Strategic impact assessment, improving impact assessment by developing an integrated impact assessment method’. The main report develops the integrated impact assessment method, which is applied in this case study. It also describes the procedure that was followed to develop this strategic impact assessment report.

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Executive summary

Introduction

This report looks at the economic, social and environmental impact of the planned development of a golf resort on the island of St. Eustatius. The island of St. Eustatius is located in the northeastern Caribbean (see figure 0.1), 60km south of St. Maarten, 15 km north of St Kitts and about 300 km east of Puerto Rico (not on the map). The island is part of the country of the Netherlands Antilles, which consists out of the islands of St. Maarten, Saba and St. Eustatius in the northeastern Caribbean and Curacao and Bonaire in the southern Caribbean.

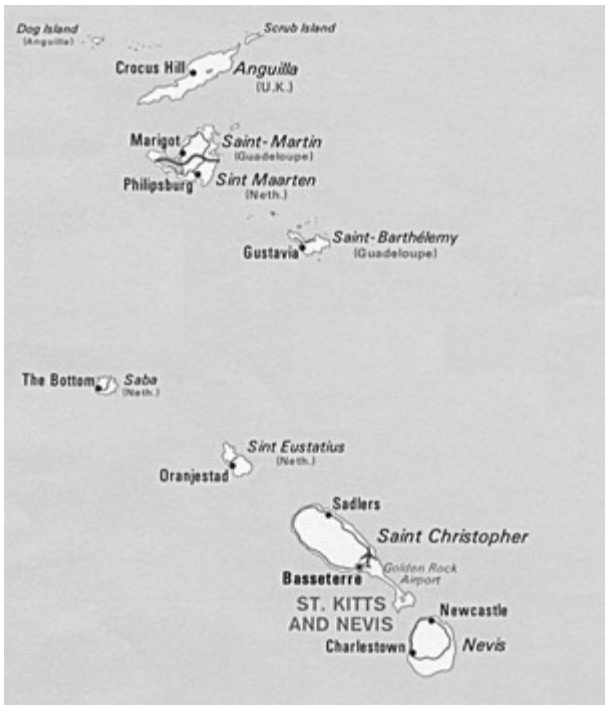

Figure 0.1 - Northeastern Caribbean
© Trailmonkey.com

St. Eustatius is a relatively small island, measuring approximately 7 by 3 km and with a surface area of around 21 km^2 (see figure 0.2). The southern part of the island features a dormant volcano, rising up to 600m above sea level. The northern part of the island features the remains of an extinct volcano, with steep hills up to 300m above sea level. The middle section of the island is relatively flat. This is where the capital and only city, Oranjestad, is located, as well as the airport and on the western side the harbour and most of the hotels. There are currently around 3100 inhabitants on the island.

The three main sources of income for the island are an oil transhipment facility on the north-western side of the island, a medical school with around 200 students and the spin off that creates in terms of house rental and catering and finally tourism, with currently an emphasis on diving.

The income from these three sources is not enough to make the island self-sustainable. Due to the nature of being an island, which makes sharing services and facilities with neighbours harder, there are a lot of cost, like the airport, a harbour, a hospital, etc. that have to be shared over a limited number of inhabitants. The island government currently has an annual budget deficiency of US$ 6.1 million.

Figure 0.2 – Map St. Eustatius
© Statiatourism.com

The golf resort project is part of a program that is aimed at making the island self-sustainable. Next to the golf resort project there is also an alternative project, an eco-resort that can have stimulate tourism and thus influence the program. A 0-option (not executing any project) and the eco-resort option are reviewed in the report as alternative projects.

Scoping the impact

A large project like the golf resort will affect many people, the stakeholders. Because St. Eustatius is a small island, there is hardly anyone who will not be affected by the project, if only due to improving connections to the island, or the government getting an additional amount of money for road improvement. Other than all inhabitants of the island, the main stakeholders are: Island government, Tourism development organisation, STEBA (St. Eustatius Business Association), Harbour, Airport,

STENAPA (St Eustatius National Parks Foundation), local delivery and tourism industry, shipping industry, future employees and tourists and an international golf-resort chain.

The main goal of the program is to increase the self-sustainability of the island. Ideally the project should bring the current budget deficit of around US$ 6.1 million back to 0, or even a budget surplus. To reach the main goal of becoming more self-sustainable, the main projects to accomplish are to increase the number of businesses on the island, to attract more tourists and create jobs and income. To guarantee the self-sustainability in the future the island should be developed in a sustainable way. Finally, government income should be increased.

The golf course is envisaged in the Zeelandia and Venus Bay areas, as well as the pass between these areas. The Zeelandia area is relatively flat. It's located on the eastern (Atlantic) side of the island. The total area, including parts of the surrounding hills, is 71.5 hectares (176 acres). Venus bay is a somewhat isolated and private valley in the northern hills. The Venus Bay area, together with the surrounding mountains, is 171.6 hectares (424 acres).

Impact assessment

The resort will consist out of 156 hotel rooms and 40 condominiums (privately owned, but rented out when the owner is not using the villa). At a maximum occupancy there will therefore be room for 512 guests. Centrally located will be the main buildings of the hotel, including restaurants and bars, a spa and swimming pool, meeting rooms, a small number of tennis courts and a small number of shops, including a supermarket. The resort will offer potable water, electricity, cable television, Internet and phone service.

The golf course will be a top of the range facility. It will feature a club/ halfway house where golfers can signup for their round of golf, refresh themselves afterwards and can get a drink. It will also have practice facilities, both for practicing putting and practicing long shots. The total length of all fairways will be around 6,400 m, with an average width of 30 m

Both Venus Bay and Zeelandia have a beach. The beach at Venus Bay is limited in size and consists mostly out of rocks; the one at Zeelandia is the largest on the island. At both locations swimming is unadvisable due to the undertow. The beach can and is used for sunbathing and walking. Not having a large, white, beach that allows for safe swimming will put the resort and the island at a disadvantage over other islands in the region. It is therefore assumed that the resort will want to create a beach where swimming is possible.

The development of the golf resort should be economically, socially and environmentally sustainable. The golf resort should as much as possible look at employing Statians to work at the resort. On the environmental field the resort should try to keep its impact small. The Iguana and the Sea turtle are two animals that use the region where the golf resort is planned. Care should be taken not to damage the populations of these animals. The economic sustainability of the golf course has been researched in the feasibility report. The economical feasibility of the golf course will therefore be considered a fact and will not be re-examined.

Supporting businesses

The estimated number of jobs that will be created by the development of a golf resort is around 530. Statians living on the island can fill around 200 jobs, around 100 additional Statians would be available from off-island. The remaining 230 jobs could be filled with the unemployed on Saba and St. Maarten.

Around 500 additional people will come to the island. An estimated 170 (single person) apartments and 125 homes for families will be required. Of the 500 people coming to the island, 75 will be under the age of 16. The housing foundation has indicated that they would be able to provide these houses. On the island enough space is available. There are several available plots at different locations on the island. When houses are constructed on the northern side of the island (for example at Grovel),

travelling to the resort would be easiest for the employees and would cause the least amount of traffic problems on the rest of the island.

There will be a large requirement for electricity. The power company on the island, GEBE, can provide this by expanding the number of turbines. Providing there is a certainty that GEBE can deliver the power to the resort for a longer period of time, they are willing to finance the necessary expansion of the power plant and the laying of electricity cables to the resort.

The water for the resort and golf course would have to be delivered by a reverse osmosis installation. This installation converts seawater into irrigation and drinking water. The installation would be backed up by a large irrigation pond, which would store rainwater and excess irrigation water that was caught by drainage. The water requirement depends highly on the kind of grass that is chosen for the golf course.

By placing reef balls (porous and hollow concrete construction, in which coral can form) or another form of barrier in the sea, the undertow that currently makes swimming on the Atlantic coast impossible, can be stopped. At the same time this will stop the beach erosion from the sea, which will cause the beach to extend into the sea. At Zeelandia, there already is a large beach area; at Venus there is a somewhat smaller beach. The sand on St. Eustatius does not have the Caribbean white colour that tourists have come to expect. It could be considered to import white sand.

Most shops will be affected by the increase in the population; the turnover will most likely go up. For the hospital and phone/ Internet company there will be an increase in jobs. The telephone and internet company (Eutel) will require at least one additional person handling service. There are three primary schools and one secondary school on the island. They can cope with the increase in students without problems.

On average the resort will create a requirement for 46 passengers per day per direction to and from Statia. There will be a concentration of departures and arrivals during the weekends, this could mean up to 107 passengers a day, per direction. This would require additional flights to the island, especially during the weekends. Bigger, more comfortable aircraft are required on the St. Maarten route.

The effect on business will not start when the resort opens. It will already start when construction commences. At this time there should already be housing available for the construction workers coming in from off the island. Construction will require a large amount of materials to be moved to the island, which means a lot of activity in the port. Finally, the additional people will be spending money on the island, supporting the local economy and increasing the tax income for the government.

Sustainable development

A major worry for sustainable development is the waste the resort will produce. On the island there are no processing plants for either solid or liquid waste. Solid waste is dumped as is in a landfill; liquid waste is disposed mainly by so called cesspools, which means the drainpipe ends in a hole in the ground, the wastewater enters the ground directly. Septic tanks are used at a limited number of locations. Even if they are used, they still drain into the ground. For both sorts of waste, the resort would have to create its own installation to be sustainable.

Two species of animals have to be taken into account. Firstly the Iguana, which is living in Venus Bay and in fact most of the northern hills area. It is endangered specie; on the island there are some 425 Iguana's. Because they live in and feed off the trees, clearing the trees for a golf course is a potential danger to these reptiles. No problems are expected though if the resort is placed at Venus Bay and the golf course at Zeelandia. It may also increase the appeal for the golf resort having iguanas on the grounds of the resort. The second animal specie to be taken into account is the sea turtle. Having the resort at Venus Bay and the course at Zeelandia would also be beneficial for the sea turtles. Young sea turtles need darkness to find their way to the beach. Having a golf course at Zeelandia will ensure

darkness in this area during the night, as a golf course is not lighted. It will also create a quiet environment for the adult turtles to come ashore during the night and lay their eggs.

It is possible to use the beach for tourism as well as sea turtle nesting. People sitting and walking on the beach will pose no threat to the nests. Since the sea turtles use the beach at night, and people during the day, this will not conflict either. Creating a barrier in the sea, for example with reef balls, will not only make swimming possible, but according to STENAPA it will actually increase the size of the beach by about 15m due to prevention of erosion. A top layer of white sand can be added for visual appeal.

Making tourists aware of the environment and the presence of sea turtles and iguana's can decrease the negative impact, as people will know what not to do (like littering on the beach). Commercial use of the beach will also mean it will be cleaned from waste coming in from the sea; this is currently not being done and poses an equally large risk for the turtles.

From the landside erosion is also playing a role. Rainwater can and does, after heavy rain, run down Zeelandia and erode the beach. This causes deep trenches in the beach and potentially allows seawater, during high seas, to enter further on the land, creating even more erosion. The sand that enters the water in this way could potentially harm the reefs, when erosion is stopped this would therefore also be beneficial for the reefs. By storing the rainwater in an irrigation pond, the water is no longer flowing over the beach, thus eliminating the erosion. The water can now be used for irrigation purposes, providing a free water source for the golf course.

The Venus Bay area is currently protected under the status of 'unique landscape'. On the basis of the law there are no grounds on which a permit could be given for building in this area. A law change will be required, which either allows "sustainable development" as basis for a building permit or which removes the status of protected area from Venus Bay.

Socially, sustainability is achieved by promoting Statians to come back and work at the golf resort. Currently Statians are leaving because no work is available. They will have the least trouble blending in with the current population and will mostly share the same believes and values. It will also mean that families can get together and live together.

Government income

The government income from the resort will normally come from the different taxes and the land lease income. The total increase in tax income for the government, not yet taking into account tax holidays, exemptions, or other arrangements, is around US$ 7.3 million. Next to the tax income there is also a US$ 710.000 land rental income. The total income increase of the government could therefore be US$ 8.0 million a year. The budget deficit of the island currently is US$ 6,1 million, which means the golf resort can deliver enough money to make the island self sustainable. Taking into account the spin-off effects for the islands businesses, the income can increase by another US$100.000.

To attract investors some tax exemptions or tax holidays will have to be granted or other arrangements to reduce the cost for the resort will have to be made. The options of waiving the profit tax and the land rental have been mentioned. This would cost the government a yearly amount of US$ 4,400,000, or more then half the amount that they could receive.

Next to the government and the investors, another large part of the income goes to the 530 people who can find a job at the resort and will therefore now be able to support themselves and play an important role in the islands economy. The total income from these employees, at an average income of US$ 12,000, will be US$ 6,36 million.

For the people currently living on the island, 200 people (About 6% of the population) will find a job with the golf resort. The remaining jobs will go to people who are not currently living on the island. For the people on the island not getting a job with the resort, the primary advantage will be an increase

in government income, which will enable to government to execute project that it are beneficial for all, but cannot be executed at the moment due to money shortage, like improving the roads, the harbour, the airport, etc. Another advantage for them can exist if they start to provide their own facilities or services for the guests.

Remaining impact
Several steps can be taken to mitigate the impact. The exact steps can be found in the report, as it would take up too much space to include the mitigation measures in the summary. It is however important to know the remaining negative impact, which is the impact that cannot be mitigated.

It should be taken into account that people living on the island, stakeholders and decision makers can have a large influence on the impact of a golf resort. When no additional activities are created, potential guests may select another island that offers a similarly luxurious golf resort, but because of the islands itself or the activities it provides offers that little more then St. Eustatius can currently offer. Adding additional activities, like sail boat rental, diving, horse riding, boat trips, hiking tours, parasailing, etc are important. If operated by the resort the money will go the resort chain and the investors, for the island it would therefore be better if local persons start offering additional services and attractions aimed at the upper class tourists. Adding the above-mentioned services will create even more jobs and will keep additional money on the island.

The resort will use around 4% of the total surface area of the island. Since large parts are already built-on area, or not suitable for construction, the area of land that would be suitable for other projects will be reduced even more. With a high certainty there are however no projects that at the same location would be more beneficial to the island. The land used by the golf resort that can no longer be used for other project will however be significant.

Regarding electricity the amount of non-renewable energy will be significant. Even when windmills would be used, which is questionable seeing that they do not pay back very fast, large amounts of diesel-generated electricity would still be required.

The possibility of using Venus Bay completely depends on a law change. The government has indicated they will be willing to change the law if they believe the project will be beneficial for the island. This is required to happen before any development can start.

There is a possibility that houses currently located in the Venus Bay area may need to be removed. Should this be required then this is a significant remaining negative impact. The golf course designer and the developer should try to avoid this from happening.

Solid waste will be produced in large amount when the population on the island increases by a third. The current dump is envisaged to last for another 5yrs and may have run out before the resort goes into (full) operation. At the current dump waste is not handled sustainably and at a small island it is very hard to find a way to create a sustainable solution for waste handling. The additional waste however still is a significant negative effect for the environment and due to non-sustainable handling at the dump also a threat for the health of the people on the island.

Golf course versus other project
The golf course is a project within a program. The program is looking at making the island more self-sustainable and less dependant on others. While this document focuses mainly on the golf resort project and its impacts, two other alternatives were reviewed for their main impact features.

The first option is always not to execute a project at all. The result of that would be an expected increase of hotel capacity by around 50 rooms in the next years, mainly for dive tourism. The creation of this hotel capacity will most likely not be enough to keep the Caribbean Sun airlines flight to St. Kitts and San Juan. A 50-room hotel, at 70% occupancy and at US$ 150 a night (average) would create a room tax alone of US$ 134,138. Most likely it will be get a tax exemption for other taxes for

about 10 years. The hotel would deliver some jobs, how many really depends on the service that the hotel will want to deliver.

The second option is to create an ecological resort, comparable to Saba, but larger. Eco tourism, like golf tourism, is a rapidly growing market. If 50 eco-lodges would be created, there would be space for 200 tourists. This would be a large enough market to keep the Caribbean Sun airlines connection. At a cheaper US$ 85 per cabin per night, the room tax income would only be around US$ 100.000 per year. For this facility as well tax exemption for the other taxes are expected for about 10 years. The eco-resort would deliver around 34 jobs.

The golf resort will consist of 156 rooms, and 40 condominiums. In total this gives capacity for 552 guests on the island. These guests would be willing to pay substantially higher prices per night. Even at a moderate price level of US$ 695 per night, the yearly income due to the taxes for the government could be around US$ 7.8 million. More realistically the resort and the government will negotiate about the amount of money the resort has to pay. In the worst case the resort will get a full exemption for the profit tax and the land lease, which leaves a tax income of US$ 3.4 million. A public private partnership may be a solution to reduce the load on the golf resort, but still give the government a good income from the resort. The Caribbean Sun airlines connection would most definitely stay; in fact the increased requirement for transport may spark more frequent or more direct flights and larger aircraft to operate to the island. The project would create around 530 jobs.

From the three projects, the golf resort creates by far the largest economical impact. With 530 jobs, it would be the largest employer on the island by far, potentially reducing the unemployment to a figure near 0. The golf resort will also have the largest negative effects, mainly in the fields of waste management, non-renewable electricity and the high land use. The direct (tax and land lease) and indirect effect of the golf course far exceeds to other two projects. The economy off the island will get a boost from tourism, especially if also local people start providing attractions and services to the golf resort tourists. When no cuts would be made in the amount of tax that the golf resort needs to pay, this project does succeed in achieving the program goal of creating a self-sustainable island, for which NAf. 11 million in tax income is required. The likely exemptions will however in the worst case bring the income back to US$ 3.4 million, in which case the project brings the budget deficit of the government back by about 55%. The other projects both deliver only around NAf. 100,000, which is negligible compared to the budget deficiency. A PPP construction should be found that would increase the government’s income above the worst-case scenario of giving an exemption of profit tax and land lease for the first 10 years, preferably in such a way that the income for the government would be around the required US$ 6.1 million.

1 Introduction

This impact report was written on request of the St. Eustatius Business Association. It reviews the social, environmental and economical impact of a planned golf resort on the island of St. Eustatius. The impact study is part of a larger research project, which examines the potential benefits and limitations of a newly developed integrated impact assessment method. For the client this improvement mainly consists of receiving a single report that looks at all impacts, instead of several reports that only review a specific field of impact, for example just an environmental or social impact study.

1.1 Project characteristics

There are two levels in which a project can be approached; a program- and a project level. The scope of the impact study at a project level is much smaller then at a program level. A program level can also contain several projects to accomplish its goals. The project that is being reviewed in this document is a golf resort. The reason for having a golf course in the first place is the question at program level. Since the program level has not been reviewed yet, it is also part of this study. On overview of the program and its projects is given in the loose supplement titled 'provisional design block diagram', a description is provided below.

1.1.1 Program level

The main goal for the stakeholders at program level is to become more self-sufficient and therefore depend less, or ideally not at all on the Netherlands. Currently 3091 people are living on Statia, together they have to finance a lot of facilities like the Harbour, the airport, the government, etc. By increasing the amount of people that are living on the island, the cost of these facilities can be shared over more people. The budget deficit of the government for the year 2005 is around US$ 6.1 million. This means that the Netherlands has to provide aid and a lot of things that need to be done cannot be done due to insufficient funds. The To become more self-sufficient three things should be done:

1) Support business
By supporting business, jobs will be created. This will generate income for people living on the island, increasing the economy. It will also enable Statians to stay on the island and find work or return to the island because work is now available.

2) ***Sustainable development***
To make sure that the island is not exploited in a way that will severely damage the culture, environment or economy it is important to develop the island sustainably. This means that development that comes to the island can potentially continue indefinitely without any significant negative impact on the environment or its inhabitants.

3) Increase government income
To become more independent from the Netherlands, it is important to increase the tax income. Income from tax can be used to finance projects by the island government. This will decrease the amount of money that has to come from overseas.

1.1.2 *Project level*

Below these three main program points, there are increasingly detailed projects. To support business for example, tourist attractions have to be offered, the number of inhabitants should be increased (to provide a workforce, but also to consume) and the island should be promoted. Offering tourist attractions is a project and can be divided in two sub-projects, namely increasing services for the tourists and increasing facilities for tourists. Services are there to make sure there is electricity, to

make sure there is enough water, to make sure there is health care. Facilities can be a whole range of things, but in this case includes a beach and a golf resort.

1.2 The research method

As indicated this report is part of a larger research project on improving the impact assessment method. This improved method is based on the construction management theories of value engineering and system engineering. In short the process starts with an investigation of the stakeholders and their requirements. When the requirements are known, functions are generated. A function is a short, usually two words, description what something has to do.

For example one of the functions of a resort is to "provide accommodation" or to "decrease unemployment". Providing accommodation can be done in many ways, so next to functions, there is also a need for attributes. An attribute is something that tells a little bit more about the function, for example "5-star+" tells that the accommodations will be very luxurious. Finally, constraints will be set, for example for accommodation a constraint can be that the accommodations buildings should not exceed 2 floors in height, or be no higher then 5m.

For each function, combined with the attributes and constraints, there is now a clear understanding what is needed. A system bearer is then attached to a function. A system bearer is a tangible solution, for example a "5-star+- hotel room" is a system solution for providing accommodation.

Each of the system solutions is a part or element of the golf resort. For this reason it can have a social, environmental or economic impact. For this reason the impact study looks at the impact of each of the system solutions.

With the impact of the system solutions known, the total impact of the resort is also known. At that time it is possible to look at measures to mitigate (reduce) the negative impact. The mitigation measures and negative impact that cannot be reduced will finally be listed.

More information about the impact assessment methodology can be found in the report titled ´Strategic impact assessment, A new impact assessment method using value engineering and system engineering elements.´. This report is part of a graduation study and is using a newly developed method. Because detailed information about the project is not yet available and cannot be because one of the main stakeholders, the party that will finance/ build the resort is not yet know, the project and thus the impact was also reviewed on it's main features only.

1.3 How to read/ use the impact assessment

An impact assessment is a document that collects and presents the expected impact of a program and project. By listing the expected impact, interested parties and decision makers will have a good view of the project and the effects it will have when it is implemented. The impact assessment is based on information gathered amongst the different stakeholders. Where stakeholders could not be reached, other sources of information were used. Next to listing the effects, the assessment also provides measures to mitigate (reduce) negative effects.

As was indicated in paragraph 1.1 the golf resort is a project that is intended to make the island more self-sustainable. There has not yet been research if a golf resort is the most appropriate solution to reach this program goal. For this reason, alternative projects that fit within the same program have also been reviewed, be it only at their main points.

The two alternatives reviewed are a 0-option, which means no project is executed and things keep going the way they currently are. In this option it is envisaged that a 50-room hotel is build on the island, mainly aimed at divers. The second option is one, which aims at ecotourism instead of high-end tourism and develops an eco-resort for these tourists.

The effects of these two alternative projects will be set out against the effects of the golf resort project. The conclusions that can be drawn from this document will therefore be the impact the golf resort will have on the island and how this compares to the impact of the alternative projects. The report will also show the measures that can be taken to mitigate the negative impact and show the impact that will remain even after mitigation.

An impact assessment is not a document that draws a conclusion whether or not the golf resort project should be approved. This decision lays ultimately with the island government, which should decide in consultation with the other stakeholders. During the decision making process, this document can be used to determine the consequences that a decision will have.

2 Scoping the impact assessment

2.1 Who are the stakeholders

The stakeholders are the people that are, in one way or the other, affected by the project. The initiative for the course was taken by the St. Eustatius Business Association (STEBA) and is now fully backed by the tourism development foundation and the local government. All three parties are main stakeholders of the project.	*STEBA* *Tourist Office* *Government*
The island is only reachable by Sea or Air, which makes the harbour and airport two important stakeholders. An increase in tourism to the island will affect the number of passengers of one or even both.	*Harbour* *Airport*
The resort would have to be run by an international resort group, like the Marriot, St Regis, etc. These large firms have the expertise to run a resort and also power and money to put in advertising.	*International golf-resort chain*
Even though the resort is planned on a nearly empty part of the island, there are some houses in the area, which may be affected. This makes the people living their stakeholders. Also the people who do not live in the area, but own or rent (long-term lease) a piece of land are stakeholders.	*Land/ house owners on or near the planned resort*
A part of the area falls under the protection of the STENAPA, the St. Eustatius National Park Association. They are a party that looks after the biophysical and natural aspects of the island.	*STENAPA*
Local businesses in the delivery industry, as bakeries, supply stores; transport shipping and local businesses in the tourism industry can be considered stakeholders.	*Local delivery- and tourism industry*
All inhabitants of the island may be considered stakeholders, as an increase in tourism and thereby an increase in inhabitants may influence all of them.	*All inhabitants*
There are also people outside the island that are stakeholders in the project, for example the shipping industry, which will have to transport addition goods to the island. Also the future employees can be regarded stakeholders, as well as future tourists.	*Shipping industry* *Future employees* *Future tourists*

2.2 Stakeholder requirements

In the initial requirements gathering phase, three interviews took place. The interviewed parties are the St. Eustatius Business Association (BA), the tourist Office (TO) and STENAPA (ST), which is the St. Eustatius National Parks foundation, which manages the two national pars on the island. The STEBA and tourist Office represent the parties that have taken the initiative to create a resort. STENAPA is a major party because part of the golf course is on a protected piece of land, which falls under the management of this foundation.

Requirement	Function	Number	Source
St. Eustatius should aim to become an exclusive destination, comparable with St. Kitts now.	Exclusive location	Attribute	TO
The golf resort should add a large portion of rooms to the island.	Provide accommodation	0.1.1	TO
The golf resort would have to decrease the social employment function of the local government.	Attract workers	0.2.1	TO
The golf course management should have a reserve for marketing, taking the load of the government to do marketing for the island	Promote Island	0.1.5	TO
The goal of the golf course is to have spin of effects increasing the islands economy and the social position	Increase economy Increase society	0.1.6	TO
Care should be taken which people are going to work on the golf resort; people from the nearby islands, Dutch Antilles and Europe/ USA are no problem. Low educated people from for example the Dominica's with big families will have a large social impact.	Offer employment	0.2.1	TO
The unique things compared to other islands are the quietness and a lack of crime, these should be maintained	Maintain quietness Maintain crime-free status	- 0.2.2	TO
Having a beach would lift a constraint that is currently tempering the tourism development.	Create beach	0.1.2	TO
Because not all persons may like golf (partners of golfers), other attractions should be offered as well to keep those people happy.	Develop attractions	0.1.3	TO
The accommodations should be aimed at a tourist that wants luxury and quality in a discreet way.	Create exclusive golf resort	0.1.1	TO
To support upper class tourists, the airport terminal and apron should be renewed. A VIP room would perhaps attract the very top of the market.	Upgrade airport	01.4	TO
The beach from the waterline to the dunes is protected and should not be used due to sea turtles.	Protect Seaturtles	0.3.4	ST
Venus Bay houses the protected Iguana delicatissima, it is rare and only exists on 4 islands. The trees (which ones) are important for the food of the iguanas and should be protected.	Protect Iguana delicatissima	0.3.1	ST
The water next to Venus Bay and Zeelandia is important for fishery, there are also corals nearby which should be protected.	Protect Coral Protect Fishery	0.3.2 0.3.3	ST
Care should be taken with effluent water from a desalination plant, not to damage corals or impact fishery.	Protect Coral Protect Fishery	0.3.3 0.3.2	ST
Eustatius should aim to promote itself as the island of Archaeology, diving, history, hiking and yachting.		Attribute	ST
In protection of the sea turtles a golf course next to the	Limit seaside lighting	Constraint	ST

dunes can keep the water edge dark and protect it against more harmful development			
The Netherlands wants St. Eustatius to be more independent by providing their own income	Self-supporting island	0.2.3	BA
The local residence have to agree with the project	Satisfy locals		BA
The buildings have to fit in with the current style, this means a maximum of 2 floors	Fit surrounding	0.3.5	BA
Offer employment for 600 to 700 people and thereby also increase the tax revenues	Offer employment Increase tax revenue	0.2.1 0.1.6.3	BA
Increase the total government tax revenue due to the taxes that the golf course has to pay	Increase tax revenue	0.1.6.3	BA
Double the islands economy by direct and indirect effects of the golf resort	Double economy	Verification criteria	BA
Decrease unemployment on the island	Decrease unemployment	0.1.6.2	BA
Make it possible for Statians that had to move abroad because there wasn't any work for them can return to the island	Provide work (to Statians)	0.2.1.2	BA
Increase the facilities and service levels on the islands	Increase facilities Increase service	0.2.3.1 0.2.3.2	BA
Make sure the project fits in with the environment, as this increases the popularity of the golf resort with tourists.	Fit (golf course) in environment	0.3.5	BA
The project should provide it's own power, if possible using renewable energy sources.	Provide power	0.1.1.6.2	BA
A requirement resulting from the legislation however is that the project should show clearly the environmental impact on Venus Bay, enabling the government to make an informed decision about whether or not to change the law to allow a golf resort.	Inform government Change Law		LG

BA : Business Association
LG : Legislation
ST : Stenapa
TO : Tourist Office

2.3 Relevant legislation

St. Eustatius is a part of the country of the Netherlands Antilles. The Netherlands Antilles itself is a part of the Kingdom of the Netherlands. The Kingdom of the Netherlands consists out of three countries; the Netherlands, the Netherlands Antilles and Aruba. While Dutch and European law is valid in the Netherlands, it does not apply to other countries of the Kingdom and therefore is not valid on St. Eustatius. For relevant legislation it is therefore required to look at federal laws and island regulations.

