



# **Feasibility Study and Development of Procurement Document for the Upgrading, Extension, Reconditioning/Rehabilitation and Closure of Municipal Solid Waste Disposal Site (MSWDS) in Philipsburg, Sint Maarten**

Feasibility Criteria and Boundary Conditions

February 21, 2025

**Our reference** R004-1293149IKR-V01-mvg-NL

## Responsibility

<b>Title</b>	Feasibility Study and Development of Procurement Document for the Upgrading, Extension, Reconditioning/Rehabilitation and Closure of Municipal Solid Waste Disposal Site (MSWDS) in Philipsburg, Sint Maarten
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<b>Reference</b>	R004-1293149IKR-V01-mvg-NL
<b>Number of pages</b>	35 (excluding attachment)
<b>Date</b>	February 21, 2025
<b>Signature</b>	This document was released with the explicit approval of authorized project management.



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Appendix 1 Feasibility Evaluation Framework

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## Executive Summary

Addressing the solid waste issues in Sint Maarten is urgent, as inaction poses significant risks to public health, environmental integrity, and economic viability. The current MSWDS operates at limited remaining volume capacity, creating short-term threats to public health and the environment. A sustainable long-term solution for the Municipal Solid Waste Disposal Site (MSWDS) and the Irma Debris Disposal Site (IDS) in Sint Maarten is undertaken under a NRPB funded project. This initiative is aimed at Upgrading, Extension, Reconditioning/Rehabilitation and (Partial) Closure of the facilities.

In light of the Sint Maarten Waste Management Vision for 2030, identified challenges, and stakeholder consultation, the objectives for the upgrade, extension and (partial) closure of the MSWDS are as follows:

- The upgraded site should have sufficient waste disposal capacity to facilitate a transformation to an alternative integrated solid waste management system based on eliminating landfill disposal while minimizing land use, considering Sint Maarten's land scarcity challenges
- The MSWDS upgrades must prioritise its robustness. This objective underscores the importance of selecting locally sourced materials and implementing efficient systems that not only reduce operational costs but also decrease the frequency of repairs and minimize downtime
- The technical design of the MSWDS upgrades must ensure an acceptable protection level for the environment and public health, considering the specific local natural conditions
- The visual appearance of the MSWDS should be improved. By improving the aesthetic value of the site, social acceptance among residents is enhanced and encourages the sustainable growth of Sint Maarten

To ensure the design effectively meets its objectives, a comprehensive set of boundary conditions and feasibility criteria has been established.

The boundary conditions set essential parameters for spatial boundaries, socio-economic viability, and health, safety, and environmental considerations. The feasibility criteria encompass technical feasibility, socio-economic viability, environmental impact, and health and safety considerations. Key aspects include evaluating the robustness, constructability and implementation schedule, capital expenditures (CAPEX), operational expenditures (OPEX), and assessing the indirect economic costs and benefits related to the landfill's operation, as well as the environmental protection level ensured and the visual appearance.

The established boundary conditions and feasibility criteria will guide the project towards achieving its objectives, ensuring compliance with necessary regulations while promoting community acceptance and participation. Through collaborative efforts and commitment to sustainability, Sint Maarten can pave the way for a cleaner and healthier future for all residents and stakeholders.

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## 1 Introduction

Sint Maarten struggles with a weak municipal solid waste (MSW) management system. The responsible Ministry of Public Housing, Spatial Planning, Environment and Infrastructure (VROMI) is operating a poor and unsanitary waste management and disposal system, while a related framework for the financial and governance setup is lacking.

Since the start of its operation in the seventies, the Solid Waste Disposal Site (SWDS), and later the Irma Debris Site (IDS), both situated at Pond Island in Philipsburg and collectively referred as the Municipal Solid Waste Disposal Sites (MSWDS), operate without a legal and regulatory framework and serves as an open dumpsite for the whole country with poor supervision, operational workflows, waste measures and controls.

In response to the Irma hurricane destruction in 2017, the Government of Sint Maarten initiated the National Recovery and Reconstruction Program, known as "Building Back Better." This program aims to facilitate the island's large-scale recovery and reconstruction efforts. Since January 2018, the World Bank has been providing assistance to the Government of Sint Maarten in implementing this program. A significant portion of the funding is provided through a Trust Fund established by the Netherlands in collaboration with the World Bank. The projects funded by this Trust Fund are managed by the National Recovery Program Bureau (NRPB), which serves as the Project Implementation Unit (PIU) for Trust Fund projects.