The island government sets the environmental laws. For the flora and fauna protection this means that the "island regulation protection fauna and flora" AB1997/06 and AB1997/07 are the relevant environmental laws. The second law is a specification of the first. Article 2 and 3 of the AB1997/06 (referring to art I and II of the AB1997/07) state that it is forbidden to damage, catch, wound or disturb a certain number of plants and the iguana delicatissima.

Article 5 states that the island government can assign certain areas with a status of unique landscape. Article 6 states that it is forbidden to change damage or destroy these landscapes. AB1997/07 gives an overview of these area's, namely: "Boven", "Venus", "Gilboa Hill", "Signal Hill" and "Bergje".

According to the AB1997/07 an exemption can only be obtained on the basis of an endangered traffic safety, the safety of private belongings and scientific research. This means economic development, which is the category a golf resort would fit it, cannot be a reason to grant an exemption. Building in Venus Bay will therefore require a change of the law itself.

According to the environmental policy of the Netherlands Antilles [IL1]:
"Environmental policy must be closely coordinated with other policy areas such as public health, spatial planning, industrial development, agriculture and fisheries, and must be clear and transparent. In the present situation economic development and poverty alleviation have the highest priority for the Netherlands Antilles, but sustainable development is only possible in combination with sound environment and nature policy. For example, without corals there will be less stay-over tourists and less economic development or a polluted environment and disappearing nature will cause new forms of poverty."

Even though by law an impact assessment is not required, it still serves its goal in combining the various fields where effects occur and delivering a single report, which explains the effects of a decision. This is especially important in this case, as legislation is effectively blocking any changes at Venus Bay. An exemption according to the law is only possible on the basis of the safety of private belongings, scientific research or traffic safety. None of these can be used as basis for requesting an exemption for the golf resort at Venus Bay. If the golf resort is constructed it should therefore be clear what its impact is. Based on the impact a decision can be made whether or not to change the law and allow a golf resort at Venus Bay.

A requirement resulting from the legislation is the environmental impact on Venus Bay should be known and reported upon, enabling the government to make an informed decision about whether or not to change the law to allow to allow development, like a golf resort, in Venus Bay.	Inform government Change Law

2.4 Local situation

Zeelandia area

The golf course is envisaged in the Zeelandia and Venus Bay areas, as well as the pass between these areas. The Zeelandia area is relatively flat. It's located on the eastern (Atlantic) side of the island. The total area, including parts of the surrounding hills, is 71.5 hectares (176 acres). The area contains six houses as well as an abandoned hotel. A road runs all the way through Zeelandia up to the entrance of Venus Bay. The area east of the road (Zeelandia side) is covered mostly with high grass and a limited numbers of, trees and bushes. The coast partially consists of a cliff, varying in height from beach level at the very northern part of the area, to about 20m at the southern edge. Nesting sea turtles use Zeelandia beach. They are protected under international law. On the western side of the road there is a valley, in this area a lot of bushes and some trees are growing. Most of those are weeds though and can be removed.

Venus Bay area

Venus bay is a somewhat isolated and private valley in the northern hills. From the sea it the first 650m the ground slopes up to a height of 40m. From this point the valley becomes part of the passages between Venus Bay and Zeelandia, climbing an additional 65m over a distance of only 240m. According to the land office (domein), the Venus Bay area is 171.6 hectares (424 acres). Next to the valley, this also includes the surrounding mountains. The mountains are suitable for construction of condominiums and hotel rooms.

Zeelandia side

Venus Bay side

Pass between Zeelandia and Venus Bay

Between Zeelandia and Venus Bay there is a pass. The highest point of the pass is about 105m above sea level. From the 40m-height mark at Venus Bay and the entry of the pass at Zeelandia, the pass is about 850m long; the width varies but is no more then about 30 to 40m. At many points water erosion has caused deep cutouts, with only a couple of meters of flat surface. The pass would offer a great challenge for golfers, although even with a lot of groundwork, it may not be possible to offer a two-way, or in fact even a one-way golf course with a 30m wide fairway in this area. The view from the pass is stunning, which may make up for a somewhat less wide fairway. As said the total length of the pass is 850m, approximately 600m is on the Zeelandia side with an average slope of 8%. The Venus Bay side of the pass has an incline of on average 15%. There is only limited vegetation on the Zeelandia side of the pass. Due to rainfall, there are guts on both sides of the pass that take the water from the surrounding hills towards the sea. A "goat track" exists, which runs along the whole length of the pass, a remembrance of earlier attempts to develop Venus Bay. This track can be made suitable for road traffic to Venus Bay, however in its current state is not suited for motorized transport.

3 Impact assessment

3.1 Description of the project

To study the impact that a resort will have, a preliminary design was created. This preliminary design, or concept of what the golf resort will look like, will be described below. The developer will naturally determine the final layout and design, however because the created design only looks at key components of the program and project, it is expected that the designs will not be very different from each other.

Functions
Based on the stakeholder requirements, functions were set up (see paragraph 2.2). The functions were ordered in a diagram using the Function Analysis System Technique (FAST), this FAST-diagram is shown in the loose supplement titled 'Customer FAST – Golf resort St. Eustatius'. For each of the functions it was determined what concrete things are required to execute these functions. For example in the case of "provide accommodation" one of the concrete "system bearers" is a hotel. By looking at the attributes of a function, more can be said about the kind of hotel needed. Because in this case the hotel should be aimed at the high-end of the tourism sector, the attributes include "luxurious, discreet, 5-star^{+}". The system solutions therefore are a 5-star hotel and 5-star condominiums. The process of going from a function to a system solution can be found in appendix I.

All system solutions were set out and ordered in the provisional design block diagram, which is included as a loose supplement titled 'preliminary design block diagram – Golf resort St. Eustatius'. The resulting diagram shows the program function at the top of the tree. The program function is a "self-sustainable island". Next to only listing the system solutions, some of them have been expended in more detail. The diagram is the provisional design for the golf resort project, or more generally the "self-sustainable island" program. Social, economic or environmental impact may occur at each of the system bearers, this means that the impact on each of these fields will be reviewed.

The resort
The resort will consist out of 156 hotel rooms and 40 condominiums (privately owned, but rented out when the owner is not using the villa). The hotel rooms will be set up for 2 persons per room, the condominiums for 6 persons. At a maximum occupancy there will therefore be room for 512 guests.

The hotel will not be a single building, but will be spread out over several smaller buildings, for example with 2, 4 or 6 rooms per building. The condominiums will be detached.

Centrally located there will be the main buildings of the hotel. Which include a number of restaurants and bars, a spa and swimming pool, meeting rooms, a small number of tennis courts and a small number of shops, including a supermarket.

The resort will offer potable water, electricity, cable television, Internet and phone service.

The golf course
The golf course will have to be a top of the range facility. It will feature a club/ halfway house where golfers can signup for their round of golf, refresh themselves afterwards and can get a drink. Near the clubhouse will be the practice facilities, both for practicing putting and practicing long shots. To compete with other courses in the region, the fairway has to be around 6400m in length and on average 30m wide.

The location
The golf course feasibility study has indicated the Venus Bay area, in combination with Zeelandia as the most suited location for a golf resort. Due to the nature of the project and the project being located on a small island, the impact of the golf resort will be felt on the whole island. Both Venus Bay and

Zeelandia have a beach. The beach at Venus Bay is limited in size; the one at Zeelandia is the largest on the island. At both locations swimming is unadvisable due to the undertow. The beach can and is used for sunbathing and walking. The western (Caribbean) side also has a beach, but it is quite small and can "move around" due to the current and waves. Not having a large, white, beach that allows for safe swimming will put the resort and the island at a disadvantage over other islands in the region. It is therefore assumed that the resort will want to create a beach on the Atlantic (east) coast. This can be either in Venus Bay or Zeelandia or in fact both.

Sustainable
The development of the golf resort should be economically, socially and environmentally sustainable.

The golf resort should as much as possible look at employing Statians to work at the resort. This has on forehand been set to reduce the effects of the project on the community. Statians will fit in best on the island, as they will already have family and friends and will share most of the values and believes.

On the environmental field the resort should minimize its impact. The Iguana and the Sea turtle are two animals that use the region where the golf resort is envisaged. Care should be taken not to damage the populations of these animals.

The economic sustainability of the golf course has been researched in the feasibility report. This report will therefore focus on the economic impact and will take the feasibility as a fact.

3.2 Impact and mitigation

This paragraph will list the impact that a golf resort will have on the system solution and what mitigation measures can be taken to reduce the impact. The number listed corresponds with the number on the provisional design block diagram (loose supplement). The higher order system solutions are a composite from the lower order solutions; this also means that the impact of the lower order solutions is added up to form the impact of the higher order solutions.

Number	System solution	Description	Mitigation required?
1.0	**Support Business**	The estimated number of jobs that will be created by the development of a golf resort is around 530. 75 people are estimated to get a job at the golf course, around 435 at the resort. The remaining jobs are in other sectors, like medical service, water production and telecommunication. Statians living on the island can fill around 200 jobs, around 20 would be available that are currently livening in the Netherlands. The total amount of Statians returning from abroad is estimated to be around 100. The remaining jobs could be filled with the unemployed on Saba and St. Maarten. Unemployment on these islands together is as high as 3,472 people [CBS, 2003]. Around 490 additional people will come to the island, 75 of which are children. An estimated 165 single homes and 124 homes for families will be required. Housing can be provided by the housing foundation. As long as guarantees and a 3-year advance notice is given, the housing foundation can finance and build these houses and apartments. On the island enough space is available, there are plots at white wall (southwest side), behind the mountain (southeast side), Lodi (between Oranjestad and the upper town) and at the north side of the airport. When the houses are constructed on the northern side of the airport, travelling to the resort would be easiest for the employees and would cause the least amount of traffic problems on the rest of the island. The resort as well as the employee housing will together create a lot of waste material. The total amount will be around 2,611 m^3 annually. There will be a large requirement for electricity. The required electricity for the housing and the resort (at 70% occupancy) together is a maximum of 678,970 kWh per month. The power company on the island, GEBE, can provide this by expending the number of turbines. They are willing to finance the project as long as they have a guarantee that they can deliver the power to the resort. The guarantee could be a pre-investment by the resort, which will be paid back by the resort. Renewable energy, in the form of windmills, will require a large investment. Most likely GEBE will not be willing to invest in the backup equipment for periods when there is not enough wind, as it is hard to	

		get a return on that investment. The resort would therefore have to create its own backup plant. The payback time of windmills for the resort would therefore be just over 10 years. The water for the resort and golf course would have to be delivered by a reverse osmosis installation. This installation converts seawater into irrigation and drinking water. The installation would be backed up by a large irrigation pond, which would store rainwater and excess irrigation water that was caught by drainage. The water requirement depends highly on the kind of grass that is chosen for the golf course. If the "standard" Caribbean golf grass specie, "Bermuda grass" is chosen, the capacity of the RO-plant has to be 2,850 m^3/ day. If a more drought resistant grass, Seashore Paspalum, is used, the RO-plant capacity can be reduced to 1,800 m^3/ day. In both cases the potable water required would be around 80 m^3/ day. By placing reef balls (porous and hollow concrete balls, which allow growth of reef on them) or another form of barrier in the sea, the undertow that currently makes swimming on the Atlantic coast impossible, can be stopped. At the same time this will stop the beach erosion from the sea, which will cause the beach to become several meters wider. At Zeelandia, there already is a large beach area; at Venus there is a somewhat smaller beach. The sand on St. Eustatius does not have the Caribbean white colour that tourists have come to expect. It could be considered to import white sand. Most shops will be affected by the increase in the population; the turnover will most likely go up. The financial aspect of this is handled in **3.0**. The phone/ internet company (Eutel) will require at least one additional person handling service. There are three primary schools on the island. They will grow with about 50 pupils. There is one secondary school, which will grow with around 32 students. Both types of schools can cope with the increase in students without problems. The third primary school has only recently started, receiving students from the other two. This has left capacity for the additional students. The secondary school can accommodate the students by extending the school schedule by a few hours. When the resort is completely full, there will be 552 guests. With an average staying time of 1 and a half weeks, the required air transport would be 85 seats. This is counting both directions, which means 43 seats per direction. At 70% occupancy of the resort this would be an average of 30 per direction. Arriving passengers will most likely be centred on the afternoon and evening flights, with departing passengers being cantered around the morning flights. There may also be increased demand in the weekends. According to	

		the feasibility study, based on talks with Winair, there should be no problem with the airlift of these persons. The Winair aircraft are not very comfortable though and there are doubts if these aircraft are up to the standard that the guests the resort is aiming for require. The effect on business will not start when the resort opens. It will already start when construction commences. At this time there should already be housing available for the construction workers coming in from off the island. Construction will require a large amount of materials to be moved to the island, which means a lot of activity in the port. Finally, the additional people will be spending money on the island, supporting the local economy and increasing the tax income for the government. This is covered in more detail in **3.0**.	
1.1	**Offer tourist attractions**	Offering tourist attractions consists out of two major elements. Firstly increasing the facilities, like the golf resort and a beach. Secondly it is also important to increase the services available on the island. The golf course will require substantial amounts of water and electricity. The local energy company, GEBE, can generate the electricity. Powering the resort with wind energy is possible, although the payback time on that investment is long and it is doubtful if GEBE will want to invest in the required backup installation. If they are not interested, the resort would have to create its own. Most likely wind energy is only feasible if it helps in promoting the resort. The water system will consist out of a storage pond, a reverse osmosis installation and drainage. The reverse osmosis plant will generate the water for the resort; this is potable water and irrigation water. The irrigation water will be supplemented with the water from the storage pond, which contains rainwater (gathered from the golf course and the roads) and excess infiltrated and irrigation water that was collected in the drainage system running under the golf course. Together, the facilities and services necessary to offer tourist attractions will generate around 530 jobs. Statians living on the island can fill about 200 jobs; the remainder will have to be filled by people off the island, preferably Statians living abroad or people from the other island of the Dutch Antilles. Since the unemployment on St. Maarten is relatively high, this could be a good source for employees. The resort aims on a group of people that is not currently visiting the island in large	***Upscale activities*** When local companies and not the resort provide activities and services, the money spend by tourists will stay on the island. This will be beneficial for the economy and also increase tax income for the government. Services could be upscale restaurants, activities like Para-sailing, surfing, jet ski rental, boat rental, boat trips, diving, etc. When a resort is created the government should promote, perhaps with tax measures or subsidies, the creation of these facilities as keeping as much of the tourists money on the island is important for the economy.

		numbers. There are currently no services or activities on the island aimed at the upper part of the tourist market. It is possible to have the resort develop all these activities and services. The money the tourists spend on these things will however go to the resort and will not benefit the people on the island.	
1.1.1	**Increase services**	The golf resort will have a big impact on the energy supply; the energy production of the island will have to be increased by about 50%. The islands energy company, GEBE, is willing to finance the expansion that is required for the power plant. They are also willing to supply and lay the electricity lines to Zeelandia/ Venus Bay. They have to be assured that the resort will be there for some time to be able to get a return on their investment. For this reasons prefinancing of the operation may be required for the resort. • Two additional generators 1.2 MW, 6,100m additional underground power line to Venus Bay • Electricity cost at 100% occupancy per year, US$ 2,160,500 and at 70% around US$ 1,512,111. • No backup system required as GEBE already has such a system. • Wind and tidal energy are unable to power the resort on their own; when enough wind/ waves are available they could be used as support to the generator, which could save fossil fuels. Further research to these systems would be required. There is not enough water available on the island for the resort. A reverse osmosis plant exists, but the capacity is far too small. The resort would have to construct its own reverse osmosis plant, most likely in the Zeelandia region. The required amount of water depends largely on the grass specie that is chosen. Selecting a grass with lower water consumption, like the Seashore Paspalum specie, can save 34% on the water usage. Around 37m^3 can be saved when shower and sink water is re-used to flush the toilets. 5 to 8% of reverse osmosis water can be saved when rainwater is collected and used for irrigation. • By Selecting the Seashore Paspalum grass instead of the commonly used Bermuda grass, 34% water and electricity cost can be saved. • The yearly savings from an irrigation pond with rainwater are 5 – 8% • A Reverse Osmosis plant should have a capacity of 1,800 – 2,850 m^3/ day, of which about 80 m^3 is potable water. • Water for the toilet can be supplied by rainwater and by collecting and reusing water from the shower and sink. • 8 Jobs	***Mitigation of electricity generation*** To reduce the environmental impact and especially the use of diesel fuels and emissions caused by that, it would be possible to use renewable energy sources. Possible sources are wind, solar and wave energy. Since solar and wave energy are highly expensive, wind energy would be the most affordable solution. Using data gathered in Friesland, the Netherlands, four wind turbines could power the resort. An additional two would be needed as backup due to maintenance and breakdowns. 6 windmills could power the resort, backed up with 2 generators. This setup has a payback time of over 10 years. ***Mitigation effects of water production*** There are some worries about using a reverse osmosis plant. The salinity of the ocean is normally around 34.500 PPM. Due to the use of reverse osmosis plants, at some places in the middle east the salinity has gone up as high as 40.000 PPM. This can potentially hurt the sea life. Since the Sea and especially the coral are major tourist attractions for the island, care should be taken not to damage it in this way. The first three measures that can be taken are all intended to reduce the amount of water that is required. These mitigation measures are: • Selecting the Seashore Paspalum grass instead of the commonly used Bermuda grass, 34% water and electricity cost can be saved.

		Statistically the number of patients travelling to St Maarten for medical purposes will increase, as well as the number of ad-hoc emergency flights. The last one will increase by 1 to about 3 a month. The first one will increase with an unknown number as the number of flights for medical purposes is not tracked. • Statistical increase of the medical flights by Winair or by the medical airlift service to around 3 times per month. • The hospital is a government service; the government would have to pay for the construction cost of the additional rooms. They would also have to pay the additional wages of the nurses and the medic. Total jobs added by an increase in services would be 16.	• The yearly savings from an irrigation pond with rainwater are 5 – 8% • Water for the toilet can be supplied by rainwater and by collecting and reusing water from the shower and sink. Another measure can be taken to reduce the effect, which is to discharge the effluent water of the RO-Plant at a place where there is a large enough current to disperse the water containing the higher salt percentage: • Discharging the effluent water of the RO-plant using a tube to such a location where the current will disperse the water of a large area will mitigate the potential negative effect of salinity build-up.
1.1.1.1	**Provide electricity**	There are several ways in which electricity can be produced. Currently diesel engines are used. The energy required for the golf resort, at maximum occupancy is around 24,365 kWh/ day **(1.1.2)** The energy required to power the additional houses and apartments is around 5,833 kWh/ day **(1.1.1.1)** GEBE, the local electricity provider, has indicated that they can provide the required electricity by adding two additional 1.2 MW generators and laying approximately 6100 m of underground electricity cable. This would together cost around US$ 1,990,000. GEBE is willing to invest in this, as long as they have some certainty that the resort will be there for an extended period. Such a certainty could be prefinancing of the installation by the resort, where the resort would be paid back by GEBE over time. The yearly cost of electricity would be around US$ 2,054,000 at a 70% occupancy rate. By using power from the islands power plant, only two additional generators have to be placed at GEBE. If the resort would need its own power plant, it would need at least 4	Mitigation measures handled in **1.1.1**

		generators, 2 running and 2 backup generators. GEBE already has these two backup generators. Wind energy could be used, in case there is enough wind available, to reduce the power required from the generators. This would save fuel and therefore save cost. The same applies to tidal energy. In both cases further study would be required to review the contribution they can deliver to the power supply and the time required to pay back the investment made for them. **Impact:** • Construction and distribution of the electricity system by GEBE, although prefinancing the installation by the resort may be required to give enough certainty to GEBE to do the investment. • Two additional generators 1.2 MW, 6,100m additional underground power line to Venus Bay • Electricity cost at 70% occupancy around US$ 2,050,000 per year. • No backup system required, as GEBE already has such a system. • Wind and tidal energy are unable to power the resort on their own; when enough wind/ waves are available they could be used as support to the generator, which could save fossil fuels. Further research to these systems would be required; on first hand neither method seems to be economically viable.	
1.1.1.1.1	**Energy plant**	**Diesel generator:** Diesel generators currently power the island. At the moment there are 6 generators, with a 7th currently being installed. At the moment the energy production is around 1.7 MW per day. The required amount of 20,090 kWh/ day would give a necessary amount of power of around 0.84 MW per day. Additionally there would be extra households on the island. The average household currently uses 424-kWh/ month (2005, double phase connection, data from GEBE). In **1.4** it was determined there will be 360 extra households, which means around 152,640 kWh per month, which is 5,018 kWh per day or 209 kW on average. The total amount of extra power needed would therefore be in the region of 1.1 MW per day, when the golf resort is running at 70% capacity (around 1.4 MW at full capacity). According to GEBE the following steps would be required if they are to provide power reliably to the golf resort and the new houses.	Mitigation measures handled in **1.1.1**

		Impact • 2 new generators, each with a capacity of around 1,200 kW. Generators of this kind would cost around NAF. 1 – 1.5 million. • About 4,600 m of underground power line to Venus Bay. There is currently no line that goes all the way to Venus Bay and an underground line would significantly reduce the chance on power cuts. An additional 1,500m of backup double wiring from Grovell to Venus Bay would suit the same purpose. According to Mr. Paul Ideler (Distribution manager GEBE, St Maarten) the cable would cost about NAF.60 per meter trench and NAF.50 per meter cable. The power line would therefore cost around NAF. 581,000 (US$ 332,778). • Fuel use of this installation would be approximately 0.28 litre/ kWh (Figure from GEBE). This will result in an extra usage of 8,736-liter diesel/ day. The cost of power on the island is highly dependent on the price for diesel fuel. There is a so-called fuel clause, which changes monthly, based on the price diesel fuel. For example for the month of October 2005, the fuel surcharge was 0.3038 NAF./ kWh. For the month of November it was 0.2810 NAF./ kWh. Since the fuel price is unpredictable and over the past time has fluctuated quite a bit, the price of fuel will most likely continue to do the same. GEBE has had a fixed rate for the electricity since the 1960's, which is not expected to change significantly. As a bulk consumer the golf resort may be able to negotiate a lower tariff, however this cannot be taken into account at this moment. The rate for the first 100 kWh is NAF. 19. After that, the next 900 kWh is NAF. 0.17 / kWh. For anything above that, the rate would be 0.15 NAF./ kWh. Assuming a 70% occupancy and a direct relation of the electricity usage with the occupancy, the power usage of the resort would be (365/12) * 20,090 kWh = 611,071 kWh/ month. The electricity use for the additional houses would be 152.640 kWh. This in total comes down to 763,711 kWh/ month, the cost would therefore be NAF. 114,579 for the energy + NAF. 232,015 fuel surcharge + NAF 0.25 stamp charges, so NAF. 346,595 per month, which is US$ 192,553. ***Impact:*** • Energy cost of around US$ 192,553 per month, or US$ 2,310,633 per year at 70% occupancy.	

		GEBE is willing to pay for both the power line / connection to the resort as well as for the generators. They will however need to be convinced that the Golf resort is not a temporary thing, but will be there for considerable time before willing to do investments. A possible option for this would be that the resort pre-finances the investment and GEBE will pay them back. **Wind energy:** Wind turbines provide wind energy. The amount of energy delivered by a wind turbine depends on many factors [IL2]. Wind speed, height of the windmill, proximity to the sea, obstacles in the terrain and the size of the blades. According to GEBE windmills cannot power the resort alone. They deliver power only when the wind is blowing, which means for periods that there is no wind, another solution has to be found. There is a system that creates hydrogen, from water, using the excess electricity in times there is wind. The hydrogen can then be used to power a generator when there is not enough wind. Currently such a system is in use in Norway, to power 10 houses on an isolated island. Further study would be required to review the feasibility of such a system powering a golf resort. An 850 kW wind generator with a height of 40m and a blade diameter of 52m provides, in the Dutch province of Friesland, approximately 2,300,000 kWh per year. This is on average 6,300 kWh / day. With the required amount of energy, 4 of these windmills could theoretically power the golf resort. To have a backup and for increased reliability, 2 additional wind turbines could be placed. In case there is no backup, like the hydrogen system, the power plant (GEBE) would still need to deliver the same amount of electricity in times of no or very little wind. The advantage of the windmills in that case would be that the amount of electricity that is used on a monthly or yearly base would be lower. A single 850kW wind generator will cost around US$ 1,183,000. In The Netherlands such a generator creates 6,300 kWh per day. 6,300 kWh of electricity per day would cost around US$ 16,000 per month, or US$ 199,800 per year. They will need maintenance for which personnel is required. With 3 persons doing maintenance and disregarding material replacement costs, the cost for maintenance would be around US$ 36,000/ year. For GEBE it would not be viable to invest in two additional generators that are only used as backup to wind turbines, as the investment would take a very long time to pay back. For this reason it would be the resort that would have to buy these two backup	

		generators. This adds another US$ 1 – 1.5 million per generator. 6 windmills are required instead of 4, to have backups in case of breakdowns and maintenance and 2 generators will have to be acquired. If it is assumed that the wind turbines can power the resort for 75% of the time, the payback time of the wind turbines can be calculated. The cost of acquiring and installing the wind turbines and generators will be around US$ 8.5 million. They will save 75% of the fuel cost, so the cost of fuel will be reduced to US$ 577,658 per year. The cost of the 3 person staff is US$ 36,000 per year. The pay back time based on these numbers therefore is just over 9 years. Since the calculation does not include replacement of parts, the real pay back time is probably even higher, making wind energy a more expensive solution. Using wind energy can however strengthen the position of the resort as "green", which can be a good for promotional means. Using wind energy would save on Diesel and reduce the environmental impact. ***Impact:*** • US$ 1,183,000 construction cost per wind turbine • 6 wind turbines, 40 m high, 52 m rotor diameter, 850 kW turbine could power the resort at times when wind is available. • Average daily capacity 25,200 kWh / day using 4. • 3 Jobs running and maintaining. • 2 backup generators in case of limited wind power. • Over 9 years payback time. **Tidal energy plant** A tidal energy plant is an energy generation plant that supplies energy generated by waves. [IL3] This kind of plant is already used on the island of Islay in Scotland. This produces on average 202 kW, which means 1,800,000 kWh per year. Since tidal energy is a relatively new power source, it is hard to estimate the cost. There is information about a 5mW facility, which would cost around 20 million pound sterling. A 5mW facility produces around 120,000 kW per day, which is too much, a facility half the size would do well too. Assuming that a facility half the size could be half the cost, the cost would be 10 million pound sterling, or at a conversion rate of 1.726, US$ 17,260,900. ***Impact:*** • US$ 17,260,900 construction cost • Tidal power generator, 2.5 MW, 60,000 kWh/ day on full capacity. • 3 Jobs running and maintaining.	