One of the projects supported by the Trust Fund is the Emergency Debris Management Project (EDMP). This project aims to effectively manage debris resulting from the hurricane and reconstruction activities, as well as improve the organization, rehabilitation, and upgrading of debris storage and municipal disposal sites.

The current assignment conducted under the EDMP aims at developing a longer-term sustainable solution at the Municipal Solid Waste Disposal Site (MSWDS) and Irma Debris Disposal Site (IDS) in Sint Maarten, through Upgrading, Extension, Reconditioning/Rehabilitation and (Partial) Closure of the landfill facilities. The current document describes the Evaluation Criteria for the Feasibility Study for this, based on previous conducted studies in combination with field studies conducted in the scope of the current assignment.

## 2 Feasibility Criteria Process

### 2.1 Objectives of Feasibility Study

Addressing the solid waste crisis in Sint Maarten is urgent. Continued inaction poses risks to the public health and environmental conditions as a result of the current waste management and disposal system, as well as the economic viability of improvements thereof.

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The current Municipal Solid Waste Disposal Site (MSWDS) has a limited remaining capacity. Furthermore, the site has become a symbol of the current ineffective waste management and disposal system and negatively impacts the attractiveness of the island and thus Sint Maarten's primary economic engine the tourism sector. As such it becomes increasingly essential to improve the current waste management system in order to ensure Sint Maarten remains an attractive destination for residents, businesses, and tourists.

In collaboration with various stakeholders, Sint Maarten has developed a shared vision for SXM in 2050. This vision includes the **Ambition 2030** goal of establishing an Integrated Sustainable Waste Management (ISWM) system in Sint Maarten by 2030. This system aims to manage waste through reuse and recycling in accordance with international best practices, thereby minimizing environmental impact.

Building a robust ISWM system requires significant resources and cannot be accomplished overnight. To address this, seven high-priority technical issues have been identified as part of the project, “**Moving to Integrated Solid Waste Management on Sint Maarten (ISWM-SXM)**”, with four issues connected to the improvement and upgrade of the MSWDS:

- **Lack of Data:** Reliable and current waste data—such as volumes, mass, origin, characterization, and complaints—are essential. Effective data collection, beginning with a functional weighing bridge at the landfill entrance, is crucial for analysis and research. This data will support the development of business cases that attract investment, enhance accountability, and improve communication
- **Uncontrolled Dumping of Hazardous Waste:** The disposal sites are currently at risk from uncontrolled dumping of hazardous materials. For instance, if a large pile of improperly stored tires ignites, it can lead to air pollution and potential airport closures. Immediate action is needed to secure proper disposal for hazardous, medical, and electronic waste (WEEE)
- **Non-Sanitized Waste Disposal Sites:** The waste disposal sites must be improved to mitigate risks to public health, the environment, and the economy. These sites could be transformed into positive symbols of the new vision—such as parks for visitors or sustainable energy-producing farms
- **Current Demand for Waste Disposal Capacity:** Sint Maarten generates one of the highest amounts of solid waste in the Caribbean. Even without considering the anticipated increase in both population and tourism, the current waste disposal capacity is insufficient. Land scarcity and potential airport restrictions present additional challenges in identifying new locations for waste management. Key strategies to reduce disposal capacity needs through implementing gate fees at the landfill, enhancing sorting and bioconversion processes, and facilitating recycling (including export opportunities). Access to international recycling facilities poses further challenges for a small island nation

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In light of the established vision, identified challenges, and stakeholder consultation, the objectives for the upgrade and closure of the MSWDS are as follows:

- The upgraded site should have sufficient waste disposal capacity to facilitate a transformation to an alternative integrated solid waste management system based on eliminating landfill disposal while minimizing land use, considering Sint Maarten's land scarcity challenges
- The MSWDS upgrades must prioritise its robustness. This objective underscores the importance of selecting locally sourced materials and implementing efficient systems that not only reduce operational costs but also decrease the frequency of repairs and minimize downtime
- The technical design of the MSWDS upgrades must ensure an acceptable protection level for the environment and public health, considering the specific local natural conditions
- The visual appearance of the MSWDS should be improved. By improving the aesthetic value of the site, social acceptance among residents is enhanced and encourages the sustainable growth of Sint Maarten