		• Power backup needed for times when waves are not strong enough.	
1.1.1.1.2	**Power backup**	When GEBE delivers the power, no backup will be required as the electricity company already has two backup generators available. In a worst-case scenario they would be able to switch to the generators of the oil terminal. By creating the underground electricity wires, as described in 1.1.1.1.1, the chance of failure of the electricity supply is greatly reduced. **Impact:** • No power backup required	No mitigation required
1.1.1.2	**Provide water**	Generally speaking a resort will require water of three qualities. Potable water has to have the highest quality as it used for preparing food and human consumption. Gray water is used where no human consumption can take place. Irrigation water will be used to irrigate the golf course. • Potable water: 74,2 m^3 / day • Grey water: 37 m^3 / day • Irrigation water quantities are dependant on specie of grass used for the course: Seashore paspalum: 220,643 m^3/ year (maximum 1,567 m^3/ day). Bermuda grass: 337,714 m^3/ year (maximum 2,507 m^3/ day) Because there are many possible ways to provide water for the golf resort, a study to the most appropriate way to provide water has been performed, this study has been included in appendix III. The conclusions from this study are that no matter what kind of grass is chosen, the irrigation will always have to rely for a large part on a RO-plant (Reverse Osmosis plant). The RO-plant will also provide the resort with drinking water. If the Bermuda grass is used, a RO-plant is needed with a maximum capacity of around 2,850m^3 per day. The yearly cost for powering this installation are expected to be around US$ 100,650 per year. A large saving could be the use of Seashore Paspalum instead. This grass uses about 34% less water. The maximum capacity of the RO-plant in that case could be 1,800 m^3 /day. The electricity consumption per year would be around US$ 59,750. Creating a large irrigation pond would save around US$ 4,623 annually. The resorts grey water supply, for flushing the toilet, can be provided by collecting the water from the shower and rainwater from the roofs. **Impact:**	Mitigation measures handled in **1.1.1**

		• By Selecting the Seashore Paspalum grass instead of the commonly used Bermuda grass, 34% water and electricity cost can be saved. • The yearly savings from an irrigation pond with rainwater are 5 – 8% • A Reverse Osmosis plant should have a capacity of 1,800 – 2,850 m^3/ day, of which about 80 m^3 is potable water. • Water for the toilet can be supplied by rainwater and by collecting and reusing water from the shower and sink. • 5 jobs RO-plant, 3 jobs maintenance of the water system.	
1.1.1.2.1	**Water catchment**	See impact study water system appendix III and **1.1.1.2**.	See **1.1.1.2**
1.1.1.2.2	**Water purification plant**	See impact study water system appendix III and **1.1.1.2**.	See **1.1.1.2**
1.1.1.2.4	**Water storage**	To prevent problems in the water supply when there are problems with the RO-Plant, storage for 2 to 3 days would be required. For the drinking water the required storage would be 150 m^3. This could be combined with a water distribution facility **(1.1.1.2.5)**. The storage of water for irrigation would be 3,200 – 5,000 m^3. This is most likely not possible in a closed storage facility, but would require a storage pond. This will however create water loss due to evaporation. The deeper the pond, the lower the loss will be. By draining the golf course, excess irrigation water can be returned to the pond, making sure no water is lost. The grey water from the showers and sink and the rainwater from the roofs would need to be stored as well. This can be done at each of the individual buildings, for example in a cistern under the building.	***Water storage*** Creating any form of open water storage will mean a lot of loss due to evaporation. The yearly average evaporation is around 2,160 mm. This means that the less water surface there is, the better. Water storage ponds should therefore be created as deep as possible, to get the most amount of storage with the least amount of water surface.
1.1.1.2.5	**Water distribution**	The RO-plant will most likely be constructed on Zeelandia, to be near the golf course, as this is the biggest water user. This means that a relatively small amount of the water needs to be pumped to Venus Bay. The water pipe could either be constructed over, through or around (via the eastern side) the mountain between Zeelandia and Venus Bay. Creating a storage tank for the potable water somewhere up the hill at Venus Bay will make sure that the distribution of water on that side can be on a free flow basis, due to gravity. The only pumps required could be large pumps transporting the water to Venus Bay. By using a few large pumps instead of many small ones electricity can be saved. At the Zeelandia side pumps will be required to distribute the water across the golf	***Mitigation water distribution effects*** It will not be viable to have a RO-plant on both the Zeelandia and Venus Bay side. Therefore the water will have to be pumped to Venus Bay. Because the amount of water needed at the Zeelandia (golf course) side is much larger, the RO-plant should be placed here. This will save on the amount of water that has to be transported. The water in Venus Bay should be stored at least

		course. Since the electricity usages of pumps depends highly on the height, the distance and the pressure they have to provide, no indication can be given about their power use. ***Impact:*** • 2 Jobs	10m above the highest facility there, this way the water distribution at Venus Bay can be a free flow system. No pumps will be required in that case.
1.1.1.3	**Provide medical service**	The information about the hospital has been gathered from interviews with Mr. Odongo, general practitioner and Mrs. M. Pantophlet, the hospitals head nurse. The Hospital currently has 20 beds. When needed it can handle at maximum 30 beds, but not sustainably. There are two general practitioners, a dermatologic and a dentist. There are no surgeons or specialists (other then the dermatologist) and therefore a person that needs surgery will need to be moved to St Maarten, or in severe cases even to Curacao. Normally a person that needs a specialist can travel to St. Maarten or St. Kitts by plane. In urgent cases there is the possibility to call Winair and get them to send a plane to fly a person to the hospital. It is also possible to get the medical airlift service, but this is only for urgent cases that need to get special treatment in Curacao, or in case of (American) tourists, probably San Juan. At the moment these special flights happen a few times per month. Increasing the number of persons on the island with about 1,000, to 4,100, will not affect the hospital much. Currently there is overcapacity in the number of doctors and the number of beds available. ***Impact:*** • Statistical increase of the medical flights by Winair or by the medical airlift service to around 3 times per month. Increase in 'hospital' passengers on normal flights, although it is hard to estimate by how many. • The hospital is expected to generate a larger income; due to a statistical certain increase in patients.	***Medical care*** There will be an increased demand for medical care, however this can be absorbed with the current capacity. It is not viable to offer surgery on St. Eustatius, not even with the increased number of residents on the island.
1.1.1.3.1	**Doctors office**	Currently there are two general practitioners, a dermatologist and dentists on the island. This is an overcapacity; no additional persons are needed when the number of people on the island increases by a 1,000. In times of need (for example in the case a hurricane would hit the island), the hospital can rely on the help of the medical school, which adds at least 12 doctors. Some of the	

		students are trained nurses, which can also help in the case of emergencies. ***Impact:*** • None	
1.1.1.3.2	**Other hospital agreements and transport**	For surgery and specific medical care patients are send to the hospital in St. Maarten and even to Curacao, or in case of (American) tourists probably San Juan. In non-urgent cases they can take the scheduled flights. In urgent there are arrangements with Winair to provide at hoc medical flights. The same agreements exist with a special medical airlift unit in case of transport to Curacao. At the moment the urgent flights take place 1 or 2 times a month. With a population increase of 33%, this can be assumed to increase by 1 to 3 times a month. ***Impact:*** • Statistical increase of the medical flights by Winair or by the medical airlift service to around 3 times per month.	***Increased medical flights*** Not significant, no mitigation required
1.1.1.4	**Offer taxi/ shuttle service**	The taxi/ shuttle service was already included in 1.1.2.2.6.	See **1.1.2.2.6**
1.1.1.5	**Telecommunication infrastructure**	The following information was provided by Mr. G. Berkel, managing director of Eutel, which provides the telephone and internet service on the island. Due to the nature of the telecommunication business, they already have most of the equipment necessary to expand. There would be a 30 – 40% growth in the number of fixed phone connections. The number of mobile connections would most likely also increase significantly, although it is hard to estimate by how many. Eutel can finance the infrastructure for the required expansion. It would most probably consist of a wireless connection between Venus Bay and Eutel, as cables would be more costly. There are no expected problems in either meeting demand for high-speed internet access or the increase in mobile or fixed telephones. For high speed internet there is an alternative in getting satellite internet. To get the contract for the golf resort Eutel will have to look into offering faster internet and higher reliability. To provide service, especially for the internet connections, at least one additional job would be required.	No mitigation required.

		Impact: • 1 Job (at least) • Increase income Eutel	
1.1.1.6	**Provide harbour facilities**	According to Mr. M. Gittens, the harbour executive, the harbour will not be significantly affected by the construction of a resort. With the current facilities the harbour can handle even a 50 or 60% increase in cargo. The harbour can also take passenger traffic. There are plans to privatize the harbour and to expend the pier and increase the water depth to allow larger boats. There are also plans for a marina for up to 80 yachts; investors however are needed to execute this plan. The expansion of the pier will allow smaller cruise ships (up to 450 – 500 passengers) to dock. Plans also exist for a scheduled mixed freight and cargo service to Saba, St. Kitts and St. Maarten, using boats that can hold around 80 passengers and 10 containers and would be able to travel from St Maarten to St. Eustatius in about 1hr and 30mins. By providing a comfortable boat service, the problem that the comfort of the Winair aircraft may pose will be mitigated. (Also see **1.0**) The privatization of the harbour, expansions of the pier, construction of additional breakwaters and a marina as well as the boat service are all projects that are being worked on already. They will have a beneficial impact on the resort, but are not constructed because of it. The impact of the resort on the harbour is therefore limited to an increase in income due to mooring charges and cargo charges.	No mitigation required.
1.1.2	**Increase facilities**	In total the land use will be 800,000 m^2. The whole island has a land surface of 21,000,000 m^2. This includes the Quill and the northern sub sector. With the construction of the golf resort, a large area of land that can also be used for different purposes is therefore taken away. Next to the land it occupies, the golf resort will also use the pass between Zeelandia and Venus Bay. This is currently the only way to go to the northern part of the island. By restricting access to this pass, effectively the whole northern part of the islands becomes inaccessible for non-guests of the golf resort.	***Land use*** The amount of land occupied by the resort is significant, but cannot be mitigated. The northern sub-sector should be kept reachable. This can be done by creating a new route over the hills, or allowing everybody to enter the pass between Venus Bay and Zeelandia and thus the grounds of the golf resort.

		The effects will not start with the opening of the resort; they will already start in the construction phase. Already at this point jobs will be created and taxes incomes for the government will start to arrive. Construction can potentially have significant effects, for example in the required housing, the income generated and transport and hindrance. For this reason it should be reviewed for it's impact. The lower level system solution construction **(1.1.2.2.8)** was added for this reason.
		
		With 60% occupancy there will be an average 332 tourists staying at the resort. Next to spending money on the resort, they can potentially also be a source of income for other businesses on the island. Additional facilities will have to be created for this though. At the moment there are a few restaurants, but they may not have the quality an upscale tourists expects or will be able to get in the resort. Diving may be the only activity that would attract these tourists. By improving the quality of current facilities and offering new ones aimed at the upscale tourists, like boat tours and guided hikes to the Quill additional income can be generated and jobs created.
		
		Impact:
		• Guest: 552
		• Jobs: 514
		• Water requirement:
		  • Potable water: 74.2 m^3 / day
		  • Gray: 37 m^3 / day
		  • Irrigation: 576 m^3 / day
		• Energy
		  • Total: 26,898 kWh/ day
		• Airlift: 85 passengers per day (counting both directions)
		• Wastewater
		  • Grey: 70.9 m^3 / day
		  • Black: 40.4 m^3 / day
		• Solid waste
		  • Total waste: 1,106 m^3 / year
		• Space
		  • Total build: 248,855 m^2
		  • Total land use: 800,000 m^2
			Additional effect tourism
			Currently the island is not oriented to up-class tourism. There are no other specific facilities or services for this group. By not having any facilities for these people, like a couple of good restaurants, guided tours, boat rental, boat tours, etc, additional money that can potentially be obtained will be wasted. So to mitigate this effect, additional tourism facilities, for example those previously mentioned, should be created.

1.1.2.1	**Beach**	According to the tourism development organization, not having a clean, white, large beach with the ability to swim in the sea puts St Eustatius at a disadvantage compared to	***Using Zeelandia beech*** The potential negative impact of using the beach

		the other islands with resorts. STENAPA is working on a beach project on the Caribbean side of the island. When realized (currently the start of this project, according to STENAPA, is planned for 2006) this beach will be located approximately 4km from the resort. The beach is constructed using a procedure called "reef ball", whereby hollow concrete "balls", with openings are put in the ocean, forming underwater dams. Coral and other sea life will grow on these balls. The also block or diminish the current and waves, preventing beach corrosion and actually allowing the beach to grow. According to STENAPA the reef balls would also be an excellent solution for creating a usable beach at Zeelandia. Next to making sure that swimming will become possible, due to a diminished undertow, the beach will grow in size due to decreased erosion. Next to the reef balls to stop the undertow and erosion from the seaside, the water coming from Zeelandia should also be collected before reaching the sea. It can then be used for irrigation purposes for the golf course and will at the same time stop erosion of the beach from the landside, which currently this is a big problem. Next to the Zeelandia area, the method can also be used at Venus Bay for the creation of a beach. Nestling sea turtles are using the beach at Zeelandia but these only come onshore during the night, more about this at section 2.1. Lifeguard service should be offered at any beach that the resort advises to its guest. 4 Lifeguards would be sufficient. ***Impact***: • Competitive constraint lifted by creation of beach on resort, beach will grow in size some 50ft (15m) due to lower erosion. • 4 Jobs as lifeguard • Coastal protection by preventing erosion. • Collecting rainwater from the hills and the Zeelandia area will stop erosion of the beach from the landside and it can be used as source of irrigation water.	can be the littering. Installing some litterbins on the beach and putting up signs to explain why it is important not to litter can reduce the amount of littering. To maintain a clean beach for the guests it is also important to reduce rubble on the beach, which means it is just as much in the interest of the resort as it is to STENAPA and the sea turtles to keep the beach clean. By not having the beach lit at night, people are discouraged to go to the beach at that time. This will also prevent young turtles to go inland instead of into the sea when hatching. By catching inland water for irrigation use, before it reaches the beach, less RO-water is needed and the beach erosion will be greatly reduced.
1.1.2.2	**Golf resort 5-star+**	According to the tourist office a resort should offer facilities for Business or wedding receptions. Comparable resorts have meeting rooms with sizes between 67m^2 and 320m^2. Total floor surface of the rooms is 1,160m^2 Next to the given surfaces, a golf resort should be located in a landscaped area. There should be a park like area, where possible using as much of the current nature as	***Accessibility northern sub sector*** The northern part of the island should remain reachable. If the current trail is to be used for the golf course and will be blocked for public use, a new trail has to be constructed. The access to the northern part of the island is currently a footpath;

		possible. The total area of the golf resort will be around 80 hectares, which means a landscaped area of about 55 hectares.
		
		The golf course will use most of the Area of Venus Bay and Zeelandia. Since Valero, the oil transhipment and storage company, owns the northwestern side of the island, the trail from Zeelandia to Venus Bay and beyond, is currently the only public way to get to the northern part of the island. When the golf resort is created, this passage will most likely be made private and part of the resort. This would effectively block access to the northern part of the island for non-guests of the resort.
		
		At a 60% occupancy rate, the number of departing passengers will be around 26 each day. They will have to pay a departure tax at the airport. If assumed that half will take the flight via San Juan (US$ 12) and half via St Maarten (US$ 5.65) then the daily income will be US$ 229.5, the yearly income is therefore US$ 83,750.
		
		Impact:
		• Guest: 552
		• Jobs: 510
		• Water requirement:
		  • Potable water: 74.2 m^3 / day
		  • Gray: 109.3 m^3 / day
		  • Irrigation: 576 m^3 / day
		• Energy
		  • Staying accommodations: 15,824 kWh/ day (includes tennis court, spa and pool and at 70% occupancy)
		  • Catering facilities: 1,318 kWh/ day
		  • Transportation: 414.9 kWh/ day
		  • Reverse Osmosis plant: 2,533 kWh/ day
		  • Total: 20,090 kWh/ day
		• Airport:
		  • 92 passengers per day (counting both directions)
		  • Airport income increases by US$ 83,750 per year (At 60% occupancy rate of the resort)
		• Wastewater
		  • Grey: 70.9 m^3 / day
		  • Black: 37 m^3 / day
		• Solid waste
			a similar type of trail would be required.

		• Staying accommodation: 847.7 m^3 / year • Restaurant: 258 m^3 / year • Total waste: 1,105,7 m^3 / year • Space • Meeting rooms: 1,160 m^2 • Staying accommodations: 12,270 m^2 • Tennis court: 1,325 m^2 • Pool: 500 m^2 • Spa: 600 m^2 • Golf course: 201,500 m^2 • Transportation: 40,000 m^2 • Restaurants: 1,800 m^2 • Total build: 258,855 m^2 • Total golf resort: 800,000 m^2	
1.1.2.2.4	**Staying accommodation**	According to STEBA and a comparison with similar resorts, there is a requirement for high speed internet, probably wireless and a phone connection to the resort. The same services will also be needed for the additional houses. The function "provide telecommunication" (0.6.1.3) was added as result of this requirement. This function resulted in the system solution 'telecommunication infrastructure', which was included as **1.1.1.5** and further examines the effects of this requirement. ***Impact***: • 294 Jobs • 552 guest (maximum) • Daily water requirements; potable: 34.5, grey: 23.2 m^3 • Daily wastewater production; grey: 33.2, black: 24.4 m^3 • The average hotel has an electricity use of 41 kWh, per guest, per night. With 552 beds, the hotel would therefore use 22,632 kWh per day [IL4]. At a more realistic 70% occupancy, the electricity usage would be 15,842 kWh per day. • Space used: 12,270m^2. • Airlift generated is approximately 46 passengers per direction per day (average, some days will be busier then others). • Solid waste: 1,105.7 m^3/ year. • Need for high-speed Internet and phone connections.	***Electricity*** The electricity usage of a resort is very high. Part of this will be caused by boilers, which are heating the water for the tap or the shower. The largest amount of water to be heated will be shower water. This water does not have to be boiling hot, most people will take a shower with water no warmer then around 40 degrees at most. To save on electricity, a solar boiler could provide the water for the shower. A 9m^2 catchment area solar boiler costs about US$ 12,250 to install [IL5]. In the Netherlands such a system can save around 3500 – 4000kWh/ year on electricity per one family household [IL6], or on average 4 persons. With 552 guests in the resort, this comes down, assuming the lower number of 3500kwh/ year on a 483,000kWh saving per year. This means total electricity savings of about NAF. US$ 972,222. The total cost of installing water boilers would be US$ 1.7 million. That makes the use of solar boilers have a return on investment time of less than two years.

			Another major part of the electricity is consumed by Air Conditioning. During most times of the year this is however required and the electricity usage for this cannot be mitigated.
1.1.2.2.4.1	**5-star+ hotel**	A 5 star hotel needs to have a reception, with an office. It needs to be cleaned and maintained. There should be a technical service to solve technical problems. The hotel will have a maximum of 2 stories and will most likely consist out of smaller buildings that are spread out over the grounds of the resort. A 5 star hotel should offer guest the option of dining in the room and have a personal assistant during their stay. In total there is a demand for 156 rooms, which comes down to a maximum number of guest of 312 in the hotel. For a luxury hotel, there should be at the very least, according to the tourist office, 1.5 persons per room staff. This comes down to a 234 people staff. With an average staying period of 1.5 weeks (1 week for the Americans, two weeks for the Europeans), the required average airlift can be calculated by dividing the total number of guest (312) by the number of days. 1.5 weeks is 10.5 days, 312/ 10.5 = 29.7 passengers. Since the guests that are leaving are being replaced with new guest, this means 30 passenger in each direction, so a total airlift requirement of 30 each way, or 60 in total. The guests in the hotel will need water. Average water use for a hotel is about 0.184 m^3 /day per room housing two persons [IL7]. For 156 rooms, this means 28.7 m^3 / day, or 28.7 m^3. This can however be divided in potable water and grey water (not used for consumption). Of the 184 litres, 74 l is used for the toilet, 37 l for the tap and 73 l for the shower. Shower water and water from the tap should be potable, to prevent health risks. This gives a need for 110 l of potable water per room per day, or 17.2 m^3 per day in total. The toilet can be flushed with less clean water, this requires 11.5 m^3. Since only a very limited amount of water will actually be used for consumption (only a couple of litre), most of the water will be leaving the room/ hotel again as wastewater. The toilet wastewater has to be considered black wastewater and will require treatment before it is discharged. The wastewater from the shower and sink is considered to be grey wastewater. It can be re-used in places where non-potable water is required. The black and grey wastewater that is not re-used has to be disposed off in a sustainable way. The total amount of wastewater can be considered the same as the amount of water that comes into the room, 28.7 m^3, the black wastewater will be slightly more then the water used for	See **1.1.2.2.4**

		flushing the toilet, about 12.3 m^3. The grey wastewater will be slightly less then the water used for the tap and shower, about 16.4 m^3. The solid waste produced by the hotel will be in the order of 4 lb/room/day [IL8]. With 156 rooms, that means 283kg per day (624 lb/ day). For a whole year that comes down to 103,295 kg, or 103,3 tons of solid waste. However half of this is attributed to catering, which is handled in section **1.1.2.2.7**, so this leaves 51.7 tons per year of solid waste. On average an m^3 of waste weighs about 200 kg [IL9]. This makes for a yearly waste production of 258 m^3 The size of a standard resort room will be around 65 sq meters. Since the hotel will most likely be a two-story building, only half of the hotel rooms take up ground space. The space taken therefore is 156 * 65 /2 = 5,070 m^2. ***Impact***: • 234 jobs • 312 guest • Airlift need of approximately 60 per day (all rooms filled), 30 each way. • Daily water requirements; potable: 17.2 m^3, grey: 11.5 m^3 • Daily wastewater production; grey: 16.4 m^3, black: 12.2 m^3 • Solid waste: 258 m^3 (51.7 ton) per year. • Space taken is around 5,070 m^2.	
1.1.2.2.4.2	**5-star+ condominiums**	Condominiums are privately owned villas that, if the owner is not using it, are rented out. They will be seat up to house a maximum of 6 persons each. The service level is the same as a hotel, therefore a 1,5 person staff may be assumed per room (1.5 staff per room is a figure supplied by the tourism development foundation as an average number). This gives a 60 person staff for the condominiums. Like the hotel rooms, the condominiums will need water. It is assumed that they will use similar amounts of water per person as the hotel rooms. There are however 6 persons in one apartment instead of 2, which makes 552 l per condominium per day. Potable water will be 110 l per two people, making 330 l per day. Toilet water will be 222 l per day. The wastewater is similar to the amount of water that comes in, 237 l will go out as black wastewater, 315 l as grey wastewater. At full capacity the condominiums can house 240 persons, at a 70% occupancy this would	See **1.1.2.2.4**

		be 168. If they stay on average 1.5 weeks at a time, the airlift per day would be around 16. The villa's will have two stories and be detached. They are around 180m^2 at ground level, with an additional 2nd floor of about the same size. The total space required will therefore be 7,200m^2. The condominiums will produce solid waste. The production will be around 1,17 tons/ apartment per year [IL10]. The total waste production will therefore be around 46,8 tons per year. Assuming the same guideline used in **1.1.2.2.4.1.** which indicated that 200kg equals an m^3, the waste production would be 234 m^3 per year. ***Impact***: • 60 Jobs • 240 guest (maximum) • Airlift need of approximately 16 per day (all rooms filled), 32 counting both ways. • Daily water requirements; potable: 13 m^3, grey: 9 m^3 • Daily wastewater production; grey: 12.5 m^3, black: 9.5 m^3 • Space used: 7,200 m^2 • Solid waste: 240 m^3 (37 ton) per year.	
1.1.2.2.3	**Tennis court**	The job of looking after the Court and renting out equipment can be combined. By doing this it is estimated the tennis court will create a single job. Depending on the underground, it may use a limited amount of water. Due to renting out of equipment income may be generated. ***Impact***: • Small income • Small amount of water • 2 Jobs • 1,325 m^2	No significant impact, no mitigation required.
1.1.2.2.3.1	**Court**	Depending on the underground there could be a limited amount of water required. A tennis court is about 13 by 26 m, so with four courts the required space is 1,325 m^2. It is necessary to have a staff of at least one person to keep an eye on things and to, also there can be a tennis teacher giving lessons.	See **1.1.2.2.3.1**
1.1.2.2.3.2	**Equipment rent**	There should be a place where tennis necessities can be borrowed or rented; a staff	See **1.1.2.2.3.1**

		member will be needed for this.	
1.1.2.2.2	**Pool**	The pool itself will have to be large, say 25 times 20 m. Yearly 95% assured rainfall is 764.8 mm and the average evaporation is 2,190 mm. This means that in a bad year, about 1,425 mm will evaporate. With a surface of 25 times 20 m this is 713 m^3 per year, or on average 2 m^3 per day. On a day with no rain and high evaporation this can however go up to 3.5 m^3. Next to the lifeguard, there should also be one person that maintains the pool and maintains the decontamination plant. ***Impact*** • Average water requirement: 2 m^3 / day • Maximum water requirement: 3.5 m^3/ day • Size approximately 25 times 20 m • Electricity: • Jobs: 2	There is no significant use of power, water and no significant negative impact to be expected from the pool. No mitigation is required.
1.1.2.2.1	**Spa**	The Spa includes a beauty farm and fitness centre. The required water and electricity are not significant in comparison to the usage by other parts of the resort. ***Impact***: • 10 Jobs, beauty treatment and instructors • Water for treatment and showers • Electricity • Space, approximately 600 m^2.	No significant negative impact expected. No mitigation required.
1.1.2.2.1.1	**Beauty farm**	A dedicated Spa/ Beauty facility offers on average 12 jobs [IL11]. This however includes management, housekeeping and laundry. Since these are already present in a resort, the number of jobs can be reduced. It is assumed the above functions will normally present 4 jobs, leaving 8 jobs. Water and electricity are assumed to be negligible. ***Impact***: • 8 Jobs, beauty treatment • 400 m^2	See **1.1.2.2.1**
1.1.2.2.1.2	**Fitness centre**	The fitness centre will house an array of fitness equipment, as well as showers and	See **1.1.2.2.1**

		changing rooms. There can be instructors giving classes in Yoga, or helping to get the most from the exercises. Water and electricity are assumed to be negligible. ***Impact***: • 2 Jobs instructors • Room with fitness equipment • 200 m^2	
1.1.2.2.5	**18-hole golf course**	• 75 jobs • Generate income (see **3.0**) • Generate tax (see **3.0**) • 201,500m^2 land use (for golf course + training facilities only, landscaped area around it not included) • Irrigation water required: 210,240 m^3 / year • Limited water usage for clubhouse • Limited sewage and fixed waste production. • Electricity usage for irrigation water (assuming Seashore Paspalum): 2,533 kWh/ day • Rainwater used for irrigation can not be used for other purposes anymore (like drinking water) • 1,800 m^3 storage in case of Ocean water • 145,080 m^3 storage in case of a closed rainwater storage	
1.1.2.2.5.1	**Golf shop**	The golf shop is where people can buy equipment they need to play golf. The shop obviously needs to be staffed, by two to three persons. It will also generate an income of which part will go to the government as tax income. ***Impact***: • 2 – 3 Jobs selling and administration • Generate income • Generate tax	
1.1.2.2.5.2	**Practise facilities**	The practice facilities consist of a driving range, which is used to practice the long shots and a putting green, which is intended for to practice putting. The first is approximately 300 m long and 30 m wide, so 9,000 m^2. The 2nd should be about 500 m^3. There should be teachers/ instructor's available, say 2 jobs.	***Saving water*** See mitigation measures at system solution **1.1.2.2.5.5**.

		Impact: • 2 jobs as instructor. • 9,500 m^2 land use • Need for irrigation water **(described in 1.1.2.2.5.5)**	
1.1.2.2.5.2.1	**Driving range**	***Impact***: • 9,000 m^2 land use • 9,855 m^3 water use / year **(described in 1.1.2.2.5.5)**	See **1.1.2.2.5.5**
1.1.2.2.5.2.2	**Putting greens**	The 500 m^2 below is considering a single practice putting green. The water use of the putting green compared to the whole golf course is not significant, if instead of a single, there would be 4 practice greens, the amount of water required would increase with less then 1%. ***Impact***: • 500 m^2 land use • 547.5 m^3 water use / year **(described in 1.1.2.2.5.5)**	See **1.1.2.2.5.5**
1.1.2.2.5.3	**Restaurant & clubhouse**	The restaurant and clubhouse is where golfers come before their round of golf to signup, possibly rent some material and get the scorecards. The golf course is usually constructed in such a way that there are 9 holes on each side of the clubhouse. This way it is a start-, end and halfway point. It can therefore be used to have a drink/ quick bite to eat halfway the course. It is also regarded the 19^{th} hole, where after the game of golf, another drink can be gotten and business can be done. There should also be changing rooms and showers. There should be about 3 people at the golf desk. For the restaurant/ bar kitchen staff and service is needed. It is estimated this would require 10 persons. Another 2 jobs are created by the need for cleaning. ***Impact***: • 15 jobs • Land use • Water use (showers, toilets, kitchen) • Water out • Energy	The restaurant/ clubhouse effects are taken into account together with the other catering facilities in **1.1.2.2.7**; any mitigation measures will therefore be handled in that section.

1.1.2.2.5.4	**Irrigation System**	The water supply system for irrigation is further described in **1.1.1.2** The irrigation system by use of reverse osmosis requires large amounts of power. In the case of Seashore paspalum it would be around 924,494 kWh per year (2,533 kWh/ day average), in the case of Bermuda grass, it would be 1,415,021 kWh per year (3,877 kWh/ day average). ***Impact***: • Bermuda grass: 3,877 kWh/ day • Seashore Paspalum: 2,533 kWh/ day	***Mitigation irrigation system*** The golf course is the highest water user of the complex. To prevent water being wasted the golf course should have a fine meshed drainage system. This water should drain back into the storage tank for reuse.
1.1.2.2.5.5	**Course**	The course itself will need a substantial amount of water. Depending on the amount of grass the amount of irrigation water for the golf course varies. The water quantity required for the grass depends on the evaporation [Brouwer et al. 1986]. The water requirement for a grass specie with a Kc-factor of 0.5 is half of the water that evaporates. This is shown by the following formula: $ET_{crop} = K_c \cdot ET_o$ Whereby: ET_{crop} : Water requirement for the "crop" / grass [mm] K_c : Factor [-] ET_o : Reference evaporation [mm] To give an indication about the required water quantity to irrigate the grass, it is necessary to look at the K_c-factor. The K_c-factor of Seashore Paspalum varies between 0.33 en 0.5. The specie SeaDwarf has the lowest value, of 0.33 to 0.4. SeaIsle I and SeaIsle 2000 have a value of up to 0.5. The K_c-factor for Bermuda grass, commonly used specie on Caribbean courses, is 0.8. With a yearly average evaporation of 2,190 mm and a maximum of around 7.1 mm per day, the amount of irrigation water required can easily be calculated. In case of the Seashore paspalum grass specie, the requirement is for 1,095 mm per year. If the Bermuda grass is selected, the requirement is for 1,752 mm per year. With a golf course of 6,400 m and an average width of 30 m, as described in the feasibility study, the	***Mitigation herbicides*** Herbicides will enter the groundwater and can flow to the sea. Here they can affect the sea life, like the coral and the sea turtles. There are a couple of measures that can be taken to prevent the herbicides to reach the sea. Firstly, according to STENAPA, the stronger the herbicides are, the faster they degrade. By a good drainage system, as mentioned in 1.1.2.2.5.4 the herbicides that enter the ground and are not used by the grass will be caught. During periods of rainfall the herbicides could runoff with the surface water. This water should also be collected and send to the irrigation pond or storage tank. A strong herbicide will break down in just about 2 days. ***Save water*** By using a more drought resistant grass specie, Seashore Paspalum instead of the more common Bermuda grass, 37.5% water can be saved. This is, on a yearly basis, 117,071 m^3. This will not just save water (and thus cost), but also means a smaller RO-plant can be constructed, which will cost less and the usage of electricity will be lower. Further the amount of reverse osmosis water will

		surface would be 192,000 m^2. Together with the 9,500 m^2 practice facilities, described in **1.1.2.2.5.2** the total amount of golf course to irrigate would be 201,500 m^2. The required amounts of irrigation water would then be: Seashore paspalum: 220,643 m^3 /year (max: 1,567 m^3 / day, average: 605 m^3/ day) Bermuda grass: 337,714 m^3 / year (max: 2,507 m^3/ day, average: 925 m^3/ day) In Maintenance of the golf course there will be around 49 jobs. To stop weeds and bugs from destroying the golf course, it will be necessary to use herbicides. ***Impact:*** • 49 jobs in maintenance • Irrigation water required: Seashore paspalum: 220,643 m^3 /year (max: 1,567 m^3 / day, average: 605 m^3/ day) Bermuda grass: 337,714 m^3 / year (max: 2,507 m^3/ day, average: 925 m^3/ day) • Land use: 192,000m^2 • Use of herbicides	Further the amount of reverse osmosis water will be reduced, thus decreasing the potential problems with build-up of salt around the island. More about saving water in **1.1.1.2**.
1.1.2.2.6	**Transportation**	The vehicles will need maintenance, it is estimated that this will require at least 3 employees. Roads will be 4m wide and run at least along the full length of the course and along the condominiums and hotel rooms. This means the road would have to be around 10,000 m. With a width of 4 m, this means 40,000 m^2 ***Impact:*** • Transport requirement for about 195 one-way trips. 85 one-way trips to the airport and back (3.3 km), 110 trips to locations on the island (3.6 km on average). (Harbour 4.4 km) • 415 kWh electricity per day • 12 – 16 Jobs as driver for the shuttle vehicles. • 6 Jobs maintenance/ rent • Roads space: 40,000 m^2	***Mitigating transportation*** When transportation uses combustion engines this can create noise pollution. For both transit service between the resort and the city/ airport and golf carts on the grounds electrical carts are available. It should be possible to power the carts by use of wind energy. This would create a 0-emission and "green" transport across the course and to the course. Similar transport is already in use for a long time at the Swiss mountain town of Zermatt, although here powered by water energy. They are being used to transport people as well as cargo to the upscale facilities.
1.1.2.2.6.1	**Off the grounds**	Transportation of the grounds means transportation outside of the resort. A big part of this transportation will be transportation to the island and the transfer from and to the airport. At the moment there is no scheduled ferry service, which means the arrivals from the	**Keeping the money on the island** When the resort provides the taxi service off grounds, the money goes to the foreign investors.

		harbour will be negligible. The expected transport to and from the airport equals the airlift expectation, generated by the staying accommodation (**1.1.2.2.4**). 85 guests in each direction (to and from the resort). Since the resort will be located at the northern part of the island, slightly away from the town (3.6 km), another part of the off grounds transport will be travel to the centre and to the south (Botanical garden, volcano trails). It is assumed that on a daily basis 10% of the guest will make use of off ground transport for these purposes. From the 552 guests, this means 55 guests. A shuttle service to and from the airport/ city could use larger golf cars, for up to 7 passengers and drive on fixed routes. These golf carts are also available electrically or gasoline powered. Assuming a 5-person car the distance per day would be 135 km/day. The average fuel needed is 0.25 – 0.5 kWh/ mile [IL14]. Assuming the higher figure due to the sloping terrain and the large carts needed, the power use would be 42 kWh daily. On average the resort will create a requirement for 46 passengers per day per direction to and from Statia. Due to the current largest aircraft being used (a Bombardier Dash 8-100), groups to be transported to and from the airport will never exceed 37 passengers on one flight; the number of guests of the resort per flight will be lower though. On most flights there is only an aircraft capacity of 19 seats, which will also have a lot of seats filled by people living on the island. The calculated air transport gives an average per day. With organized (group) travel there will most likely be one or two days of concentrated arrivals and departures. For American guests this will mostly be concentrated around the weekends. Assuming two thirds of the guests will arrive in two days, this means 107 passengers a day, per direction. These guests will have to transfer at St Maarten, San Juan or St Kitts. In the weekends, 74 seats are available from St. Kitts and San Juan, however these need to be shared with people travelling between San Juan and St Kitts. Around 84 seats are available between St Maarten and St Eustatius, although 38 of these need to be shared with people travelling between St Maarten and Saba. Next to the 70 extra passengers that are estimated, there are already passengers travelling on the routes. The St Maarten flights have a high load	When local entrepreneurs provide the service, the money stays on the island. For the impact on the island it would therefore be beneficial of a local company could run the off ground service, perhaps under supervision of the resort. ***Transport*** As the aircraft between St. Maarten and St. Eustatius are not of the comfort that would be required to transport upscale tourists, more comfortable aircraft would be required. A larger aircraft, for example one from Caribbean Sun (Dash 8) operating twice a day on this route would give an additional 36 seats to St Maarten and solve the comfort problems. These flights should be scheduled around the arriving and departing American and European flights. When the flights from San Juan to St. Maarten would no longer operate via St Kitts, this would give another capacity increase of around 34 seats. In total these two measures would add 70 seats, 110% of what is needed. Schedules for flights should be more closely matched around the flights to the USA and Europe, as at the moment waiting times for connecting flights can be up to 4 or 5 hours. Guests travelling from the USA can transfer at San Juan, possibly with better connection times. A boat service is being looked at between Statia and the islands of St Maarten, Saba and St. Kitts. It will most likely not be used by guests coming in from the USA or Europe, however pending the schedule can be used for day, or short trips from these islands to the golf resort. Resort guests can also do daytrips to other islands in the area using the boat service. A boat can take around 80

		factor; assumed to be around 80%. This means only 17 additional seats per day would be available. The Caribbean sun flight is assumed to have a load factor of 65%, which means 26 seats are available per day (with two flights in the weekend). In total this gives an availability of, on average, 43. Another 64 seats are therefore required. It may be expected that golf resorts guests arrive with their own aircraft. There are currently no parking places for medium or larger private jets and only limited apron space for small and medium sized turboprop corporate aircraft and light jets. ***Impact***: • Transport requirement for about 195 one-way trips. 85 one-way trips to the airport and back (3.3 km), 110 trips to locations on the island (3.6 km on average). (Harbour 4.4 km) • Electricity: 42 kWh.	passengers and will take 1hr 30min from St. Maarten to St. Eustatius. A boat service between Statia and St Kitts will mitigate the effects of a loss of the flights between these two islands. ***Airport apron*** Extending the airport apron may stimulate arrivals of private turboprops and jets. Research would have to be done to determine the demand for this kind of flights to the island and the amount of aircraft that would have a stay over period at the airport.
1.1.2.2.6.2	**On the grounds**	On the grounds itself golfers may want to make use of golf carts. Depending how spread out the hotel rooms are, other transport, like a shuttle service on the grounds, may also need to be provided. A round of golf typically lasts 4hrs. With a flight (group of golfers, maximum 4), leaving every 5min. Suppose they are all taking a golf cart, and such a cart can hold 4 persons, this means that the number of golf carts needed is (4 * 60 / 5 =) 48. These carts typically run on either electricity or gasoline. 48 Carts on electricity, on average driving around 25 km, would require 373 kWh per day. A shuttle service on the golf resort could use larger golf cars, for up to 7 passengers and drive on fixed routes. These golf carts are also available electrically or gasoline powered. Another option would be to have a golf cart for every hotel room. This would eliminate the need for shuttle service, as people can drive their own vehicles around the grounds. If a vehicle per two persons were assumed, at a maximum capacity of 512 guests, the necessary amount of golf carts would be 256. On electricity this would mean a power usage of 1,989 kWh per day. ***Impact***: • 372.9 kWh or 1,989 kWh per day.	

		• 6 Jobs rent	
1.1.2.2.7	**Catering facilities**	The catering facilities include the restaurants, bars, private chefs and the breakfast facilities. The resort will offer the option for a private chef. Suppose 5% of the guests (at 70% occupancy) will request such a service, this will deliver 18 jobs. The guests in the condominiums have a kitchen and can prepare their own meals. Not all guests will use dinner at the same time. If it is assumed that 50% of the guests will use the restaurant facility at the same time, the maximum capacity would be 156 guests. This will require 15 jobs in the kitchen and 30 waiters. There is also a need for staff running the restaurant, which keep track of the inventory, who keep track of the stock and cleaners for the restaurants. This is assumed to add an additional 20 jobs. The kitchen should be staffed 24-hrs a day, to allow for room service. This means that the 15 jobs should be tripled to allow for 3-shifts. This gives a total number of kitchen personal of 45. A guideline for a restaurant is that it takes about 4 m^2 per guest. If half of the guest will arrive at the same time, 592 m^2 of restaurant space is needed. Terraces are needed, as well as a separate dinning, breakfast room and bar. Even though they can all be served from the same kitchen, this will require additional space; 1,200 m^2 will be reserved for the separate catering facilities, 300 m^2 for the kitchen. An additional 300 m^2 will be reserved for storage and freezers. This make the total space used 1,800 m^2. Food and beverages will have to be bought and transported to the resort. A similar resort already in operation in the Caribbean buys 20% of its products locally and around 80% is imported. Only Seafood and some fruit and vegetables are bought locally, as well as some 30% of the beverages. Most of the main supplies are flown in from the USA. The total spending on food and beverages is around US$ 2 million a year, with most of the cost being transport. Assuming 50% of the costs goes into transport this leaves US$ 1 million spend on the actual acquiring of the food and beverages. With only 20% bought locally the money spend on the island would only be US$ 200,000 a year. Instead of on the island where this similar resort is housed, Statia does not produce fish or any substantial amounts of fruit and vegetables (although a project has been set up to start producing the last two). If bought on the island the goods may simply be delivered, but if by boat, a truck will be needed to get the goods from the harbour. It may be necessary to increase the amount of	***Local products*** There are very few local products being produced. This means that the resort will have to buy all catering products from abroad. By creating local products additional jobs can be generated and money will stay on the island, instead of go abroad. Another option to create additional income on the island would be to start a wholesale on the island. A wholesale could cater both to the existing business and supermarkets on the islands as well as the resort. Next to additional income for the island a wholesale would also create new jobs. A similar resort gets large parts of its (fresh) products from the USA however, even when wholesales are available on nearby islands. It would therefore not be certain that a wholesale could count on a large part of the purchases of a resort. A big opportunity could also be fishery. In the waters around the island there is a lot of fish. Currently fish is brought in from as far away as Taiwan, local fishermen could catch fresh fish for the resort, but also for the local people. On a limited scale, agriculture would also be possible and could supply the resort with fresh products like fruit and vegetables. A project is currently underway to start producing on a small scale; such projects should be supported to further improve the economy.

		freight capacity to the island. There are plans to start a mixed freight and passenger service to the island. This would be a good opportunity for further improvement within the program of creating a self-sustainable island. By having its own boat service, the island is no longer dependant on foreign companies and ever increasing freight prices. Also this would create a limited number of jobs and would keep the money now spend on foreign companies on the island. To look at the effects on the harbour, which is the point of entry for virtually all freight, a new system bearer was added, "provide harbour facilities". This was added as **1.1.1.6**. The kitchen will use water for the preparation of food and to clean. Waste will be liquid and solid. The water use according to an average is 12gall per person per day. [IL12] This is 45.5 litres per person per day. With one full meal a day per person and two smaller meals (breakfast and lunch), which will be counted as half a meal each, 2 meals per person will be counted. This means one person uses 91 litres of water. This means a total of 50.2 m^3 of water used for catering purposes on a daily basis. Since restaurant water includes water used for the toilets, it will be assumed that 25% of the water used is for the toilet. This makes that 25%, or 12.6 m^3 of the incoming water can be grey water, 37.7 m^3 needs to be potable. The outgoing water will be 37.7 m^3 'grey' and 12.6 m^3 'black' wastewater. The solid waste will be in the range of one lb per seat per day. Even though not all guests will go to eat at the restaurant, there will still be waste, as they have to eat somewhere. The solid waste for the condominiums is included in the figures for the staying facilities (**1.1.2.2.4.2**), so this leaves the hotel rooms. With 3 meals a day, this will be counted as two full meals, so 2 lb per guest per day, which, with 312 guests, gives a total of 624 lb/ day. This is 227,800 lb or 103.3 metric tons per year. 103.3 metric tons means 520 m^3/ year. Energy will be required for airco, lights, etc. In the kitchen energy will be required to prepare food. A study was performed in Hawaii, which has a somewhat similar climate, which found an energy use of 75.5 kWh per sq feet per year for a restaurant. With 592 m^2, which is 6,372 ft^2, the energy use will be 481,000 kWh per year. ***Impact***: • 113 jobs • Water requirement: 38 m^3 potable, 13 m^3 grey (per day)	

		• Wastewater: 38 m^3 grey, 13 m^3 black (per day) • Solid waste: 520 m^3 / year • Energy: 481,000 kWh/ year • Space used about 1,800 m^2	
1.1.2.2.8	**Construction**	Construction of a similar resort on the nearby island of Anguilla will take 3 years. At Anguilla the main contractor is a company from the United States. For the resort at Statia the contractor will also have to be from off the island, since the contractors on the island have no experience and do not have the capacity to handle projects of this size. The local companies can be hired as sub-contractor for certain parts of the job. In Anguilla the workforce on the project can be divided between the work on the golf course and the work on the resort. The construction of the golf course, according to Dr. A. Hariggan, of the Anguilla government, is not very labour intensive and requires a large deal of heavy equipment in landscaping the terrain. 50 Anguillians do the work, with one off-island supervisor. The construction of the resort villas is very labour intensive. On Anguilla there are 450 persons working on construction, with 100 additional workers to be added soon. Of these 450, 300 are local residents of Anguilla. 150 persons are coming from the CARICOM region [IL13], which consists out of a large group of Caribbean and some south American countries. These people have a long-term residence for Anguilla. The 100 additional workers are brought in on a temporary basis from the Dominican Republic. The area that the golf resort uses on Anguilla is around 115 hectares (286 acres). The resort on Statia could potentially take 171 hectares at Venus Bay and 71 hectares at Zeelandia, although most likely the resort will not use all this land. Anguilla is looking at 20 estate homes, 16-oceanfront villas and 97 hotel rooms. For Statia this number is 40 condominiums and 156 hotel rooms. The construction project at Statia will therefore not differ greatly from the one on Anguilla, expect for the more mountainous terrain, which will add some construction challenges. The amount of construction personal currently used at Anguilla is taken as indicator for the amount that will build the Statia resort. The required labour for Statia will therefore also be around 50 for the golf course and 450 for the resort construction. The construction of the golf course will take around 2 years, with on average 50 people working on it. If they make on average US$ 12,000 p.p. the income tax will be US$ 996	***Mitigation required personnel*** The required 450-construction workers are not available on the island. Even if 50 of the unemployed Statians can be used as construction workers, there are still about 350 construction workers required. The number of workers can be reduced in two ways. Firstly by extending the period of time that the construction is allowed to take, for example from 2 years to 3 years, the amount of workers needed may well go down from 450 to 300. Assuming the same 100 construction workers and unemployed available on the islands, this would only leave a requirement for 200 foreign workers. This already assumes that the golf course and golf resort are constructed after each other and not at the same time. Further, creating a planning based on the available personnel, it may be possible to rearrange the phasing of construction in such a way that fewer personnel is required. This could perhaps save another 10% on the staff, leaving 270 persons required to build the resort. 170 people would have to be brought in to the island. ***Mitigation housing personnel*** The construction personnel from abroad have to find housing for the duration of the construction project. Since this is temporary labour, they will not require a permanent house and will most likely not bring families. For the resort personnel

		per person. For 50 persons this will therefore be US$ 49,800 a year. Over a construction period of 2 years this results in US$ 99,600. The construction of the golf resort will also take two years; however on average 450 people will be working on this project. If they have the same average income, this will result in a tax income of US$ 448,200 a year, so for two years in US$ 896,400. According to the CBS [2003] there are 102 people working in construction on the island of Statia. Next to the construction of the resort, the "normal" construction of houses would also continue. Not all 102 people will therefore be able to start working on the construction of the resort. Suppose 50% of the personnel can be set aside, then 51 would be available. This means the golf course can potentially be build by Statian contractors, under supervision of a foreign construction management, for example a construction manager for one of the golf course design firms. For the construction of the resort, there is a shortage of 400 people. There are ways to reduce the number of people needed for the construction; these are handled in the mitigation section on the right. A large part of the construction workers would however have to be found abroad. These people will require housing on the island. The contractor will have to pay turnover tax. This is 3% over the turnover. It is hard to put a price tag on the resort on forehand. The price can severely differ from one resort to the other, depending on the quality and luxury level. The resort at St Kitts cost around US$ 100 million. The resort at Anguilla is said to cost around US$ 300 million. In the first case the potential turnover tax would be US$ 3 million. In the 2nd case it would be around US$ 9 million. There is also a tax over the profit that the contractor would make; this is a percentage of 34,5%. In case of a 5% profit on the total cost, the profit would be 5 to 15 million dollars. The profit tax would then be US$ 1,7 to 5,2 million. The total tax income from construction for the government could therefore be US$ 5,7 – 15,2 million dollar over 4 years of construction. Because the amount of tax is significant, there will be negotiations between the government and the investors/ contractor about the amount of tax to be paid. It will most likely result in a fixed sum being paid that is substantial, but also substantially lower then the calculated amounts. To look at the effects on the harbour, which will be the point of entry for all freight, a new system solution, "provide harbour facilities" was added (**1.1.1.6**), as part of the increase	there is a requirement of about 165 apartments. If these could be constructed first, prior to the start of construction of the resort, the personnel from abroad could use these houses. Another option is to bring in barracks and house the personnel in these, near the construction yard. The first option should be stimulated however, because it will bring in additional income for the island (especially if the houses are financed and owned by local people).

		services solution.	
1.2	**Island promotion material**	The golf resort will spend a lot of money on advertising. Next to promoting the resort itself, it will also promote the island, which can have a positive effect on the tourism industry on the island. A good example of the promotional capabilities of a resort is the Sandals resort, on St. Lucia, which is promoting the resort and the island with commercials on CNN. On Anguilla the government is not participating in the promotion and advertisement on the resort, other then promoting it via their website and the website of the tourism board. The budget for promotional activities, like adds on TV, the radio, papers and magazines by the resort far exceed the budget that the island could even have to promote itself. ***Impact:*** • Likely increase in tourism, also outside of the resort.	No mitigation required
1.4	**Increase inhabitants**	The number of people that would have to come and work on the resort from outside the island is about 330. Since they will include partners and children, the total size of the group will be around 490, including 75 children. The preference would be to attract Statians that left the island due to the unavailability of work or career opportunities. The required amount of housing is as follows: ***Impact:*** • 165 single homes -> 165 people • 124 family homes -> 322 people (of which 75 are children). Next to an increase in the number of houses and people, there will also be an increase in the demand for schools, health care, electricity, groceries, etc. As indicated above, there will be an additional 75 children on the island, which will increase the demand for schools. Health care is handled in **1.1.1.3.** Electricity use of a house is around 5,914 kWh / year in California per household. Since the climate in California is not that different, the same usage could be expected here. For a year and 289 households this means a power requirement of 1,710,000 kWh/ year, or 4,700 kWh/ day.	***Housing*** According to 1.4.1.4 there is a potential need for 165 apartments or single person housing and a further need for 124 houses for families. Because Statians living abroad are an important group that is being focused on, the actual need for housing will be lower. A number of Statians living off island already has a house on Statia. No records are kept about the amount of houses that are empty or the amount of Statians living abroad though. The golf course will probably at first attract a large number of 'single' employees. They will require apartments. When they are staying on the island for a longer time they may want to move to family housing. The demand for apartments may therefore be getting lower, while the demand for houses may go up. It would therefore be justified to create houses in the first place and accept that

		Impact: • 4,700 kWh/ day.	housing will not completely fit the first inhabitants requirements, or to make the apartment buildings flexible. The flexibility means that the apartments should be easy to reconfigure into multi room apartments, suitable for more then one person.
1.4.1	**Recruit people off island**	Of the 530 jobs that are predicted to come into existence with the development of the resort, 330 will have to be filled by people not currently living on Statia. These people will require a home, or apartment on the island. For 330 jobs the number of people will be higher, because of families and children. 487 people is an estimated number of people who may came to the island as a consequence of the golf resort. ***Impact:*** • Look for Statians first • 330 Jobs for people off-island • 490 people coming to the island in total	***Recruiting people*** A 16% increase in population on the island is expected. The effect this has is both positive and negative. Planning their arrival in advance can mitigate negative effects like a shortage of housing. Building sustainably can partially reduce other effects like an increased demand for power. The effects the additional people have are described in this report; mitigation measures will be given per effect.
1.4.1.1	**Find people**	330 people need to be found off-island. Preferably these would be Statians living off the island. A primary target group would be Statians who had to migrate off the island because of a lack of work, but want to return. No records are being kept about the amount of Statians living abroad. Immigration and emigration data is available. This shows over the last 10 years that 438 Statians left the island and 527 returned to Statia. This is not a complete figure, as Statians going for example to the USA will usually remain registered in Statia. The CBS in the Netherlands only tracks the number of people from the Dutch Antilles and Aruba. In 2004 a total of 130,538 people from the Dutch Antilles and Aruba were living in the Netherlands. The number does not separate between the populations of the six islands. The largest group however is the people from Curacao, where a large unemployment has motivated people to immigrate to the Netherlands. This group is said to be about 70% of all the people from the Dutch Antilles and Aruba living in the Netherlands. This is 91,376 people and leaves 39,162 for the other islands. To divide this number a very rough estimate would be to look at the size of the total population per island and assume the percentage of people living on that island compared to the total of people is an indication for how the group in the Netherlands is divided. The total population of the Dutch Antilles and Aruba, but without Curacao is 146,948 [CBS 2003]	***Finding people*** It is assumed that around 655 Statians are living in the Netherlands. A large part of them will still be at school or are already on a pension. From those who are able to work at the resort, not all will want to return to St. Eustatius, because they have build a live in the Netherlands, or have found a good job, etc. If 5% would be willing to return that would fill 20 jobs. Assuming another 80 Statians can return from the other islands of the Netherlands Antilles, the USA and other countries, 100 additional jobs could be filled by Statians. This would leave 230 jobs to be filled by non-Statians. The unemployment on the nearby islands, especially St Maarten, is high enough to provide even all employees for the golf resort. St. Maarten is highly multi cultural, a large group of

		people. The number of people in the same year is 2.498 [CBS 2003], which gives Statia a percentage of 1.7%. This percentage from 39,162 people would give an estimated 665 Statians living in the Netherlands. This is however purely based on the above-mentioned assumptions. Assuming these people are of all ages, only around 50% would be at an age where they could work at the resort. Of these 330 Statians, it is a question how many are willing to leave the Netherlands and their current job to come back to Statia, no number is available, if 5% is assumed, about 20 Statians would be returning to the island. The Netherlands has a big appeal to the Netherlands Antilles because of the ties between the two countries and the possibilities for education. The other islands of the Dutch Antilles, other nearby islands and the USA also have relatively large groups of Statians. From talks with Mr. W. Berkel it can be assumed that the USA has at least a similar amount of Statians, figures from the Dutch Antilles and other nearby islands are unknown. If it were assumed that a similar amount (20 persons each) of Statians would be available from the USA, St Maarten and 40 from other countries and islands (for example Curacao, St Maarten, St Kitts), an additional 80 would be available, making the total amount of available Statians from outside the islands, around 100.
		
		For the remaining jobs the focus should shift to people from the other Dutch Antillean islands. The nearby islands of St Maarten en Saba have more or less the same culture so the cultural impact of people coming from these islands will be minimal. The unemployment on Saba, according to the CBS [2003], is 39 people; the unemployment on St Maarten in 2003 was 3.433 people. This means that a small part of the unemployed on St Maarten would already be enough to fill the jobs for the golf resort.
		
		Impact:
		• 530 total jobs delivered by the resort
		  • 200 jobs filled by Statians on the island
		  • 100 jobs filled by Statians off the island
		  • 230 additional people required
			the unemployed will be people from the surrounding islands, it can be expected that portions of the employees of the resort will therefore be from Dominica, the Dominican republic, Guyana, etc. St. Eustatius is already multi ethnic, with residents from all of these locations, china and the USA and Europe. The aim should be to get as many Statians and residents in the Dutch Antilles to work at the resort, other groups will however most likely also be needed to get enough employees.

1.4.1.2	**Extra classrooms**	To determine the impact on schools, interviews were conducted at two schools, with an informal conversation at a third. The two formal interviews took place at the Gwendalyn van Putten school, a secondary school and the Goldenrock Elementary school, a school for primary eduction.75 additional children mean that there will also be an increase in the demand for education. The school system on Statia is similar to the Dutch system. With primary school from the age of 4 to 11 and secondary school from 12 to around 16 (the highest education is HAVO, which takes 5yrs, so to 17). On the island there are 323 persons age 0 to 9 and 465 age 10 to 19. Assuming these students are equally divided over	No mitigation required

		the ages and are representative for the children coming to the island, the impact for the schools can be calculated. Another assumption is that children over the age of 16 will not be coming to Statia with their parents because there is no schooling available. In total there are 323 children between 0 and 9. They have to go to school when they turn 4, so 60% of the children are in primary school, which means 194 in total. There are 465 children aged 10 to 19. Primary school is up to the age of 11, so that means 20% of this group is in primary school; 93 in total. This means that at the moment there are about 287 children in primary school. From 12 to 16 is the period for secondary school, which means 40% of 465, which is 186 students. Of the total group of 602 children between 0 and 16 living on the island, 186 go to secondary school, 287 go to primary school. With 75 children between the age of 0 and 16 coming to the island, this will add, using this same partition, 23 children at secondary school and 36 at primary school. On the secondary school no effects are expected. The 23 students can be handled by the current number of teachers and by making changes to the school timetable any extra classes can be accommodated in the present classrooms. For the primary school the effects are also small. Recently a 3rd primary school was added on the island, taking some students of the other two. On the golden rock elementary school the number of students went down from over 170 to 146 at the moment. This means at this school alone the capacity is readily available to take at least 24 students. One of the problems that the schools have is that the funding has to come from the government. The government at the moment has a large deficit and thus cannot spend a lot of money on the schools. With the increased government income, more money would be available for schools, which could increase the quality. ***Impact:*** • 36 children at primary school • 23 children at secondary school	
1.4.1.3	**Extra staff at schools**	It is not expected that the schools require additional staff due to the increase in students.	No mitigation required

		Impact: • None	
1.4.1.4	**Private houses**	It is assumed that 50% of the people who are working at the resort and golf course are single. They will be coming to the island alone and need housing for one person. The other group will be families. In 2003 the number of people living on the island was 2,498 (currently 3,100), with 965 households. This means the average household consists out of 2.59 people. Further it is assumed that 50% of the families will have both adults and the other 50% will have one adult working at the resort. This will result in 165 singles and 165 people with families. Of the group with families 50%, so 82 people, have both adults working in the resort. This group has a size of 107 people, 25 of which are children. The other 50% of the families has only one adult working at the resort, resulting in a group size of 215 people, 50 of which are children. According to the St. Eustatius Housing Foundation there will not be any problems constructing the houses. At the moment there are plans for constructing around 50 houses by the Housing Foundation. The government is also constructing housing. It is expected that the current waiting list of 50 people that are looking for housing will go down to a surplus of 25 houses. There are no problems expected in the amount of land that is available. An apartment building for 12 apartments could take about 25 x 40 meters (900 m^2). A single house could be about 10 x 15m (150 m^2). This means that the housing alone would take about 15,375 m^2 in apartments and 23,250 m^2 in family houses. The required roads would use about 6m in width, and around 1 km long (to cover all the housing). This would add an additional 6,000 m^2. It is therefore estimated that housing will take at least 4.5 hectares or about 11 acre's. Currently a housing project is going on at White Wall, but also there is also land available or currently being used to construct houses at Lodi (enough space for 25 apartments), compagnie (50 acres), grovel (60 acres) and the English quarter (710 acres). Grovel is located near the resort, which would be ideal in terms of travelling distance for the employees. Having the housing at White wall can potentially cause traffic problems, as all traffic going from White wall to the resort has to pass through Oranjestad. Further more this is the longest distance housing can be placed away from the resort, making White wall not the most favourable location. The St. Eustatius Housing Foundation is willing and able to finance the construction of	***Consumption*** The amount of waste that the additional housing produces is significant. Because no recycling or waste reduction programs exist on the island, mitigating the amount of waste is not possible. More about the effects of the waste on the environment in 2.5 ***Housing*** The housing can be provided by the housing foundation. As long as they have a guarantee that the resort will be constructed. The housing can be financed by the housing foundation. A limited amount of housing should be available before start of construction, to allow foreign construction workers to live on the island (also see **1.1.2.2.8**). On nearby resorts staff housing for ex-pats (people from abroad working on the resort) is available on the resort grounds. This could be done for the resort on St. Eustatius as well, however the revenue from these houses will then go to the resort. If housing is provided locally, for example by the housing foundation, the money will stay on the island.

		the houses (getting loans from banks). The thing they would need from the resort however is a guarantee that the houses will be filled at least for 80%. To have the houses ready at the same time the resort opens, they would need about 3 years advance notification. The water for the current houses on Statia is taken from the rainwater. This is stored in a cistern and used for all sourced instead of drink water, for which bottled water is used. This is a sustainable system, apart from the water bottles, which are not recycled but thrown away onto the dump. Waste will be produced in quantities of about 500 kg per person per year. With 487 people, there will be 245,000 kg of waste per year. On average an m^3 of waste weighs about 200 [IL9]. This makes for a yearly waste production of 1,220 m^3 The houses require a phone and internet connection, just like the resort needs a phone and internet connection. For this reason 'provide telecommunication' was added as function **0.6.1.3.** ***Impact:*** • 165 single homes -> 165 people • 124 family homes -> 322 people (of which 75 are children).	
1.4.2	**Education minimum for immigration**	According to the St. Eustatius Tourism Development Foundation there is a large chance that people from nearby islands, willing to work for law wages, will be attracted by the project. If many of them find a job at the resort, the effects for Statians may be greatly reduced; these people may send most money back to their families on the other islands. The lower income and the money disappearing from the island will decrease the tax incomes and the unemployment on the island may not drop.	***Mitigation low cost workers*** The government should have a reserved attitude against immigration from people who are not living on the Netherlands Antilles. Employees from outside the Netherlands Antilles will most likely turn out to be necessary, but care should be taken that they do not take the bulk of the jobs and that the people from the Netherlands Antilles miss out.
2.0	**Sustainable development**	The major worry for this section, sustainable development, is the solid and liquid waste. On the island there are no processing plants available for either of them. Solid waste is dumped as is in a landfill; liquid waste is disposed mainly by so called cesspools, which means the drainpipe ends in a hole in the ground, the wastewater enters the ground directly. Septic tanks are used at a limited number of locations. Even if they are used, they still drain into the ground. For both sorts of waste, the resort would have to create its own	***Solid waste*** The resort can partially reduce the solid waste that it has to dispose of, for example by supplying their own bottled potable water from the reverse osmosis plant in glass bottles that are reusable. The remaining amount of waste will however still

		installation to be sustainable. Two species of animals have to be taken into account. Firstly the Iguana, which is living in Venus Bay and in fact most of the northern hills area. It is endangered specie; on the island there are some 425 Iguana's. Because they live in and feed off the trees, clearing the trees for a golf course is a potential danger to these reptiles. No problems are expected though if the resort is placed at Venus Bay and the golf course at Zeelandia. It may also increase the appeal for the golf resort having iguanas on the grounds of the resort. Having the resort at Venus Bay and the course at Zeelandia would also be beneficial for the Sea turtles. Young sea turtles need darkness to find their way to the beach. Having a golf course at Zeelandia will ensure darkness at night. It will also create a quiet environment for the adult turtles to come ashore and lay their eggs. It is possible to use the beach for tourism as well as sea turtle nesting. People sitting and walking on the beach will pose no threat to the nests. Since the sea turtles use the beach at night, and people during the day, this will not conflict either. Creating a barrier in the sea, for example with reef balls, will not only make swimming possible, but will actually increase the size of the beach by about 15m due to prevention of erosion. A top layer of white sand can be added for visual appeal. Making tourists aware of the environment and the presence of sea turtles and iguana's can decrease the negative impact, as people will know what not to do (like littering on the beach). Commercial use of the beach will also mean it will be cleaned from waste coming in from the sea; this is currently not being done and poses an equally large risk for the turtles. From the landside erosion is also playing a role. Rainwater can, after heavy rain, rain down Zeelandia and erode the beach. This causes deep trenches in the beach and potentially allows seawater, during high seas, to enter further on the land, creating even more erosion. The sand that enters the water in this way could potentially harm the reefs, when erosion is stopped this would therefore also be beneficial for the reefs. By storing the rainwater in an irrigation pond, the water is no longer flowing over the beach, thus eliminating the erosion. The water can now be used for irrigation purposes, providing a free water source for the golf course. By creating water channels from the surrounding area to the irrigation pond, erosion of the surrounding area can be prevented in case trees and bushes need to be removed and even more water will be available for	be significant and have a significant effect on the environment. ***Liquid waste*** The liquid waste can be cleaned effectively by running it through a three-stage septic tank, followed by a reed land (acting as a biologic filter). This solution will need the cooperation of the guests, as chemicals being flushed through the sink or toilet can damage the reed land. If implemented successfully this system will however reduce the impact of the liquid waste to a less then significant effect.

		irrigation. Reef damage, caused by sand reaching the reef, can also be reduced when an irrigation pond is constructed. The Venus Bay area is currently protected under the status of 'unique landscape'. On the basis of the law there are no reasons why a permit could be given for building in this area. Therefore a law change will be required, which either allows "sustainable development" as basis for a permit to build or which removes the status of protected area from Venus Bay. Socially, sustainability is achieved by promoting Statians to come back and work at the golf resort. Statians are used to living on the island and may have departed because no work was available. They will have the least trouble blending in with the current population and share the same believes and values. It will also mean that families can get together and live together. ***Impact:*** • For sea turtle nesting the beach should be clean of trash • During the nesting season there should be no visible lights from the landside. • A golf course at Zeelandia, with the golf resort at Venus Bay will prevent hatchlings to move inland instead of to the sea, because a golf course does not have to be lit up at night. • People walking and sitting on the beach will do no damage to the eggs Sea turtles use the beach at night; people usually do not use the beach at night. • Removal of tree's and bushes will increase the flow of water and therefore potentially increase the erosion. • Law change required to use the landscape protected Venus Bay area • Loss of a hiking area to locals and non-golf resort tourist • Alterations in a unique landscape area • Make tourists aware of the environment and thereby reduce the negative impact. • For iguana protection, golf resort at Venus Bay, golf course at Zeelandia. • A golf course at Venus Bay would be a major threat to the iguana. • Families can stay together • Little social or cultural change	
2.1	**Protect sea turtle**	STENAPA has indicated that the Zeelandia beach area is a nesting ground for sea turtles. Law protects sea turtles, making that it is forbidden to have a Sea turtle in possession, or take it or kill it. It is also illegal to damage or destroy turtle nests or to take sea turtle eggs	***Mitigation impact on Sea Turtles*** Sea turtles and use of the beach for tourism can go together. There are two effects that need

		or hatchlings from their nest. The international laws protecting the turtles are the CITES treaty, which is mostly centred around moving the animals, the UNEP SPAW, which is a protection treaty between several Caribbean nations and the Inter American Convention for the protection and conservation of Sea Turtles (IAC). In a leaflet about turtle protection, several threats are mentioned. These include the transformation of a nesting beach into a recreational beach. In this case "*coastal development, lights, noise, pollution, beach driving and general harassment can chase turtles away*" [Stenapa, sea turtle leaflet]. As a simple solution, education and protection are mentioned. When people stick to the rules, recreation and turtle protection can go hand in hand. Another threat to the turtles is posed by trash. The animals see this as food and it can also obstruct nesting grounds and trap emerging hatchlings. A simple solution would be to keep the beach clean of litter and larger objects, not to drive on the beach or dump any toxins as oil or pesticides. According to STENAPA it is possible to use the beach for both recreational purposes and for sea turtle nesting. Also see **1.1.2.1.** ***Impact:*** • For sea turtle nesting the beach should be clean of trash • During the nesting season there should be no visible lights from the landside. • A golf course at Zeelandia, with the golf resort at Venus Bay will prevent hatchlings to move inland instead of to the sea, because a golf course does not have to be lit up at night. • People walking and sitting on the beach will do no damage to the eggs • Sea turtles use the beach at night; people usually do not use the beach at night.	mitigation, which is the lighting near the beach. This should be minimized during the nesting season. Also the waste on the beach should be minimized. The first can be achieved by adjusting the location of the golf resort. By having the golf course at Zeelandia and the resort at Venus Bay the lights can be minimized around the beach at night.
2.1.1	**Lighting setup**	Hatchlings, which are the Sea turtles that are just coming out of the eggs, are using the light reflecting of the sea to find their way to the water. If there are any bright lights on the landside, they will move there. During the nesting season this means that lights should be setup in such a way that they are not visible from the beach. By having the golf resort at Venus Bay and the golf course at Zeelandia, light pollution at Zeelandia will be kept at a minimum, because the golf course will not be lit up at night.	***Lights near the beach*** To protect the young hatchlings from moving in the wrong direction (they are moving towards the light that is reflected from the Ocean) the lights near the beach should be minimized at night. By having the golf resort at Venus Bay and the golf course at Zeelandia, light pollution at Zeelandia will be kept at a minimum, because the golf

		Impact: • A golf course at Zeelandia, with the golf resort at Venus Bay will prevent hatchlings to move inland instead of to the sea, because a golf course does not have to be lit up at night.	course will not be lit up at night.
2.1.2	**Egg protection**	Whether Zeelandia beach is made suitable for swimming or remains as is, it can be expected that tourist will use the beach. Currently the beach is mostly deserted, but with a resort housing over 500 tourists, this may well change. People walking or sitting on the beach will not do damage to the nests (according to STENAPA). The adult sea turtles come ashore at night to lay their eggs and the hatchlings are coming out at night as well for their trip back into the sea. The beach will usually not be used by tourists during the night. To be sure the beach, during the nesting season, could be closed off during the night. ***Impact:*** • People walking and sitting on the beach will do no damage to the eggs • Sea turtles use the beach at night; people usually do not use the beach at night.	***Egg protection*** To protect the sea turtle eggs vehicles on the beach should be prevented. Walking or lying on the beach is no problem.
2.2	**Inform tourist about environment**	According to the a leaflet about turtle protecting, providing information to the tourists about the sea turtles or the iguana's can reduce littering and harmful behaviour. This will decrease the negative impact that tourists have. ***Impact:*** • Make tourists aware of the environment and thereby reduce the negative impact.	***Information program*** Make tourists aware of the special wildlife in the area and explain how they can decrease their impact on them. This could be in the form of information boards, leaflets and warning signs.
2.3	**Protect iguana**	STENAPA indicates that the Antillean iguana, living on the northern part of the island, is endangered. When young it lives mostly on the ground, adults spend most of their time in trees. They feed on leaves and fruits/ vegetables that can be found in the trees. The specie is endangered mostly due to free roaming goats and the disappearing of its habitat due to tourism development. They live mostly in the Northern hills. According to the latest estimates there are some 425 iguana's living on the island. Venus Bay is one of the major living areas for these reptiles. No, or very few, iguana's can be found at Zeelandia. A golf course at Zeelandia would do little damage to the Iguana's or any other specie. For	***Mitigation impact on Iguana*** For the Iguana the trees are important. As long as the trees can, to a large extend, be kept, there will be no danger to the Iguana. For this reason it would be advisable to create the golf course at Zeelandia, as it will require extensive landscaping. The resort could then be built in Venus Bay. Reviewing the current situation in Venus Bay, the chance that a significant number of trees have to be removed is small.

		iguana protection it would be best if the golf resort is build at Venus Bay, while the golf course is constructed at Zeelandia. The iguana is protected both by island legislation and by the world conservation Union (IUCN). ***Impact***: • For iguana protection, the golf resort should be placed in Venus Bay and the golf course in Zeelandia. • A golf course in Venus Bay would be a major threat to the iguana.	
2.3.1	**Protect trees**	To protect the iguana from extinction it is important to protect the trees they use for feeding. Iguana's can mix perfectly with the small hotel buildings, as long as a large part of the trees can be saved. According to STENAPA it would be no problem to have the golf resort (the hotel part) in Venus Bay. It would be a problem if the area is completely landscaped and trees removed for the purpose of building a golf course. ***Impact:*** • Golf course at Zeelandia, resort at Venus Bay would give an acceptable impact on the iguana's • Golf course in Venus Bay would be a major threat to the iguana.	See **2.3**
2.4	**Attract Statian workers**	According to STEBA, attracting Statians, either those living on the island at the moment, or those that had to move away or stayed abroad after their study due to a lack of jobs, will assist to minimize the negative impact on the society. The large positive effect would be that it would enable families to stay closer together. Next to that, Statians share the same cultural background and will find it easier to fit in to the society on the island again. ***Impact:*** • Families can stay together • Little social or cultural change The island at the moment is already multi cultural/ multi ethnic; there are significant populations from China, Guyana, the Dominican republic, the other Dutch Antilles, the USA and Europeans on the island.	***Mitigation attracting Statian workers*** Since it is not sure that there are enough Statians willing to return to Statia to fill all jobs, other groups should also be looked at. A good source of workers would be the nearby island of St Maarten. This island is also part of the Netherlands Antilles and therefore will share some of the same culture and history. A study in 2003, by the central bureau of statistics, showed unemployment of 3.433 people (17.5%). This means that if not enough Statians are available to work at the golf course, a part of the unemployed at St. Maarten or Saba can find work. There are more then enough unemployed to be able to fill the jobs without the

		Data from the islands census bureau shows that over the last 10 years, 438 Statians have left the island, primarily to the Netherlands and to the other islands of the Dutch Antilles. This figure may not be complete, as for example Statians moving to the USA usually stay written in on Statia. The number of Statians who come back to the island in the last 10 years is 527. It is mostly unknown where they came from. The emigration and immigration figures can therefore not tell a lot about the number of Statians living abroad, other then that this number decreased by 89 in the last 10yrs.	need for people from elsewhere. Having people from the two other windward islands coming to Statia ensures that the negative Social impact, due to cultural differences is limited.
2.5	**Discharge of waste**	Waste on the island of St. Eustatius is currently not taken care of in a sustainable way. Solid waste is dumped in a landfill, but ineffective management of the waste flows means that it regularly piles up around the landfill. There are plans to upgrade the solid waste facilities, by introducing waste separation, but so far this has not happened. Effluent water from houses is not collected centrally or put through a sewage treatment plant. Most houses have a cesspool, which is hole in the ground where the sewage is dumped. Due to the porous soil, the waste will flow down into the ground and groundwater. There are only very limited houses that have a septic tank. Even the septic tank overflows directly into the ground. Septic tanks are not emptied, nor or there any facilities to do so. This means that effectively all the sewage will disappear into the ground. This includes any chemicals (For example the popular cleaning mean, chloride) being flushed through the toilet or sink. This is a highly unsustainable solution and potentially has very negative consequences for the soil and groundwater quality.	See **2.5.1** and **2.5.2**
2.5.1	**Discharge effluent water**	Effluent water from houses is not collected centrally or put through a sewage treatment plant. Most houses have a cesspool, only a few have a septic tank. Both drain into the ground. Septic tanks are not emptied, nor or there any facilities to do so. This means that effectively all the sewage will disappear into the ground. This includes any chemicals being flushed through the toilet or sink. This is a highly unsustainable solution and potentially has very negative consequences for the soil and groundwater quality. As sustainable is defined as something that is able to be continued indefinitely without a significant negative impact on the environment or its inhabitants, this solution can not be seen as sustainable. The impact on the environment, especially the contamination of the ground and the groundwater, can be large. The groundwater is currently being used as drinking water for cattle. The quality is acceptable, although containing a high amount of minerals (due to the volcanic nature of the island). The groundwater also reaches the sea though, where it can potentially hurt the environment and pose a threat for the safety of	***Discharge of effluent water*** In theory a three-stage septic tank with an overflow into a reed land can filter black water to a quality where it can be returned into the environment. There are however restrictions to this system, for example the use of chemicals (for cleaning the toilets, etc) can damage the reed field. If such a system is chosen biodegradable-cleaning products should be used and notices should be given to tourists not to flush chemicals through the toilet or sink.

		drinking water. The only wastewater that the resort produces is the black water; the grey water can be reused. Black water production is 37 m^3 per day. ***Impact:*** • No available sewage purification plants on the island • Standard solution (sewage tank with overflow to the soil) is not adequate for sewage purification and will contaminate ground, groundwater and possibly the seawater around the island.	
2.5.2	**Dump solid waste**	The resort will produce solid waste at an estimated amount of around 1,105.7 m^3 / year. The 490 additional people living on the island, according to **1.4.1.4**, will create 1,220 m^3/ year. So the total additional waste flow will be around 2,300 m^3 / year. That is an area of roughly 34 by 34m, 2m high. The landfill at the current rate of waste production is expected to last no more then 5 years, according to Mr. Timber from the Dienst Openbare werken. Because no sorting or recycling of the waste takes place the waste flow is much larger then it could be. There is no separation of the waste and the groundwater. Chemicals and oil remains can flow down to the groundwater and flow into the sea. This can cause contamination of the water around the island. It has the potential to harm the sea life, make the water more expensive to convert into drinking water, or even make it unfit for this purpose. Unclean water can also hurt tourism in general. ***Impact:*** • No available sustainable solid waste processing solutions on the island • A waste dump is available; space at current location will run out in 5 years, the dump posses a threat to groundwater and the environment.	***Solid waste mitigation*** Plans already exist for privatizing the waste gathering and processing. By privatizing the thought is that the private company will find ways to recycle those parts of the waste that deliver money. It will prevent a large part of the waste (for example green waste, glass, etc.) from ending up at the dump. There are some other simple measures, which may save a lot of waste though. For example working out a deposit system on the water bottles. Because no drinking water is available from the tap, many people drink bottled water. The (plastic) bottles all end up at the dump or are thrown away elsewhere on the island. Charging money from islands residents based on the amount of waste that is produced can potentially also save a lot of waste.
2.7	**Erosion prevention**	Erosion of the beach, according to STENAPA, is a major problem. Erosion is taking place both from the side of the land and from the sea. Erosion from the sea can be stopped with reef balls, see **1.1.2.1.** This has the added advantage that the beach will grow by about 15m and swimming will be possible.	***Prevent erosion*** For the construction of the golf course a large part of the vegetation that can currently be found at the Zeelandia area will have to be removed. Because the bushes and trees are holding back the water,

		Erosion from the land is causing deep trenches in the beach, as well as further in the water, creating dangerous undertows. In case trees and bushes are removed at Zeelandia the erosion can increase. Next to damaging the beach, the sand that the water carries away can potentially also damage the reefs, further in the water. Collecting the water from the landside can stop this form of erosion. The added advantage is that the water can be used for irrigation purposes. ***Impact:*** • Removal of tree's and bushes will increase the flow of rainwater to the sea and therefore potentially increase the erosion.	removing them will increase the amount of runoff water and therefore increase erosion problems at Zeelandia. By storing the water in an infiltration pond, before it reaches the beach, it cannot create erosion damage. Replanting new bushes and trees around the golf course will also mitigate erosion.
2.7.1	**Use existing landscape**	By minimizing landscaping, the area will keep its original shape and rainwater will be held back, instead of flow directly to the sea. The hills around the area and the Zeelandia area itself can potentially collect a lot of rainwater. By creating an irrigation lake and channelling water from the surrounding area into the lake, water can be stored for irrigation purposes and at the same time it can be prevented that water flows over the beach into the sea, causing erosion. ***Impact:*** • Using the landscape and installing an irrigation pond and some channels makes it possible to collect irrigation water, while beach erosion is stopped by collecting the water before it reaches the beach, instead of letting it run over the beach and into the sea.	See **2.7.1**
2.7.2	**Use existing flora**	Currently large parts of Zeelandia are covered with bushes and some trees; most of these are thorn bushes, which are growing all over the island. They are not protected or endangered. They do however use water and will keep some of the rainwater from flowing to and over the beach. When they are removed, the water will flow down in the direction of the beach faster and in larger quantities, increasing the erosion of the beach. ***Impact:*** • Potentially clearing trees and bushes can cause water to run down to the sea faster, taking with it the soil and thus creating erosion. By limiting the amount of clearing, or replanting and channelling the water down to the irrigation pond, this can be prevented.	See **2.7.1**

2.8	**Change (environmental) law**	Venus and Venus Bay are protected areas, among other sections of the Northern part of the island. Article 5 and 6 of the 'island regulation protection fauna and flora' give this protection. Article 5 states that a region or part of the island can be classified as unique landscape. Article 6 determines that a region appointed in article 5 can only be changed for the reasons of: endangered traffic safety, the safety of private belongings or scientific research. ***Impact:*** • Law change required to use the landscape protected Venus Bay area • Loss of a hiking area to locals and non-golf resort tourist • Alterations in a unique landscape area	***Change law*** The current law blocks development in Venus Bay. An exemption of the law cannot be provided for any reason that a golf course with fit under. The island government will have to change the law to make development possible. There are two possible solutions for changing the law. The first one is to eliminate the protected status of Venus Bay, as granted in article 5 of the 'island regulation protection flora and fauna'. Another option is changing article 6 by including 'economic and social development' as reason for granting an exemption. To diminish worries about the impact, in article 6 there can also be included 'sustainable economic and social development'. This will make sure that the requesting party has thought about and can prove the sustainability of the project. This also ensures that the area is not spoiled, but can be used for the reason of social and economical development. The law has been created by the local government and therefore can also be changed by the local government. When they are convinced that the golf resort project will be beneficial for the island they will change this law.
2.9	**Remote location**	To maintain the peaceful 'laidback' appearance of the island, the golf resort should be 'separated' from the most inhabited part island. The location at Venus Bay and Zeelandia is perfect for this purpose. Venus Bay cannot be seen from Oranjestad or the houses on the Volcano, Zeelandia is also in a valley, which obstructs the view to it from most of the island. For the people on the island this means that the project will not be very visible. In Zeelandia there are only 5 to 6 houses and an abandoned and ruinous hotel at Zeelandia. The hotel is in such a bad state that it cannot be used anymore and will have to be demolished. The houses are mostly built to the side of valley at Zeelandia, which makes that they should not be in the way for golf course construction. During the design	***Mitigation current houses Zeelandia*** Depending on the final design of the golf course, it may be necessary to remove houses. In case this should happen, the golf resort has a negative impact for these house owners, in the sense that they may loose their home. They should obviously be well compensated, either financially or by providing a similar house in a different location on the island or both.

		of the golf course this will have to become clear if the houses are not in the way of a good design. In all cases arrangements will have to be made with the house owners, because their houses may end up encircled by the golf resort. If any houses should get in the way of a good golf course they may have to be removed. The road from the airport to the location of the resort does not pass through Oranjestad, only a couple of houses will be affected by additional traffic.	Houses in the Zeelandia area will see an increase in value, but may also see a deteriorating view and a limited amount of noise pollution. These cases should be individually reviewed and where appropriate, compensation may be given.

3.0	**Increase government income**	***Impact***:
		• Direct income: US$ 8,000,000
		  • Room tax: US$ 2,900,000
		  • Turnover tax: US$ 430,000
		  • Profit tax: US$ 3,700,000
		  • Land lease: US$ 710,000
		  • Wage tax: US$ 290,000
		• Indirect income: US$ 94,500
		  • Profit tax (34,5%): US$ 73,500
		  • Turnover tax (1%): US$ 21,000
		• Total extra tax income government: US$ 8,100,000
		• Some taxes (mainly profit tax) and the land lease cost may be waived, further investigation is required to research the best solution for the government to attract and stimulate investors, but still get a good income from the resort (for example by use of PPP). When profit tax and the land lease would be waived, the government tax income would go down to US$ 3,400,000 (NAf. 6,120,000), which obviously is substantially lower and also still leaves the government with a budget deficit.
		• Expected reduction in 'social jobs' at the government	

3.1	**Increase tax income**	Government income is increased by way of taxes and income from land use. According to the STEBA, Venus Bay belongs completely to the government. They government prefers the use of a long-term lease contract instead of selling the ground. The land lease rate is Naf 0.35 per m^2. According to the "Domein" (domain) office the Venus Bay area has a surface of 424 acre's, or 172 hectares. This includes most of the surrounding hills as well. Assuming that the resort will want the rent the whole area of Venus Bay, the income is US$ 602,000 per year. Zeelandia is partially owned by the government and partially privately owned by an American group. The privately owned piece is 100 acres, or 40.5 hectares. The land price	***Tax waiver*** A tax waiver, even if 'only' for the first 10 years, will cost the government a lot of income. Further research should be performed to methods by which the government can promote the development of a golf resort, but will not loose more then half of the income. This may be possible by participating as investor (for example by bringing in the land) and by other forms of public private partnership (PPP).

		is a maximum of around US$ 6 per m^2, which would result in a total cost of the land of US$ 2,430,000.The total Zeelandia area is 71.5 hectares, which means the remaining piece that can be rented from the government is 31 hectares, which would result in rental costs of US$ 108,500 per year. The income from land rental for the government is US$ 710,500 annually. Next to that the American owned piece will cost the golf resort US$ 2,430,000. There are a number of taxes: • Room tax is a raised over the hotel and other room rental prices. It is a 7% tax over the price charged for the room. • Turnover tax is 3% over any spending; it is non-deductible and will be charged every time money is spent. • A profit tax is raised over the profit that a business makes; it is 34,5% of the profit. With similar resorts, the room prices start at US$ 200, with a standard rate of US$ 695 and higher rates up to US$ 1,095 per night. Assuming a 60% occupancy at the standard rate, the room tax income would be .6 (occupancy) * 552 (guests) / 2 (per room) * 695 (rate) * 0.07 (tax) = US$ 8,050 per day. Per year this would be US$ 2,900,000. There is a 3% turnover tax on any spending. It is estimated that the golf course, after the 2nd year, will start generating about US$ 5.5 million revenue. This means that there is a tax income of US$ 165,000 over this amount. For the resort this means 3% over at least the room income. Assuming 60% occupancy, the turnover from the room rent alone would be (.6 * 156 * 695 * 0.03 * 365) US$ 712,000. The actual amount would however be higher, as the hotel guests will spend money on drinks and diner and other activities as well. Assuming this to be US$ 200 per day (a similar resorts charge US$ 194 for a meal plan), the additional tax (turnover) income would be (.6 occupancy * 156 rooms * 2 persons * 200 spending/ day * 0.03 tax * 365 days) US$ 410,000. The total turnover tax would therefore be US$ 1,290,000. The total amount first goes to the national government in Curacao. A third then comes back to the island, resulting in an income of US$ 430,000 for the island. The employees need to pay tax over their income. With an average wage of US$ 12,000, the average annual income tax would be US$ 670 per year. For a total of 430 jobs (100	***Keeping the money on the island*** The majority of shareholders or investors for the resort will be foreign. This means that a lot of the money the resort generates will also go abroad. The challenge for the government and the private sector would be to keep as much of the money on the island. One way to do this is to make sure those tourist facilities and attractions are owned and operated by local entrepreneurs and not by the resort. For example if the resort would offer boat rental, the income would go to the resort and the money would go to foreign investors. If a local company would offer boat rental, the money would stay with the local company and thus on the island. This last situation is much better for the island. The government should promote the startup of tourism related facilities and attractions for the tourism segment that the golf course aims for. If additional attractions and services can spark the guests to spend another US$100 per person per day, this would in turnover tax alone add US$205.000 (assuming a 60% occupancy of the resort). If this money stays on the island, the economy increases with US$ 12 million. If 10% of this is profit, the profit tax income for the government would increase with US$ 420.000. ***Additional expenses*** It was indicated there would be additional costs for nurses and a doctor and for roads. The roads are a one-time investment, they will need some maintenance over the years, but the impact is not significant. The hospital, when it is expended, will require additional money. Most of it will have to come from the patients and insurance companies however. With more patients, the cost of care

		the average annual income tax would be US$ 670 per year. For a total of 430 jobs (100 persons are already assumed to have a job, so are already paying this tax) this means a tax income of US$ 290,000 per year. According to the feasibility study for the golf course, the profit for the course alone would be around US$ 3.85 million in full operation (from the 3rd year of operation). With a larger turnover, the profit of the resort could be double that amount, around US$ 7 million. The total of the two together would then be around US$ 10,850,000 per year. The profit tax is 34.5%, which comes to US$ 3,700,000 per year. The spin-off effects, like increased spending on the island by the new inhabitants will have relatively little effect on the tax income compared with the amounts that the resort is bringing in. Suppose 1/3rd of the income is being spent on the island, 530 people will spend US$ 2.12 million. The turnover tax (3%) over that amount is US$ 63,600, of which 1% goes to the local government. Next to this, the shops will probably be able to get a higher profit and will get a higher turnover. If they make a 10% profit over the US$ 2.12 million the profit tax (34.5%) income will increase by US$ 73,140. So roughly the increase in tax income due to the increase spending by the employees on the island will be around US$ 94,500. There will also be a number of costs, for example the costs of putting down roads for the new houses and the cost of expanding the hospital and the wages for a doctor and nurses. See mitigation under additional expenses. It is also important to review how the impact is shared of the stakeholders. The bulk of the income of the resort will go to the investors. The total increase in government income, not yet taking into account tax holidays, exemptions, or other arrangements, is around US$ 7 million. Next to the tax there is also a US$ 710,000 land rental income. The total income of the government could therefore be US$ 7.7 million a year. The budget deficit of the island currently is US$ 6.1 million, which means the golf resort can deliver enough money to make the island self sustainable. To attract investors some tax exemptions or tax holidays will have to be granted or other arrangements to reduce the cost for the resort will have to be made. The options of waiving the profit tax and the land rental have been mentioned. This would cost the government a yearly amount of US$ 4.4 million, or more then half the amount that they could receive.	should not have to go up, due to scale advantages; the cost may actually go down. The impact of additional cost will therefore be less then significant.

		Next to the government and the investors, another large part of the income goes to the 530 people who can find a job at the resort and will therefore now be able to support themselves and play an important role in the islands economy. The total income from these employees, at an average income of US$ 12,000, will be US$ 6.36 million. For the people currently living on the island, 200 people (About 6% of the population) will find a job with the golf resort. The remaining jobs will go to people who are not currently living on the island. For the people on the island not getting a job with the resort the primary advantage will be an increase in government income, which will enable to government to execute project that it are beneficial for all, but cannot be executed at the moment due to money shortage, like improving the roads, the harbor, the airport, etc. Another advantage for them can exist if they start to provide their own facilities or services for the guests.	
3.2	**Decrease unemployment**	The unemployment rate on the island of St. Eustatius, in 2003, was 8.5% [CBS 2003]. From the available 1,134 economically active people in the population, this means that there are 96 unemployed. The resort will have the following impact: ***Impact***: • Effectively reducing unemployment on the island to a figure near 0, in theory everybody who does not have a job on the island now can find work with the resort. • Decreasing or solving the hidden unemployment, increasing the efficiency of business/ government. • Statians on island currently unemployed and finding a job: 94. • Total number of Statians on island finding a golf resort related job at the golf resort: 200. • 255 single homes -> 255 people • 191 family homes -> 495 people (of which 113 are children). • 1,748 m^3 of solid waste production annually	No mitigation required
3.2.1	**Attract unemployed Statians**	It is hard to find a real number of unemployed people on St. Eustatius. The labour office only tracks those that are registered with the office and have no job. At the end of 2005 the number of people who were not employed and written in with the labour office was 15. When asked for an estimate the labour office indicated the real number of unemployed is probably around 30. If the underemployment is taken into this number rises to 45 people. Underemployment means people have a job, but for less hours then	No mitigation required.

		they are available and want to work. The unemployment rate on St. Eustatius in 2003, according to the Central Bureau of Statistics, was 8.5% [CBS 2003]. From the available 1,134 economically active people in the population, this means that there were 96 people unemployed. Both the under employment and the unemployment are not recorded. The underemployment may be relatively high. The government for example has hired people on a social basis, whereby they have a full time job, but only work several hours a day. At the slaughterhouse there are also jobs that have several full time workers who are only required to work an hour a day. By increasing the efficiency of personnel, the number of available jobs with current businesses will decrease, increasing the amount of people from the island that can work with the golf resort. Because hidden unemployment is by definition not visible, it is hard to give an indication how many people this concerns. A figure of 10%, which is 104 persons from the 1,038 people currently employed, would most probably not be an overstatement, so this would increase the number of Statians currently living on the island who would be able to get a job at the Golf resort to 200. The remaining personnel would have to come from outside the island. For this group see **1.4**. ***Impact***: • Effectively reducing unemployment to 0 • Decreasing or solving the hidden unemployment, increasing the efficiency of business/ government. • Number of unemployed finding a job at the resort: 94. • Total number of Statians on the island able to find work due to golf resort: 200.	
3.2.2	**Training program**	Because the people currently unemployed may have little or no experience in the field of hospitality, cleaning, maintenance, etc, training will be required. Training will normally be done by the resort chain and will most likely take place off-island. Training is an important part to match the unemployed with the new jobs.	***Unemployed do not fit resort need*** By supplying training to the unemployed Statians looking for a job at the resort they can be made to fit the job descriptions they can perform at the resort.

3.3 Alternative projects

A project does not have to be executed, the simplest alternative to doing a program or project like making the island less dependant on the Netherlands, or creating a golf resort is to do nothing (0-option). Another alternative for the golf course, fitting the same program goal of making the island more self-sustainable is eco-tourism. These two alternatives will be discussed in more detail.

3.3.1 0-option

The 0-option is the option of not executing a project. This option reviews what will happen when no projects are executed. A zero options does not exclude development There are already, outside this program, plans for projects that will most likely become reality, regardless of the program to improve the self-sustainability of the island. This option has been briefly described in the feasibility study for the golf course. Tourism at the moment is mainly limited to dive tourists. There are currently around 71 rooms available on the island; the largest hotels only have 20 rooms, making it difficult to organize group travel (for larger groups). In a 0-option, only limited hotel capacity will be added, at most 50 rooms. With no other facilities or attractions being constructed these rooms will most likely attract divers, perhaps allowing organized dive trips to the island.

When the occupancy rate is around 70% annually and people stay around 1 week on average, there will be an additional 1,825 people coming to the island annually. For the transport to and from the island this means 5 passengers per day in each direction on top of the current amount of passengers. This will most likely not be enough to maintain the current Caribbean Sun connection to San Juan and St. Kitts.

With 50 rooms and a less luxurious hotel then a 5-star+ facility would be, the number of employees will be limited to around 25. The prices will also be lower then can be charged for a resort, similar (but smaller) hotels on the island charge around US$ 150 per night. With such a room price, the annual income of the 50-room hotel, at 70% occupancy rate, would be around US$ 1,916,250 per year. Room tax, which is income for the government, would be around US$ 134,000. A 10% profit over this amount would give US$ 66,000 profit tax and a 1% turnover tax would give an additional income of US$ 19,500.

Assuming the hotel would be placed on the Caribbean side of the island, it can be connected to the water plant and getting electricity from the net should be no problem either.

The Harbour expansion plans, including a marina would still continue. A boat link to St. Maarten, St. Kitts and Saba is planned and will continue to be looked at independently of any other project.

In conclusion the zero option will have the following effects:

- Increasing the hotel room capacity to around 120 rooms.
- Making organized (dive) tourism possible.
- Reducing unemployment.
- Slight increase government income, around US$ 220,000.
- High chance of loss of the Caribbean Sun airline connection to San Juan and St Kitts.
- Harbour expansion, including marina.
- Possible boat connection to St. Maarten, Saba and St. Kitts

3.3.2 Eco-tourism option

The Eco-tourism option will be a development happening next to the 0-option. The 0-option is the development that is likely to happen independent of the program. The program level goals for the program are a self-sustainable island, supporting business, sustainable development and increase government income. Like golf, eco-tourism is a "booming" business. Current activities for eco-tourism on the island are hiking and diving, other activities need to be developed, like lodging, horse riding, mountain climbing (white wall), yachting, etc.

The big difference with the golf course project is the budget of tourists that are attracted. On the nearby island of Saba there is an eco-lodging hotel, which has 11 cabins, for 4 persons per cabin. This hotel charges around US$ 85 per night, per cabin. Suppose 50 ecotourism lodges were placed on the island, this would allow 200 tourists to stay. At a 70% occupancy rate, the average amount of tourists would 140. If on average 3 people share a lodge, the amount of lodges taken will be 46. At US$ 85 a night, this will result in US$ 3,910 per night, or US$ 1.427.150 per year. A 7% room tax would give a government income of US$ 99,900. A 10% profit over this amount would give US$ 49,000 profit tax and a 1% turnover tax would give an additional income of US$ 14,500.

The lodges do not necessarily have to offer electricity, depending on their location; a kitchen may be required as well as water. The eco-lodges on Saba have a restaurant on the ground where people can have lunch and dinner. 50 lodges, for 4 persons on average, would make organized (group) ecotourism travel possible.

With 140 people staying on average a week, the amount of transport to and from the island that is needed would be 20 seats per day, in each direction. This would most likely be sufficient to keep the current Caribbean Sun connection to San Juan and St Kitts.

The number of employees required for the ecotourism hotel will probably be limited, the eco-lodges will most likely have to be cleaned by the guests and the service level required will be low. One, or more, restaurants would require staff; say around a 15 person staff for the restaurant and a 5 person staff to run the hotel. Next to the eco-hotel, there would be attractions, like the cliff (white wall) climbing, horse riding and yachting that would require personnel. The increase in diving may also create a number of new jobs for dive instructors. The amount of additional jobs created in this way is hard to predict, but it is assumed it will be around 14. The total amount of additional jobs would therefore be 34.

To get the same number of employees that a golf resort can deliver (630), at least 925 eco-lodges would be required. At 70% occupancy this would mean 2590 tourists are required to be on the island (on average). At this size, the government would receive around US$3,000,000 in additional tax income per year.

The sustainability of this option is high; eco-tourism is a growing market and is expected to keep growing as people become more aware of their impact of the environment. The negative impact of ecotourism is very small and sustainable.

An eco-resort will not be able to spend as much on marketing as a large golf resort. The importance of marketing can be seen at Nevis, this island was put on the map by the Four Seasons resort.

The Harbour expansion plans, including a marina would still continue. A boat link to St. Maarten, St. Kitts and Saba is planned and will continue to be looked at independent of any other project.

In conclusion the eco-tourism option will have the following effects: (Assuming the construction of 50 lodges, of a similar time to those at the nearby island of Saba)

- Creating eco-lodges on the island, which can accommodate a maximum of 200 persons
- Creating tourists attractions like climbing, hiking, yachting, additional diving opportunities, horse riding, etc.
- With an average 70% occupancy of the eco-resort the Caribbean Sun connection will most likely remain. Eco-tourist will most likely have no problems with the comfort of the current Winair connection.
- Reducing the unemployment by an estimated 34 jobs
- Around US$ 163,000 tax income for the government

4 Conclusions and recommendations

4.1 Remaining impact and mitigation measures

4.1.1 Transportation

Transportation to St. Eustatius relies heavily on aircraft. There are two airlines serving the island, with four destinations; St. Maarten, St. Kitts, San Juan and Saba, only the first three offer connections to other destinations. The aircraft between St. Maarten and St. Eustatius are not of the comfort that would be required to transport upscale tourists, more comfortable aircraft would be required. A larger aircraft, for example one from Caribbean Sun (Dash 8) operating twice a day on this route would give an additional 36 seats (each way) to St Maarten and would also solve the comfort problems. These flights should be scheduled around the arriving and departing American and European flights. When the flights from San Juan to St. Maarten would no longer operate via St Kitts, this would give another capacity increase of around 34 seats. In total these two measures would add 70 seats. It is estimated that currently about 45 seats are open on a daily basis, in total around 110 seats will be required on busy days (Saturday/ Sunday). Making the San Juan to St Eustatius flight a direct one and changing two flights to St Maarten to a Dash 8 will give the required airlift.

Schedules for flights should be more closely matched around the flights to the USA and Europe, as at the moment waiting times for connecting flights can be up to 4 or 5 hours. Guests travelling from the USA can transfer at San Juan, possibly with better connection times.

A boat service is being looked at between Statia and the islands of St Maarten, Saba and St. Kitts. It will most likely not be used by guests coming in from the USA or Europe, however pending the schedule can be used for day, or short trips from these islands to the golf resort. Resort guests can also do daytrips to other islands in the area using the boat service. A boat can take around 80 passengers and will take 1hr 30min from St. Maarten to St. Eustatius. A boat service between Statia and St Kitts will mitigate the effects of a loss of the flights between these two islands if the San Juan flight is operating directly to and from St. Eustatius. Without having the check-inn time at the airport, a boat connection may not take much longer then the aircraft, probably around an hour.

Extending the airport apron may stimulate arrivals of private turboprops and jets. Research would have to be done to determine the demand for these kinds of flights to the island and the amount of aircraft that would have a stay over period at the airport.

When transportation uses combustion engines this can create noise pollution and use non-renewable energy. For both transit service between the resort and the city, airport or harbour and transportation on the resort grounds, electrical carts should be used. Preferably the carts will be powered by use of wind energy. This would create a 0-emission and “green” transport across the course and to the course. Similar transport is already in use for a long time at the Swiss mountain town of Zermatt, although here powered by water energy. They are being used to transport people as well as cargo to the upscale facilities. Using electric carts will increase the status of the resort as a “green resort”. With consumers becoming more aware of the environmental impact they have, this can be a key selling point.

Remaining negative impact; No significant negative effects expected

4.1.2 Additional activities and services

Currently the island is not oriented to up-class tourism. There are no other specific facilities or services for this group. By not having any facilities for these people, like a couple of good restaurants, guided tours, boat rental, boat tours, etc, additional money that can potentially be obtained will be wasted. So to mitigate this effect, additional tourism facilities, for example those previously mentioned, should be created.

When local companies and not the resort provide activities and services, the money spend by tourists will stay on the island. This will be beneficial for the economy and also increase tax income for the government. Services could be upscale restaurants, activities like Para-sailing, surfing, jet ski rental, boat rental, boat trips, diving, etc. When a resort is created the government should promote, perhaps with tax measures or subsidies, the creation of these facilities as keeping as much of the tourists money on the island is important for the economy.

There are very few local products being produced. This means that the resort will have to buy all catering products from abroad. By creating local products additional jobs can be generated and money will stay on the island, instead of go abroad.

Another option, to create additional income on the island, would be to start a wholesale. A wholesale could cater both to the existing business and supermarkets on the islands as well as the resort. Next to additional income for the island a wholesale would also create new jobs.

A big opportunity for local products could be fishery. In the waters around the island there is a lot of fish. Currently fish is brought in from as far away as Taiwan, local fishermen could catch fresh fish for the resort, but also for the local people. On a limited scale, agriculture may also be possible and could supply the resort with fresh products as well.

Remaining negative impact: When no additional activities are created, potential guests may select another island that offers a similarly luxurious golf resort, but because of the islands itself or the activities it provides offers that little more then St. Eustatius can currently offer. Adding additional activities like mentioned above therefore are important, if done by the resort the money will go the resort chain and the investors, for the island it would therefore be better if local persons start offering additional services and attractions aimed at the upper class tourists. Adding the above-mentioned services will create even more jobs and will keep additional money on the island.

4.1.3 Irrigation & Water

The golf course uses most of the water that a golf resort requires. To prevent water being wasted the golf course should have a fine meshed drainage system. This water should drain back into the storage tank for re-use. Creating any form of open water storage will mean a lot of loss due to evaporation. The yearly average evaporation is around 2160mm. This means that the less water surface there is, the better. Water storage ponds should therefore be created as deep as possible, to get the most amount of storage with the least amount of water surface.

There are some worries about using a reverse osmosis plant. The salinity of the ocean is normally around 34,500 PPM (Parts per Million). Due to the use of reverse osmosis plants, at some places in the Middle East the salinity has gone up as high as 40,000 PPM. This can potentially hurt the sea life. Since the Sea and especially the coral are major tourist attractions for the island, care should be taken not to damage it in this way.

The first three measures that can be taken are all intended to reduce the amount of water that is required. These mitigation measures are:

- Selecting the Seashore Paspalum grass instead of the commonly used Bermuda grass, 34% water and electricity cost can be saved.
- The yearly savings from an irrigation pond with rainwater are 5 – 8%
- Water for the toilet can be supplied by rainwater and by collecting and reusing water from the shower and sink.

Another measure can be taken to reduce the effect, which is to discharge the effluent water of the RO-Plant at a place where there is a large enough current to disperse the water containing the higher salt percentage:

- Discharging the effluent water of the RO-plant using a tube to such a location where the current will disperse the water of a large area will mitigate the potential negative effect of salinity build-up.

Therefore the water will have to be pumped to Venus Bay. Because the amount of water needed at the Zeelandia (golf course) side is much larger, the RO-plant should be placed here. This will save on the amount of water that has to be transported.

The water in Venus Bay should be stored at least 10 m above the highest facility there, this way the water distribution at Venus Bay can be a free flow system. No pumps will be required in that case.

By using a more drought resistant grass specie, Seashore Paspalum instead of the more common Bermuda grass, 37.5% water can be saved. This is, on a yearly basis, 117,100 m^3. This will not just save water (and thus cost), but also means a smaller RO-plant can be constructed, which will cost less and the usage of electricity will be lower. Further the amount of reverse osmosis water will be reduced, thus decreasing the potential problems with build-up of salt around the island.

Remaining negative impact: The required amount of water for a golf course remains high. Because no natural fresh water is available on the island, reverse osmosis is always required. When the outlet for the reverse osmosis plant is placed at a point where the water is quickly dispersed there should be no significant remaining effect.

4.1.4 Land use

The amount of land occupied by the resort is significant, but cannot be mitigated. The northern sub-sector should be kept reachable. This can be done by creating a new route over the hills, or allowing everybody to enter the pass between Venus Bay and Zeelandia and thus the grounds of the golf resort. This is not uncommon, at least during the day resorts located on St Maarten also allow non-guests on their grounds.

Remaining impact: The resort will use around 4% of the total surface area of the island. Since large parts are already built-on area, or not suitable for construction, the area of land that would be suitable for other projects will be reduced by more then this 4%. With a high certainty there are however no projects that at the same location would be more beneficial to the island. The loss of land available for other projects remains significant however.

4.1.5 Electricity

The electricity usage of a resort is very high. Some large energy consumers are the air-conditioning and the heating of water for the tap or the shower. During most times of the year air-conditioning will be required; the electricity usage for this cannot be mitigated.

The bulk of the water to be heated will be shower water. This water does not have to be boiling hot, most people will take a shower with water no warmer then around 40 degrees at most. To save on electricity, a solar boiler could provide the water for the shower. A 9m^2 catchment area solar boiler costs about EUR10.558 to install[1]. In the Netherlands such a system can save around 3500 – 4000kWh/ year on electricity per one family household[2], or on average 4 persons. With 552 guests in the resort, this comes down, assuming the lower number of 3500kwh/ year, to a 483.000kWh saving per year. This means total electricity savings of about US$ 972,000. The total cost of installing water boilers would be US$ 1.9 million. That makes the use of solar boilers have a return on investment time of less than two years.

[1] http://iwssolar.ch/pages/solarthermik/sunrise2000/sunrise2000.html
[2] http://www.solar.ch/Solar-Boiler_System/Solar_Boiler.htm

To reduce the environmental impact and especially the use of diesel fuels and the emissions it causes, renewable energy sources could be used. Possible sources are wind, solar and wave energy. Since solar and wave energy are highly expensive, wind energy would be the most affordable solution. Using data gathered in Friesland, the Netherlands, four wind turbines could power the resort at moments when sufficient wind is available. An additional two would be needed as backup due to maintenance and breakdowns. 6 windmills could power the resort, backed up with 2 or 3 generators. This setup has a payback time of over 10 years.

Remaining negative impact: Even when windmills would be used, which is questionable seeing that they do not pay back very fast, significant amounts of non-renewable fuels are required to power the resort and course. Windmills could help to provide the resort with a "green" image and can possibly reduce the requirement for non-renewable energy by 50 to 75%.

4.1.6 Housing

There is a potential need for 165 apartments or single person housing and a further need for 124 houses for families. Because Statians living abroad are an important group that is being focused on, the actual need for housing will be lower. A number of Statians living off island already has a house on Statia. No records are kept about the amount of houses that are empty or the amount of Statians living abroad though.

The golf course will probably at first attract a large number of 'single' employees. They will require apartments. When they are staying on the island for a longer time they may want to move to family housing. The demand for apartments may therefore be getting lower, while the demand for houses may go up. It would therefore be justified to create houses in the first place and accept that housing will not completely fit the first inhabitants requirements, or to make the apartment buildings flexible. The flexibility means that the apartments should be easy to reconfigure into multi room apartments, suitable for more then one person. This requirement can be taken into account during the design process of the apartments at little or no extra cost.

The housing can be provided by the housing foundation, as long as they have a guarantee that the resort will be constructed. The housing can also be financed by the housing foundation.

On nearby resorts staff housing for ex-pats (people from abroad working on the resort) is available on the resort grounds. This could be done for the resort on St. Eustatius as well, however the revenue from these houses will then go to the resort. If housing is provided locally, for example by the housing foundation, the money will stay on the island.

Remaining negative impact: When enough houses are constructed, the increase in inhabitants will not pose any problems, they will be able to move to the island and work at the resort. Even though a lot of extra houses need to be built, the negative effect will be less then significant.

4.1.7 Finding and recruiting people

A 16% increase in population on the island is expected. The effect this has is both positive and negative. Planning their arrival in advance can mitigate negative effects like a shortage of housing. Building sustainably can partially reduce other effects like an increased demand for power.

It is assumed that around 655 Statians are living in the Netherlands. A large part of them will still be at school or are already on a pension. From those who are able to work at the resort, not all will want to return to St. Eustatius, because they have build a live in the Netherlands, have a good job they do not want to resign from, etc. If 5% would be willing to return that would fill 20 jobs. Assuming another 80 Statians can return from the other Netherlands Antilles and the USA and other countries, 100 additional jobs could be filled by Statians.

This would leave 230 jobs to be filled by non-Statians. The unemployment on the nearby islands, especially St Maarten, is high enough to provide even all employees for the golf resort. St. Maarten is highly multi cultural, a large group of the unemployed will be people from the surrounding islands, it can be expected that portions of the employees of the resort will therefore be from Dominica, the Dominican Republic, Guyana, etc. St. Eustatius is already multi ethnic, with residents from all of these locations, China and the USA and Europe. The aim should be to get as many Statians and residents of the Dutch Antilles to work at the resort, other groups will however most likely also be needed to get enough employees.

By supplying training to the unemployed Statians, looking for a job at the resort, they can be made to fit the job descriptions they can perform at the resort. The government should have a reserved attitude against immigration from people who are not living on the Netherlands Antilles. Employees from outside the Netherlands Antilles will most likely turn out to be necessary, but care should be taken that they do not take the bulk of the jobs and that the people from the Netherlands Antilles and Statia especially, do not miss out.

Remaining negative impact: No significant negative effects are expected due to the increase in population if mainly people originally from Statia and from the nearby islands of St Maarten and Saba find jobs at the resort.

4.1.8 Construction

The construction personnel from abroad will have to find housing for the duration of the construction project. Since this is temporary labour, they will not require a permanent house and will most likely not bring families. For the resort personnel there is a requirement of about 165 apartments. The construction personnel can use these same apartments. They will have to be ready before the first personnel from abroad is brought in though. Another option is to bring in barracks and house the personnel in these, near the construction yard. The first option should be stimulated however, because it will bring in additional income for the island (especially if the houses are financed and owned by local people).

The required 450-construction workers are not available on the island. Even if 50 of the unemployed Statians can be used as construction workers, there are still about 350 construction workers required. The number of workers can be reduced in two ways. Firstly by extending the period of time that the construction is allowed to take, for example from 2 years to 3 years, the amount of workers needed may well go down from 450 to 300. Assuming the same 100 construction workers and unemployed available on the islands, this would only leave a requirement for 200 foreign workers. This already assumes that the golf course and golf resort are constructed after each other and not at the same time.

Further, creating a planning based on the available personnel, it may be possible to rearrange the phasing of construction in such a way that fewer personnel is required. This could perhaps save another 10% on the staff, leaving 270 persons required to build the resort. 170 people would have to be brought in to the island.

Remaining negative impact: By default a construction project is temporary, any negative effects will therefore also be temporary. Temporary negative effects could be materials that have to be moved over the island from the harbour to Zeelandia and Venus Bay and noise pollution will most likely occur. No significant permanent negative effects are expected.

4.1.9 Environmental effects

Sea turtles and use of the beach for tourism can go together. There are two effects that need mitigation, which is the lighting near the beach and littering on the beach. The first should be minimized during

the nesting season by adjusting the location of the golf resort. By having the golf course at Zeelandia and the resort at Venus Bay the lights can be minimized around the beach at night.

By installing some litter bins on the beach and putting up signs to explain why it is important not to litter the amount of littering can be reduced. To maintain a clean beach for the guests it is also important to clear rubble originating from the sea. A clean beach is as much in the interest of the resort and its guests as it is to Stenapa and the Sea turtles.

To protect the sea turtle eggs, vehicles on the beach should be prevented. Walking or lying on the beach is no problem. Littering and damaging of nests could also be reduced by making tourists aware of the special wildlife in the area and explain how they can decrease their impact on them. This could be in the form of information boards, leaflets and warning signs.

For the Iguana the trees are important. As long as the trees can, to a large extend, be kept, there will be no danger to the Iguana. For this reason it would be advisable to create the golf course at Zeelandia, as it will require extensive landscaping. The resort could then be built in Venus Bay. Reviewing the current situation in Venus Bay, the chance that a significant number of trees have to be removed is small.

To lay out the golf course a large part of the fruit trees that can currently be found at the Zeelandia area have to be removed. Because the trees are currently holding back the water, removing them will increase the amount of runoff water and therefore increase the erosion problems at Zeelandia. By storing the water, short of the beach, in an infiltration pond the water will not reach Zeelandia beach, where it can do damage and this will have the added advantage that the water can be used for irrigation purposes and not be lost.

Herbicides will enter the groundwater and can flow to the sea. Here they can affect the sea life, like the coral and the sea turtles. There are a couple of measures that can be taken to prevent the herbicides to reach the sea. Firstly, according to STENAPA, the stronger the herbicides are, the faster they degrade. By a good drainage system, as mentioned in 1.1.2.2.5.4 the herbicides that enter the ground and are not used by the grass will be caught.

During periods of rainfall the herbicides could runoff with the surface water. This water should also be collected and send to the irrigation pond or storage tank. A strong herbicide will break down in just about 2 days.

For the construction of the golf course a large part of the vegetation that can currently be found at the Zeelandia area will have to be removed. Because the bushes and trees are holding back the water, removing them will increase the amount of runoff water and therefore increase erosion problems at Zeelandia. By storing the water in an infiltration pond, before it reaches the beach, it cannot create erosion damage. Replanting new bushes and trees around the golf course will also mitigate erosion.

Remaining negative impact: With the above measures, no significant negative effects for the environment are expected.

4.1.10 Law change

The current law blocks development in Venus Bay. An exemption of the law cannot be provided for any reason that a golf course with fit under.

The island government will have to change the law to make development possible. There are two possible solutions for changing the law. The first one is to eliminate the protected status of Venus Bay, as granted in article 5 of the ‘island regulation protection flora and fauna’. Another option is changing article 6 by including ‘economic and social development’ as reason for granting an exemption. To diminish worries about the impact, in article 6 there can also be included ‘sustainable economic and

social development'. This will make sure that the requesting party has thought about and can prove the sustainability of the project. This also ensures that the area is not spoiled, but can be used for the reason of social and economical development.

The law has been created by the local government and therefore can also be changed by the local government. They have indicated that when they are convinced that the golf resort project will be beneficial for the island they will change this law.

Remaining negative impact: If the law is changed then no negative impact remains, if the law is left unchanged then the effect is very significant, with the current law, no construction can take place in Venus Bay and no exemption can be granted for construction based upon this law.

4.1.11 Effects on current owners

Depending on the final design of the golf course, it may be necessary to remove houses. In case this should happen, the golf resort has a negative impact for these house owners, in the sense that they loose their home. They should obviously be well compensated, either financially or by providing a similar house in a different location on the island or both.

Houses in the Zeelandia area will see an increase in value, but may also see a deteriorating view and a limited amount of noise pollution. These cases should be individually reviewed and where appropriate, compensation may be given.

Remaining negative impact: If houses need to be removed, this is a negative impact for the families involved. Should this be required then this is a significant remaining negative impact.

4.1.12 Economical effects

A tax waiver, even if 'only' for the first 10 years, will cost the government a lot of income. Further research should be performed to methods by which the government can promote the development of a golf resort, but will not loose more then half of the income tax income, which is what a tax waiver would cause. A possibility may be that the government is participating as investor (for example by bringing in the land) and by other forms of public private partnership (PPP).

The majority of shareholders or investors for the resort will be foreign. This means that a lot of the money the resort generates will also go abroad. The challenge for the government and the private sector would be to keep as much of the money on the island. One way to do this is to make sure those tourist facilities and attractions are owned and operated by local entrepreneurs and not by the resort. For example if the resort would offer boat rental, the income would go to the resort and the money would go to foreign investors. If a local company would offer boat rental, the money would stay with the local company and thus on the island. This last situation is much better for the island. The government should promote the start-up of tourism related facilities and attractions for the tourism segment that the golf course aims for.

If additional attractions and services can spark the guests to spend another US$ 100 per person per day, this would in turnover tax alone add US$ 205,000 (assuming a 60% occupancy of the resort). If this money stays on the island, the economy increases with US$ 12 million. If 10% of this is profit, the profit tax income for the government would increase with US$ 420,000.

There are very few local products being produced. This means that the resort will have to buy all catering products from abroad. By creating local products additional jobs can be generated and money will stay on the island, instead of go abroad.

Another option to create additional income on the island would be to start a wholesale on the island. A wholesale could cater both to the existing business and supermarkets on the islands as well as the

resort. Next to additional income for the island a wholesale would also create new jobs. A similar resort gets large parts of its (fresh), up to 80%, products from the USA however. It would therefore not be certain that a wholesale could count on a large part of the purchases of a resort.

A big opportunity could also be fishery. In the waters around the island there is a lot of fish. Currently fish is brought in from as far away as Taiwan, local fishermen could catch fresh fish for the resort, but also for the local people.

On a limited scale, agriculture would also be possible and could supply the resort with fresh products like fruit and vegetables. A project is currently underway to start producing on a small scale; such projects should be supported to further improve the economy.

There will be additional cost for laying roads to and around the new houses for personnel. They are an onetime investments, although they will requires some maintenance over the years. The impact is not significant though. With more patients, the hospital will see increased income.

Remaining negative impact: No significant remaining effects

4.1.13 Waste

Plans already exist for privatizing the waste gathering and processing. By privatizing it is expected that the private company will find ways to recycle those parts of the waste that deliver money. It will potentially prevent a large part of the waste (for example green waste, glass, etc.) from ending up at the dump.

The resort can partially reduce the solid waste that it has to dispose of, for example by supplying their own bottled potable water from the reverse osmosis plant in glass bottles that are reusable. The remaining amount of waste will however still be significant and have a significant effect on the environment.

For the liquid waste a three-stage septic tank with an overflow into a reed land can filter black water to a quality where it can be returned into the environment. There are however restrictions to this system, for example the use of chemicals (for cleaning the toilets, etc) can damage the reed field. If such a system is chosen biodegradable-cleaning products should be used and notices should be given to tourists not to flush chemicals through the toilet or sink. If implemented successfully this system will however reduce the impact of the liquid waste to a less then significant effect.

Remaining negative impact: If the three-stage septic tank, reed field and the measures to prevent chemicals to be flushed down are implemented successfully this system will reduce the impact of the liquid waste to a less then significant effect.

For the solid waste some of the measures above can soften the impact. There will however be a significant increase in waste, which will put additional pressure on an already non-sustainable system. The additional waste is a significant negative effect for the environment and due to non-sustainable handling at the dump also a threat for the health of the people on the island.

4.2 Requirements review

At the start of the project a number of requirements for the golf resort project were gathered and constraints were set. With the whole project reviewed, the mitigation measures determined and the remaining impact known, the final question is whether the project meets the requirements set at the start of the impact analysis. This can be confirmed by checking the constraints that were set at the start of the project. If the project stays within the set constraints, it meets the requirements.

When this is done, it is determined that, taking into account the mitigation measures, the project does not meet all requirements. The attractions (0.5.3), including accommodations (0.1.1) and the required energy that has to be provided (0.6.1.2) are running into problems with sustainability. There are no plans or mitigation measures that can effectively solve the waste management problem. This means that over the coming 50 years waste will likely remain to be handled in a non-sustainable way. Diesel generators, using non-renewable energy, deliver the electricity.

Economically the requirement was to increase the income of the government by NAf. 11 million per year (0.2.1), thus solving the budget deficit. When tax and or land lease waivers are given this requirement cannot be met. Further investigation, for example into PPS constructions, has to be done to review if these constructions can for fill this requirement.

The government has no plans to stop or discourage ‘low cost’ workers from nearby islands to enter St. Eustatius by setting any limits, for example one on education minimums (0.3.1 and 0.7.2.2). This was part of the requirement to maximize the number of Statian and other Dutch Antilleans getting a job at the resort.

Requirement 0.7.2.1.1.4 states that potable, safe and clean water should be available to the employees of the golf resort. There is no water main on St. Eustatius and the private houses and apartments for new employees are therefore most likely build with a rainwater catchment system.

All requirements not mentioned above are met by the golf course project.

4.3 Golf Resort versus alternative projects

The golf course is a project within a program. The program is attempting to make the island more self-sustainable and less dependant on, mostly, the Netherlands. While this document focuses mainly on the golf resort project and its impacts, two other alternatives were reviewed for their main impact features.

The first option is always not to execute a project at all. The result of that would be an expected increase of hotel capacity by around 50 rooms in the next years, mainly for dive tourism. The creation of this hotel capacity will most likely not be enough to keep the Caribbean Sun airlines flight to St. Kitts and San Juan. A 50-room hotel, at 70% occupancy and at US$ 150 a night (average) would create a room tax alone of US$ 134,138. Most likely it will be get a tax exemption for other taxes for about 10 years. The hotel would deliver some jobs, how many really depends on the service that the hotel will want to deliver.

The second option is to create an ecological resort, comparable to Saba, but larger. Eco tourism, like golf tourism, is a rapidly growing market. If 50 eco-lodges would be created, there would be space for 200 tourists. This would be a large enough market to keep the Caribbean Sun airlines connection. At a cheaper US$ 85 per cabin per night, the room tax income would only be around US$ 100,000 per year. For this facility as well tax exemption for the other taxes are expected for about 10 years. The eco-resort would deliver around 34 jobs.

The golf resort will consist of 156 rooms, and 40 condominiums. In total this gives capacity for 552 guests on the island. These guests would be willing to pay substantially higher prices per night. Even at a moderate price level of US$ 695 per night, the yearly income due to the taxes for the government could be around US$ 7.8 million. More realistically the resort and the government will negotiate about the amount of money the resort has to pay. In the worst case the resort will get a full exemption for the profit tax and the land lease, which leaves a tax income of US$ 3.4 million. A public private partnership may be a solution to reduce the load on the golf resort, but still give the government a good income from the resort. The Caribbean Sun airlines connection would most definitely stay; in fact the increased requirement for transport may spark more frequent or more direct flights and larger aircraft to operate to the island. The project would create around 530 jobs.

The resort would create a large amount of waste, at the moment waste is not handled in a sustainable way and there is no reason to assume that this will change if the golf resort is build. This means that a substantial additional amount of waste will be dumped on the island, posing an ever-growing risk at contaminating the ground water and water around the island. The resort will use a large amount of electricity. Windmills can partially create the required amount of energy, but it is unlikely that the resort will install windmills, due to the long payback time. The resort therefore will likely use a large amount of non-renewable energy.

The land use of a golf resort is very large as well; it will use Venus Bay and most of the Zeelandia area. Finally a big potential negative effect could be way the income is distributed. There are no services and facilities aimed at the upscale tourism market; currently they are more aimed at the dive-tourism and eco-tourism segment. This gives the risk that the golf resort will decide to run all the services and facilities by themselves. Virtually all the money spent by the guests will then go to the resort and therefore to the foreign investors. When facilities and services are provided by local people the impact on the economy of the island will be much larger, as the money is kept on the island. The island government should focus on this point, as the question about the amount of impact that the resort will have very much depends on the amount of money that can be kept on the island by providing services and facilities to resort tourists, independent of the resort itself.

From the three projects, the golf course creates by far the largest economical impact. With 530 jobs, it would be the largest employer on the island, potentially reducing the unemployment to a figure near 0. The golf resort will also have the largest negative effects, mainly in the fields of waste management,

non-renewable electricity and the high land use. The direct (tax and land lease) and indirect effect of the golf course far exceeds to other two projects. The economy off the island will get a boost from tourism, especially if also local people start providing attractions and services to the golf resort tourists. When no cuts would be made in the amount of tax that the golf resort needs to pay, this project does succeed in achieving the program goal of creating a self-sustainable island, for which US$ 6.1 million in tax income is required. The likely exemptions will however in the worst case bring the income back to US$ 3.4 million, in which case the project brings the budget deficit of the government back by about 55%. The other projects both deliver only around US$ 56,000, which is negligible compared to the budget deficiency. A PPP construction should be found that would increase the government's income above the worst-case scenario of giving an exemption of profit tax and land lease for the first 10 years, preferably in such a way that the income for the government would be around the required US$ 6.1 million.

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Appendix I – Functions to system solutions:

Number	Functions	Hidden Evident Frill	Attributes (Must have, Want to have, Ignore) Constraints System solutions
0.1.1	Provide accommodation (for golf resort)	E	**Attributes:** Luxurious (W), discreet (W), two-stories (W), theme (I), complete (I), **5-star+ (M), Sustainable (M)** Provide accommodation facilities for the golf resort of a quality that is to be expected of a golf resort with a 5-star+ rating that is sustainable over a period of at least 50 years. **Constraints:** • 5-star+ • Sustainable for a minimum of 50 years **System solution:** • 5-star+ hotel [1.1.2.2.4.1] • 5-star+ condominiums [1.1.2.2.4.2]
0.1.2	Provide eating facilities (for golf resort)	E	**Attributes:** Luxurious (W), discreet (W), two-stories (W), theme (I), **high quality (M)**, good choice (W), fine drinks (W) Provide eating facilities for the golf resort of a high quality, which means the option to select from different facilities and providing a high standard (5-star^{+} quality). **Constraints:** • Full catering facilities • High quality **System solution:** • Catering facilities [1.1.2.2.7]
0.1.3	Provide health care facilities (for golf resort)	E	**Attributes:** Personal (I), luxurious (I), service (W), **basic healthcare service (M)** Provide medical care, which is able to give basic healthcare and first aid and make sure arrangements are in place to be able to quickly transport clients to the islands or other nearby hospitals. **Constraints:** • Ability to provide basic health care • Ability to provide first aid • Agreements with local hospital • Agreements with other hospitals and transport services **System solution:** • Doctors office [1.1.1.3.1] • Hospital/ Airlift agreements [1.1.1.3.3]
0.1.4	Create golf resort	E	**Attributes:** **18-holes (M)**, challenging (W), using landscape (I), nice views (I), luxurious (W), discreet (W), two-stories (I), theme (I), high quality (W), good choice (I),

			fine drinks (W), **service (M), Low water usage (M),** Renewable water source (W), **Sustainable (M)** Create a golf resort with a minimum of 18 holes, which is woman friendly, has a high service level, meaning a golf shop, practice drive range and putting greens and has pro's in house as well as a restaurant and clubhouse. Finally it has to be sustainable over a period of at least 50 years. **Constraints:** • 18-holes or more • Golf shop • Practice driving range, putting greens • Pro's in house • Restaurant • Clubhouse • Sustainable for 50yrs or more **System solution:** • 18-hole golf course [1.1.2.2.5] • Golf shop [1.1.2.2.5.1] • Driving range [1.1.2.2.5.2.1] • Putting greens [1.1.2.2.5.2.2] • Restaurant & Clubhouse [1.1.2.2.5.3] • Water plant [1.1.1.2]
0.2.1	Increase tax revenues	H	**Attributes:** **Airport tax (M), Income tax (M)**, **Tourist tax (M)** Increase the tax incomes resulting from the airport, income and tourist tax. **Constraints:** • Increase revenue from taxes, preferably up to or above current budget deficit (NAf. 11 million). **System solution:** • Offer tourist attractions [1.1] • Support current businesses [1.0] • Create new businesses [1.0] • Island promotion material [1.2]
0.2.2	Decrease unemployment	H	**Attributes:** **Statians (M)**, hidden unemployment (Government) (W)**, Sustainable (M)** Decrease unemployment by getting Statian people to work for the golf course or for the companies that will be started or grow due to the golf resort's existence **Constraints:** • Decrease unemployment, no amount set • Make sure this happens in a sustainable way so in 50yrs there is still a decreased unemployment due to this project. **System solution:** • Offer tourist attractions [1.1]

			• Support current businesses [1.0] • Create new businesses [1.0] • Island promotion material [1.2]
0.3.1	Increase inhabitants	H	**Attributes:** **Statians living abroad (M)**, United States (W), Europe (W), not low cost countries like the Dominica (I)**, Sustainable (M)** Increase the number of people living on the island by creating jobs to attract Statians living abroad and make sure the increase in inhabitants is in a sustainable way, which means that the increase will still be there in 50yrs. **Constraints:** • Growth should mainly come from Statians living abroad supplemented by people from the Dutch Antilles and nearby islands. • Limit the amount of "low cost" workers by setting education limit for immigration • Make sure this happens in a sustainable way so in 50yrs there are still an increased number of people living on the island. **System solution:** • Support current businesses [1.0] • Create new businesses [1.0] • Attract unemployed Statians [3.2.1] • Set education minimums for immigration [1.4.1]
0.3.2	Promote island	E	**Attributes:** **Golf course (M)**, **island promotion (M)**, hiking (W), golden rock (W)**, Sustainable (M)** Promote the golf course and the island in a sustainable way by attracting the right type of tourists and not mass tourism. **Constraints:** • Do not attract mass tourism, attract the upper class of the tourist industry • Promote the island as to encourage sustainable tourism taking place **System solution:** • Island promotion material [1.2]
0.4.1	Ensure accessibility	H	**Attributes:** Airport (W), harbour (W), **taxi (M)**, private jet (W), private yacht (I) Ensure accessibility of the island by providing taxi service to tourist **Constraints:** • Increase the taxi service on the island so guests can be transported from and to the point of entry and across the island. **System solution:** • Offer tourist attractions [1.1] • Offer shuttle service [1.1.1.4]
0.4.2	Upgrade airport	E	**Attributes:** Comfortable (W), drinks (W), dinner (W), VIP room (W), safe (W), promote tourism (W), Business jet parking, **taxi / transfer service (M), Sustainable (M)**

			Upgrade the airport with a taxi service and or a transfer service to the resort and make sure the airport is sustainable. **Constraints:** • Provide a taxi/ transfer service from the airport to the resort • Provide an airport that will ensure a sustainable operation of the resort for at least 50 yrs. **System solution:** • Offer tourist attractions [1.1] • Offer shuttle service [1.1.1.4]
0.5.1.1	Offer Tennis court	H	**Attributes:** Large (W), **safe (M)**, clean (W), big (W), tropic (W), cool (W), good surface (W)**, Sustainable (M)** Offer four tennis courts that are safe and make sure they are sustainable for at least 50yrs. **Constraints:** • Four tennis courts • Safe and sustainable for at least 50yrs. **System solution:** • Tennis court [1.1.2.2.3] • Tennis equipment rent [1.1.2.2.3.2]
0.5.1.2	Offer swimming pool	H	**Attributes:** **Safe (M)**, large (W), **clean (M)**, **supervised (W)**, renewable energy sources (W), **limit water use (M)**, **Sustainable (M)** Offer a safe, clean swimming pool, that is limited in the use of fresh water and is sustainable for at least 50yrs. **Constraints:** • Offer at least a 500m^2-pool • Limited use of water • Sustainable for 50yrs • Supervised **System solution:** • Swimming pool [1.1.2.2.2]
0.5.2	Create Beach	H	**Attributes:** Clean (W), sandy (W), white (I), **safe (M)**, large (W), offer drinks (W), **offer lifeguard (M)**, renting equipment (I), let out seats (I), let out boats (I) Offer a safe beach, with lifeguard service. **Constraints:** • Lifeguard service • Block dangerous currents **System solution:** • Beach [1.1.2.1]
0.5.3	Create attractions	F	**Attributes:** **Safe (M)**, fun (W), **for target group (M), Sustainable (M)**

			Create other attractions that are safe and intended for the target group and that are sustainable for at least 50 years. **Constraints:** • Intended for the target group, which is the upper class of the tourists. • Sustainable for at least 50 yrs. **System solution:** • 5-star+, 18 holes golf resort [1.1.2.2] • Beach [1.1.2.1]
0.6.1.1	Provide water	H	**Attributes:** **Potable (M)**, **clean (M)**, cheap (W), **reliable (M)**, cold (W), **safe (M), Sustainable (M)** Provide a reliable source of water, which delivers potable, clean and safe water in a sustainable way for at least 50 yrs. **Constraints:** • Potable, reliable, safe and clean water source • Sustainable for at least 50 yrs. **System solution:** • Water purification plant [1.1.1.2] • Water catchment/ pump [1.1.1.2.1] • Water testing [1.1.1.2.2] • Water storage [1.1.1.2.3] • Water distribution [1.1.1.2.4]
0.6.1.2	Provide electricity	H	**Attributes:** Renewable (W), **reliable (M)**, 110v 60hz (W), clean (W), cheap (W)**, Sustainable (M)** Provide reliable energy that is sustainable for at least 50yrs. **Constraints:** • Reliable 99% uptime. • Sustainable for at least 50 yrs. **System solution:** • Reliable power plant [1.1.1.1.1] • Backup power plant [1.1.1.1.2]
0.7.1.1.2	Increase facilities	H	**Attributes:** Supermarkets (W), shops (W), Restaurants (W)**, Sustainable (M), Upscale market (M)** Increase the facilities aimed for tourists from the high end of the tourist market on the island in a sustainable way. **Constraints:** • Increase the upscale facilities on the island • Sustainable for at least 50 yrs. **System solution:** • Increase facilities

0.7.1.1.3	Increase services	H	**Attributes:** ATM's (W), airport (W), **taxi (M)**, bicycle rent (W), car rent (W), harbour (W)**, Sustainable (M)** Increase the services on the island sustainably, offering at the very least an improved taxi service around the island. **Constraints:** • Increase the services on the island. • Sustainable for at least 50 yrs. **System solution:** • Offer tourist attractions [1.1] • Offer taxi service [1.1.1.4]
0.7.2.1.1.1	Provide housing (new inhabitants)	H	**Attributes:** Cheap (W), near site (W)**, Sustainable (M)** Provide sustainable housing **Constraints:** • Sustainable housing for at least 50 yrs. **System solution:** • Private houses [1.4.1.4]
0.7.2.1.1.2	Provide schools (new inhabitants)	H	**Attributes:** Good quality (W)**, Sustainable (M)** Sustainably provide schooling **Constraints:** • Sustainable schools for at least 50 yrs. **System solution:** • Extra classrooms [1.4.1.2] • Extra staff at schools [1.4.1.3]
0.7.2.1.1.3	Provide electricity (new inhabitants)	H	**Attributes:** Renewable (W), **reliable (M)**, 110v 60hz (W), clean (W), cheap (W)**, Sustainable (M)** Sustainably provide electricity which is reliable **Constraints:** • Reliable, 99% of the time. • Sustainable for at least 50 yrs. **System solution:** • Power plant [1.1.1.1.1] • Backup power plant [1.1.1.1.2]
0.7.2.1.1.4	Provide water (new inhabitants)	H	**Attributes:** Potable (W), **clean (M)**, cheap (W), reliable (W), cold (W), **safe (M), Sustainable (M)** Sustainably provide water that is reliable, safe, clean and potable. **Constraints:** • Potable, safe and clean water • Sustainable for at least 50 yrs.

			System solution: • Water catchment/ pump [1.1.1.2.1] • Water storage [1.1.1.2.4]
0.7.2.1.1.5	Provide health care (new inhabitants)	H	**Attributes:** Personal (I), luxurious (I), service (W), **basic healthcare service (M), Sustainable (M)** Sustainably provide basic health care. **Constraints:** • Ability to provide basic health care • Ability to provide first aid • Agreements with local hospital • Agreements with other hospitals and transport services **System solution:** • Doctors office [1.1.1.3.1] • Hospital/ Airlift agreements [1.1.1.3.3]
0.7.2.1.2	Attract local workers	H	**Attributes:** Unemployed (M), government workers (M)**, Sustainable (M)** Attract local workers sustainably by providing jobs and training to make Statians have to opportunity to reach all positions within the organization. **Constraints:** • Attract local workers, reduce firstly the unemployed, secondly reduce the surplus government workers • Provide training to make sure Statian involvement is sustainable. **System solution:** • Training program [3.3.2] • Attract unemployed Statians [3.3.1]
0.7.2.2	Maintain crimelessness	H	**Attributes:** **Statians (M)**, Statians living abroad (W), US (I), EU (I) Maintain crimelessness by attracting mostly people from Statia and Statians living abroad. **Constraints:** • Attract Statians and Statians living off-island • Discourage others to come to the island by setting education standards **System solution:** • Set education standard for immigration [2.6] • Attract Statian workers [3.2.1]
0.7.2.3	Maintain quietness	H	**Attributes:** **Invisible (M)**, discreet (W), **separated (M)** Maintain quietness (and the laidback culture) by separating the resort and making it as invisible as possible from the island. **Constraints** • Physically separate resort from the main populated areas on St. Eustatius

			System solutions: • Remote location [2.8]
0.7.3.1	Protect Iguana	H	**Attributes:** **Protect trees (M)**, **inform tourists (M), Sustainable (M)** Protect the Iguana in a sustainable way by protecting the trees they feed on and live in, as well as by informing tourist about the presence and the need for protection. **Constraints:** • Protect the iguana trees and the iguana sustainably over the next 50yrs from any damage the golf resort may pose to it. • Inform public about Iguana **System solution:** • Protect iguana trees [2.3.1] • Environmental information program [2.2]
0.7.3.2	Protect Coral	H	**Attributes:** **Ensure water quality (M)**, **inform tourists (M), Sustainable (M)** Protect the Coral in a sustainable way by ensuring the water quality does not get outside the tolerance of coral for a period of at least 50 yrs, as well as by informing tourist about the presence and the need for protection. **Constraints:** • Protect the coral sustainably over the next 50yrs from any damage the golf resort may pose to it. • Inform public about Coral and its protection **System solution:** • Discharge clean effluent water [2.5.1] • Environmental information program [2.2]
0.7.3.3	Protect Fishery	H	**Ensure water quality (M)**, prevent toxic entering the water (W)**, Sustainable (M)** Protect the sustainability of the local fishery by ensuring the water quality does not get outside the tolerance of fish for a period of at least 50 yrs. **Constraints:** • Protect the fishery over the next 50yrs from any damage the golf resort may pose to it. **System solution:** • Discharge clean effluent water [2.5.1]
0.7.3.4	Protect Sea turtles	H	Protect beach (W), **inform tourists (M)**, **protect eggs (M)**, **limit seashore lights (M), Sustainable (M)** Protect the Sea Turtles in a sustainable way, by informing the tourists about the presence of these animals and by protecting their eggs for a period of at least 50yrs. **Constraints:** • Limit seashore lights • Protect eggs on the beach for at least 50 yrs.

			• Information program for the tourists **System solution:** • Discharge clean effluent water [2.5.1] • Egg protection program on beach [2.1.2] • Lighting setup to prevent seashore lights [2.1.1] • Environmental information program [2.2]
0.7.3.5	Fit (golf course) in environment	H	**Use landscape (M)**, limit landscaping (W), use island materials (W)**, Sustainable (M)** Fit the golf course into the environment in a sustainable way by using the existing landscape and by preventing erosion or other damages to the landscape a golf resort may bring about. **Constraints:** • Use existing landscape, which means only a limited amount of landscaping. • Prevent erosion of the landscape due to interference creating a sustainable landscape for at least 50 years. **System solution:** • Erosion prevention [2.7] • Design to fit landscape [2.7.1] • Use existing flora and fauna [2.7.2]
0.7.3.6	Change law	H	Unbiased (W), completely (W), all effects (W), **Sustainable (M)** Change law to unblock the Venus Bay area for economic development, but do so in a way that allows for sustainable development of the area and does not spoil it. **Constraints:** • Change law, in such a way that development for an economic purpose is allowed, but sustainable development of the area is mandatory. **System solution:** • Change law [2.6]

Appendix II - Rainwater availability

Rainwater is free source of fresh water; it will automatically irrigate the grass without any technical requirements. Rainwater is also a sustainable source, in the sense that it will be available in the future as well. The availability of rainwater is, obviously, not constant though. The average rainfall at the island of St. Eustatius over the period 1971 – 2000 is displayed in table 2 below.

St. Eustatius, Roosevelt Airport (1971-2000)														
Element	**Unit**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Avg. Rainfall	mm	52	50.5	48.8	55.7	87.1	60.6	74.1	106.9	123.2	106.5	128.6	74.6	985.8

Table 2 – Source: Meteorological service of the Netherlands Antilles and Aruba

The above table shows an average annual rainfall of 985.8mm at St. Eustatius Roosevelt Airport. The average rainfall does not say anything about the extremes though. It is therefore necessary to find a statistically certain amount of rainfall, which will be available monthly or yearly.

With statistics it is required to select a certainty. For the calculation of the rainfall per month, a certainty of 95% will be used. This means that it is 95% sure that the amount of rain calculated will be reached or surpassed for the month. This also means that in 5% of the cases there will be less than the calculated amount of rainwater available.

To calculate the amounts, more information is needed about the actual rainfall over a period of several years. Unfortunately the underlying data of the averages of table 2 is not available. There is however data available from the period 1919 – 1937. Because there is no reason to suspect that the amount of rainfall will have changed substantially over the last century, this data should still be valid. It is shown in table 3. The data is taken at a different place on the island; Oranjestad instead of the airport. This may explain the different average yearly rainfall, which in this case is 1087,67mm (measured over the years where complete data is available).

St Eustatius, Oranjestad														
Year	**Unit**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
1919	mm	66.7	13.6	116.5	102	23	88.4	39.5	33	142.5	299.4	219	X	1143.6
1920	mm	28.5	95	55.3	2	30.4	41.2	42	59.4	102	172.2	115.5	54	797.5
1921	mm	125.2	86.9	96.6	46.2	46.2	22.4	144.5	94.7	109.7	148.3	86.7	66.6	1074
1922	mm	33.1	53.9	73.7	31.2	30.8	93.4	96.8	121.4	149.4	156.7	55	85.6	981
1923	mm	31.4	48.6	125.6	30.7	50.3	171.8	138.7	136.6	63.9	279.3	54.7	50.9	1182.5
1924	mm	75	88.4	5	68.9	113.4	79.2	128.3	175.1	132.6	171.5	51.5	82.8	1171.7
1925	mm	36.8	20.6	28	96	36.4	74.4	58.5	90.3	131.8	181.7	73.5	9.5	837.5
1926	mm	71	86	41	47.3	154	179	76	143	198.2	118	182.2	90	1385.7
1927	mm	X	18.6	X	108	76	81	218	46	62	81	158	64	912.6
1928	mm	32	58	134	20	20	89	75	99	85.2	176.5	38	68	894.7
1929	mm	61.5	39	65.4	19	94	158	134	109.5	159	107	146	115	1207.4
1931	mm	12.5	46	26	97	114	69	82.3	125.9	46.5	66.5	208.6	144.6	1038.9
1932	mm	130	26.2	38.5	104.2	36.8	121	134.8	181.8	122	206.5	414	94	1609.8
1933	mm	73	18	58	66	77.5	32.9	150.7	41.1	306.5	42	107	177.3	1150
1934	mm	94.4	33.5	110.9	17.8	35	22.7	101.4	201.6	155.9	66.6	189	136.1	1164.9
1935	mm	76	52.5	21	51	52.5	76	115	81.8	93.6	176	204.2	68.5	1068.1
1936	mm	71.5	75	3	23	101.5	38.5	160	136.3	105	143.5	126	110.3	1093.6
1937	mm	171	31	16	48.5	33	48	39.6	127.8	42.5	94	63.1	30.9	745.4

Table 3 – Source; KNMI 1919 – 1937

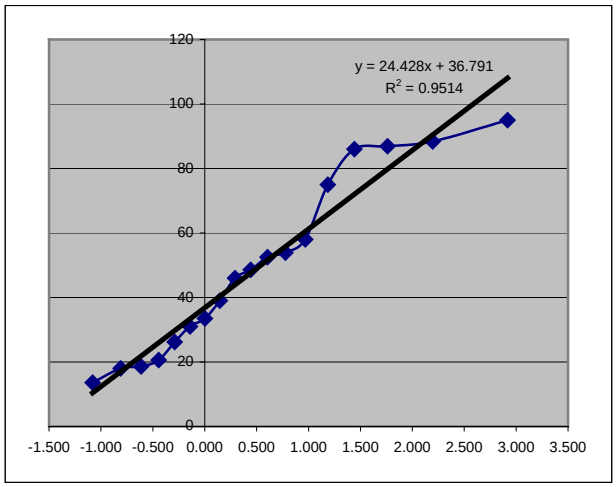
Using the statistic gumbel distribution the 95% certain rainfall per month can be calculated [Smink 2004]. The following formula is used;

$$\tau = -\ln\left[-\ln\left[i/(n+1)\right]\right]$$

For the month February the calculation is as follows:

F(X) = i /(n+1)	T = -LN(-LN(F(X)))	Rainfall February
0.053	-1.080	13.6
0.105	-0.812	18
0.158	-0.613	18.6
0.211	-0.443	20.6
0.263	-0.289	26.2
0.316	-0.142	31
0.368	0.001	33.5
0.421	0.145	39
0.474	0.291	46
0.526	0.443	48.6
0.579	0.604	52.5
0.632	0.778	53.9
0.684	0.969	58
0.737	1.186	75
0.789	1.442	86
0.842	1.761	86.9
0.895	2.196	88.4
0.947	2.918	95

Table 4



Graph 1

The figures are placed in a graph and using linear regression the formula of the black line is calculated. This is 24.428T + 36.791. This T for a certainty of 95% is –ln(-ln(0.05)) = -1.097. The 95% certain rainfall in February can then be calculated: (24.428 · -1.097) + 36.791 ≈ 10mm. For the other months the same calculation has been performed. The 95% certain rainfall is shown below:

Jan	Feb	Mrt	Apr	Mei	Jun	Jul	Aug	Sep	Okt	Nov	Dec
8.239	9.989	0.000	4.381	5.848	11.873	36.525	40.201	32.883	47.136	7.358	31.266

Table 5

These values can be used as the minimum available rainfall per month. The lowest rainfall is in March, with no rainfall at all; the highest rainfall is October with a 95% certainty of 47mm. Using the same calculation, the 95% certain yearly rainfall (calculated over the years with full data available) is 764.8mm.

The conclusion of this calculation is that, with a certainty of 95%, the yearly rainfall will be 764.8mm or more. With the same certainty, the minimum monthly rainfall is as is indicated in table 5. Note that the sum of the 95% monthly rainfall is only 235.7mm. As calculated the yearly rainfall is 764.8mm, which means that even though some months can be very dry, the yearly rainfall will still be relatively high.

Appendix III – Water system:

This study will review the provisional design of the water system for the resort. It will make a choice between different sources of water to reach a durable water delivery solution. To achieve this solution the following questions will be answered:

What are the necessary water quantities?
What are the water sources and how much can they sustainably provide?
Can a sustainable water system for the resort be created and what would it look like?

What are the necessary water quantities?
The necessary water quantities have been determined in the impact analysis to be the following:

- Potable water: 74.2 m^3 / day
- Grey: 37 m^3 / day
- Irrigation: (depending on type of grass)
  Seashore paspalum grass: 220,643m^3 / year (max: 1,567 m^3 / day)
  Bermuda grass: 337,714 m^3 / year (max: 2,507 m^3 / day)

What are the water sources and how much can they sustainably provide?
Water sources that are available on the island are:

- Rainwater
- Seawater
- Groundwater
- Waste water
- Existing RO-plant (Reverse Osmosis)

Rainwater
The availability of rainwater is unpredictable; there is no certainty when rain will fall. A yearly or monthly figure can be calculated however. For St. Eustatius this has been done in appendix II. For the calculation, a certainty of 95% was chosen. This means that it is expected that only in 5% of the years there will be less rainfall then 764.8mm per year.

Rainwater is ideally suited for use as irrigation water and with the right treatment as drinking water.

Rainwater availability depends on the catchment area. On a solid surface, like concrete roads, or roofs, 90% of the rainwater can be collected. On soft surfaces, like grass or the golf course, about 50% of the water will infiltrate immediately. Only about 25% can be collected.

The following amounts can be used:

- Direct infiltration on the golf course will be: .5 · 764.8 mm = 382.4 mm, with 201,500 m^2 of golf course surface, this means a yearly amount of 77,053 m^3 direct infiltration.
- Collectable rainwater from soft surface: .25 · 764.8 mm = 191.2 mm, 25% of the water of the golf course will runoff and can be stored in an irrigation pond. This is 38,526.8 m^3 yearly.
- Runoff from ground outside the golf course: .10 · 764.8mm = 76.48 mm, the area around the golf resort in Zeelandia can be landscaped in such a way that the rainwater will partially runoff into the irrigation pond. To be on the safe side only 10% is considered to runoff, this will most likely be higher. With a remaining area of 195,400 m^2 the runoff will be 14,940 m^2.
- Rainwater from roads and rooftops: .90 · 764.8 mm = 688.3 mm. There is about 6,400m roadway, following the courses. If the road on average is 4.20 m wide (including a gut to transport the water to the pond), the surface would be 26,880 m^2. This would deliver 24,192 m^3 of water for the irrigation pond.
- Rainwater falling on water: 1.0 · 764.8 mm = 764.8 mm
  depending on the size of the irrigation pond, 764.8 mm of rainwater would yearly be added to the pond. The evaporation from the pond however is as high as 2,190mm per year.

77,053 m^3 is available for direct infiltration. This will happen regardless of any irrigation solution. From roofs, roads and run-off, another 77,660m^3 is available. This amount would have to be stored in an irrigation pond. Because it is unsure when the rain falls, the full amount has to be able to be stored in this pond. Suppose this pond is 5m deep on average, it would measure 125 by 125m.

Seawater
Seawater is available in unlimited quantities. A large problem however is the salinity of seawater. On average there is about 3.5% salts in the water. If no desalination takes place, the salt makes this water unfit for consumption or irrigation. It could be used for the toilet, so as source for grey water. For seawater catchment a pump would be required. If desalination takes place it would most likely be with a reverse osmosis plant, which converts seawater into (nearly) salt free water. A 1,500 m^2 RO-plant uses around 4.2 kWh per cubic meter of water produced[3]. In the case of Seashore paspalum it would be around 924,494 kWh per year (2,533 kWh/ day average), in the case of Bermuda grass, it would be 1,415,021 kWh per year (3,877 kWh/ day average).

Groundwater
Due to the size of the island, groundwater is limited. Since the solid waste is dumped in a landfill and the toilet and other wastewater of houses is also dumped into the ground, the groundwater is either already or will in the future be of a very poor quality. For both these reasons, groundwater should not be used as it is not sustainable or of reliable quality.

Wastewater
Wastewater can be reused. For example water that was used for the shower or the sink is clean enough to be reused in the toilet. The daily production of grey water, which is the water from the shower and sink, is 70.85m^3. Using wastewater for the toilet will reduce the demand on other sources of water, which increases the sustainability. Since no sewer or sewage treatment plants are available on the island, the black wastewater will also have to be treated on the resort. After treatment this water can also be reused (40.35m^3).

Existing reverse osmosis plant
The existing reverse osmosis plant has a capacity of 250 m^3 per day of potable reverse osmosis water. At the moment only a small number of offices and hotels that are located on the Caribbean sea coast are connected to the plant. A plan to lay water pipes up to some parts of the island and connect more houses to the plant exists. The 250 m^3 is far too little for the golf resort, so this is no source that can be used.

Can a sustainable water system for the resort be created and what would it look like?
Seen over a full year, the direct rainwater infiltration on the golf course would be 77,053m^3. This happens in all cases. This would leave 143,590 m^3 to be supplied by other sources in the case of Seashore Paspalum and 260,661 m^3 in case of Bermuda grass. For the resort 74.2 m^3 of potable water and 37 m^3 of grey water would be required.

The maximum capacity of the irrigation water supply has to be 1,567 – 2,507 m^3 / day. These quantities cannot be delivered by a rainwater system without extensive landscaping. The choice here has to go to a system that uses reverse osmosis water. The Temenos resort that is currently build on Anguilla for example uses an RO-plant[4] that produces up to 4,732 m^3 of water per day, of this amount, a maximum of 1,817m^3 can be produced as drinking water, with the remaining part used for irritation. For the golf resort on Statia a reverse osmosis plant could produce the required 74.2 m^3 of potable water and 1,567 – 2,507 m^3 of irrigation water from seawater. The maximum capacity should then be around 1,800 – 2,850 m^3 / day. At an energy usage of 4.19 kWh per m^3 of water, this would give an electricity usage of 715,120 – 1,205,648 kWh / year. If taken from the net, that would cost NAF. 107,535 – 181,114 / year.

[3] http://www.desalco.ky/d-pdfs/valley.pdf
[4] http://www.tsgwater.com/client_9.htm

Constructing an infiltration pond could reduce the amount of required water. 77,660m^3 is available for storage; this would be a lake, 5m deep, and 125 by 125m. If constructed, 34,219 m^3 will evaporate from this lake yearly, 11,950 m^3 will be added by rainfall. The total yearly available amount from this lake will therefore be 55,481 m^3. This means an annual saving of US$ 4,600. It is therefore not economically feasible to construct a large lake for a relatively small saving. A smaller lake should still be used to catch excess irrigation water, so it can be reused.

The grey water could be provided by either the rainwater from the roofs of the houses, or by the effluent water from the tap and the shower. The first source will deliver about 11,203 m^3 of water, or 30.7 m^3 daily. The 2nd source will deliver around 74m^3 daily. This together is more then enough to provide a sustainable source for grey water, which is to be used in the toilet.

Conclusion

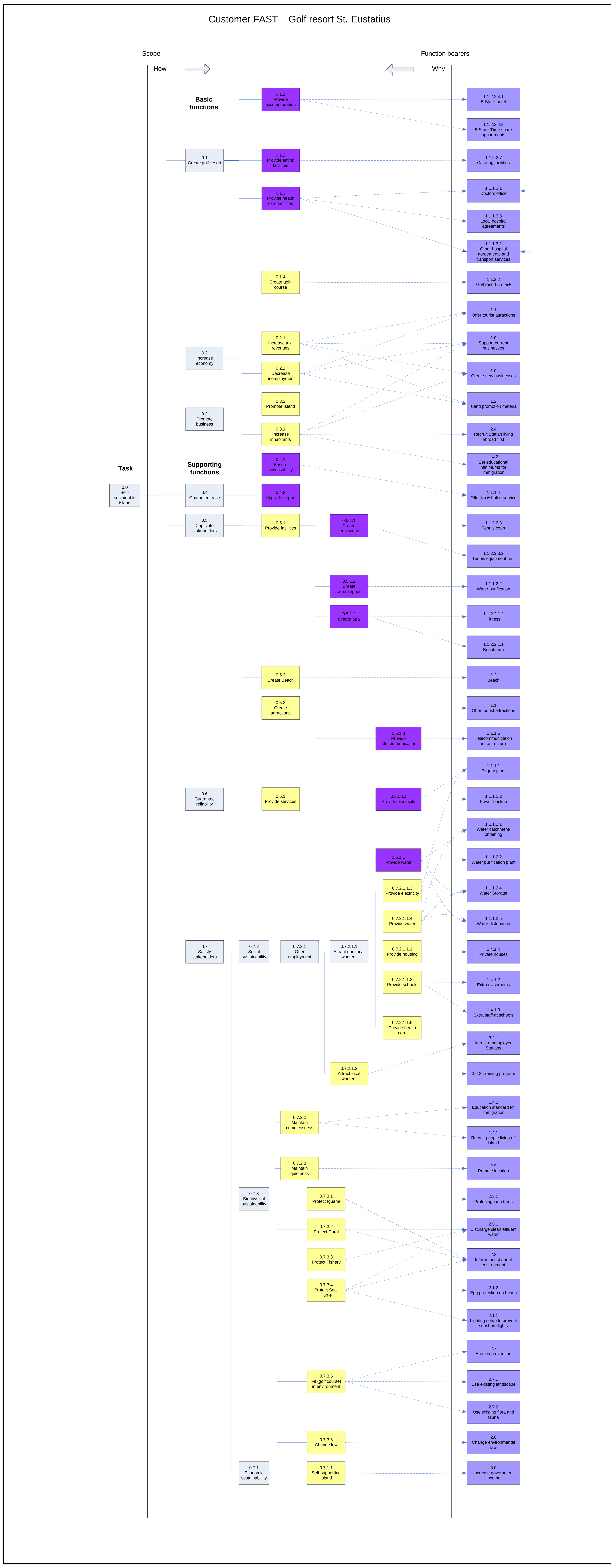
No matter what kind of grass is chosen, the irrigation will always have to rely for a large part on a RO-plant. The RO-plant will also provide the resort with drinking water. If the Bermuda grass is used, a RO-plant is needed with a maximum capacity of around 2,850m^3 per day. The yearly cost for powering this installation are expected to be around US$ 100,650 per year. A large saving could be the use of Seashore Paspalum instead. This grass uses about 34% less water. The maximum capacity of the RO-plant in that case could be 1,800 m^3 / day. The electricity consumption per year would be around US$ 59,750. Creating a large irrigation pond would save around US$ 4,623 annually. The resorts grey water supply, for flushing the toilet, can be provided by collecting the water from the shower and rainwater from the roofs.

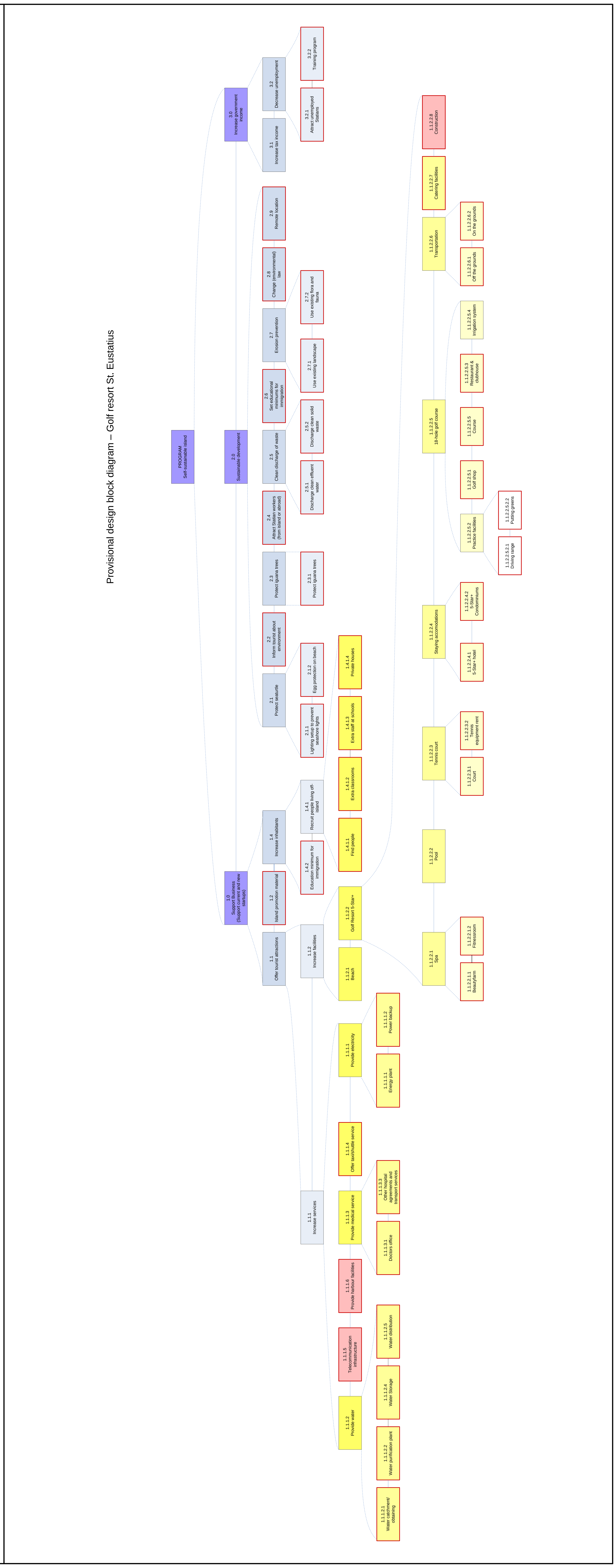
Appendix IV - Definitions:

Sustainable	Able to be continued indefinitely without a significant negative impact on the environment or its inhabitants www.weblife.org/humanure/glossary.html

Appendix V - References:

Benevolent foundation (USA)	Mr. W. Berkel – Director
Census Office	Mr. D. Simmons, Census Office
Dienst Openbare werken (Public works)	Mr. M. Timber, D.R.O.B. Executive
Eutel	Mr. G. Berkel, Managing director
GEBE (Electricity company)	Mr. F. Cuvalay, GEBE Executive Mr. P. Pompier, GEBE Mr. P. Ideler, Distribution manager GEBE
Goldenrock elementary school	Mrs. D. Brown, School principal
Government of Anguilla (Anguilla)	Dr. A. Hariggan, Director of Economic planning
Gwendalyn van Putten School	Mrs. J. Lopez, School principal
Harbour Office	Mr. M. Gittens, Harbour executive
Hensel Phelps (Anguilla)	Mr. C. Molson, Construction manager
Island government	Mr. R. Hooker, Commissioner
Labour Office	Mrs. C. Duinkerk, Executive
Marriot resort, golf facilities (St. Kitts)	Mr. G. Downer – Director of Golf Mr. G. Lende – Resort manager
Queen Beatrix Hospital	Mr. Odongo, General practitioner Mrs. M. Pantophlet, Head nurse
Raffles Resort (Canouan Island)	Mr. C. Ganster, Executive Assistant Manager
St Eustatius National Parks (STENAPA)	Mrs. N. Esteban, STENAPA Executive Mr. R. Courtar, STENAPA Executive
St. Eustatius Business Association	Mr. K. Sneek, STEBA president
St. Eustatius Housing Foundation	Mr. V. R. Fortin, Managing director
Tourist Office	Mrs. A. Francis, Tourist Office Executive


Customer FAST – Golf resort St. Eustatius
Scope
How
Function bearers
Why
Basic functions
Supporting functions
Task


Provisional design block diagram – Golf resort St. Eustatius