## 2.2 Methodology

The criteria outlined in this section are derived from a comprehensive analysis involving stakeholder consultations, field studies, and an extensive review of relevant project documentation, legislation, and international best practices. The following documents have been pivotal in formulating the criteria:

- Project's Background Documentation
  - Environmental Field Survey Report, Feasibility Study and Development of Procurement Document for the Municipal Solid Waste Disposal Site (MSWDS) in Philipsburg, Sint Maarten, Consortium Witteveen+Bos and TAUW bv, R002-1293149ABR-V02-mvg-NL, November 28, 2024
  - Geotechnical and Geographical Survey Report, Feasibility Study and Development of Procurement Document for the Municipal Solid Waste Disposal Site (MSWDS) in Philipsburg, Sint Maarten, Consortium Witteveen+Bos and TAUW bv, R003-1293149GMC-V01, October 16, 2024
  - Waste Authority Report, Project "Moving to Integrated Solid Waste Management on Sint Maarten (ISWM SXM)", VNG International, Version 3.0, 15 October 2023.
  - Environmental and Social Management Plan (ESMP), Municipal Solid Waste Site and Irma Debris Site management and related activities, Emergency Debris Management Project, (P167347) December 15, 2023
  - Environmental and Social Impact Assessment (ESIA), Installation of a Temporary Weighbridge and Reconstruction of the Access road to the MSW Site Daily Management of the MSW Site Operations including Fire Suppression and Slope Recontouring, Emergency Debris Management Project, (P167347) December 15, 2023
- National Legal Framework and Policies
  - Sint Maarten National Ordinance on Environmental Protection (Landsverordening Milieu) 1995
- International Best Practices

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- United States Resource Conservation and Recovery Act (RCRA) Regulations, Part 258— criteria for municipal solid waste landfills
- IFC (2007). International, Health, and Safety General Guidelines for Waste Management Facilities, International Finance Corporation, April 2007
- World Bank (2004). Sanitary Landfill Design and Siting Criteria, published May 1996, updated May 2004
- World Bank (2018a). Municipal Solid Waste Management, a Roadmap for Reform for Policy Makers, World Bank, April 2018
- World Bank (2018b). Decision Maker’s Guides for Solid Waste Management Technologies, , Silpa Kaza and Perinaz Bhada-Tata, September 2018

The comparative sustainability assessment and economic analysis of the current proposals, alteration(s) and alternatives, will integrate the Project Boundary Conditions. These conditions delineate the essential parameters for design compliance, serving as a framework of feasibility criteria. The established criteria will facilitate the ranking of existing proposals, alteration(s), and alternative(s) through a comparative sustainability assessment and preliminary economic analyses. Furthermore, these criteria will align with the objectives outlined in the Feasibility Study (Section 2.1) and adhere to the People-Planet-Profit principles alongside feedback from key stakeholders.

### 3 Boundary Conditions

**The Project Boundary Conditions define the critical parameters necessary for design compliance, establishing a framework for the feasibility study. These conditions encompass various dimensions, including spatial boundaries, socio-economic viability, and health, safety, and environmental considerations. Furthermore, all design options must adhere to the national legal and regulatory framework to ensure alignment with applicable laws and standards.**

#### 3.1 Spatial Boundaries

This section outlines the spatial boundary conditions relevant to the Improvement and Upgrade of the MSWDS, defining the various areal units that influence operations and planning. The key areas include:

- The Solid Waste Disposal Site, which serves as the primary location for waste management activities;
- The Construction and Demolition Processing Area operated by Windward Roads N.V., which handles construction debris and other inert materials;
- The northern part of the Irma Disposal Site section located at the formerly closed dump east of Soualiga Road, without land-use limitations;
- The southern part of the Irma Disposal Site under a long lease agreement with the Sint Maarten Soccer Association;
- The area leased by Steel Crushers B.V., designated for metal processing materials;
- The Previous Resettlement area of impact and

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- The VROMI Yard, which serves as a facility for the Ministry of Public Housing, Spatial Planning, Environment and Infrastructure (VROMI).

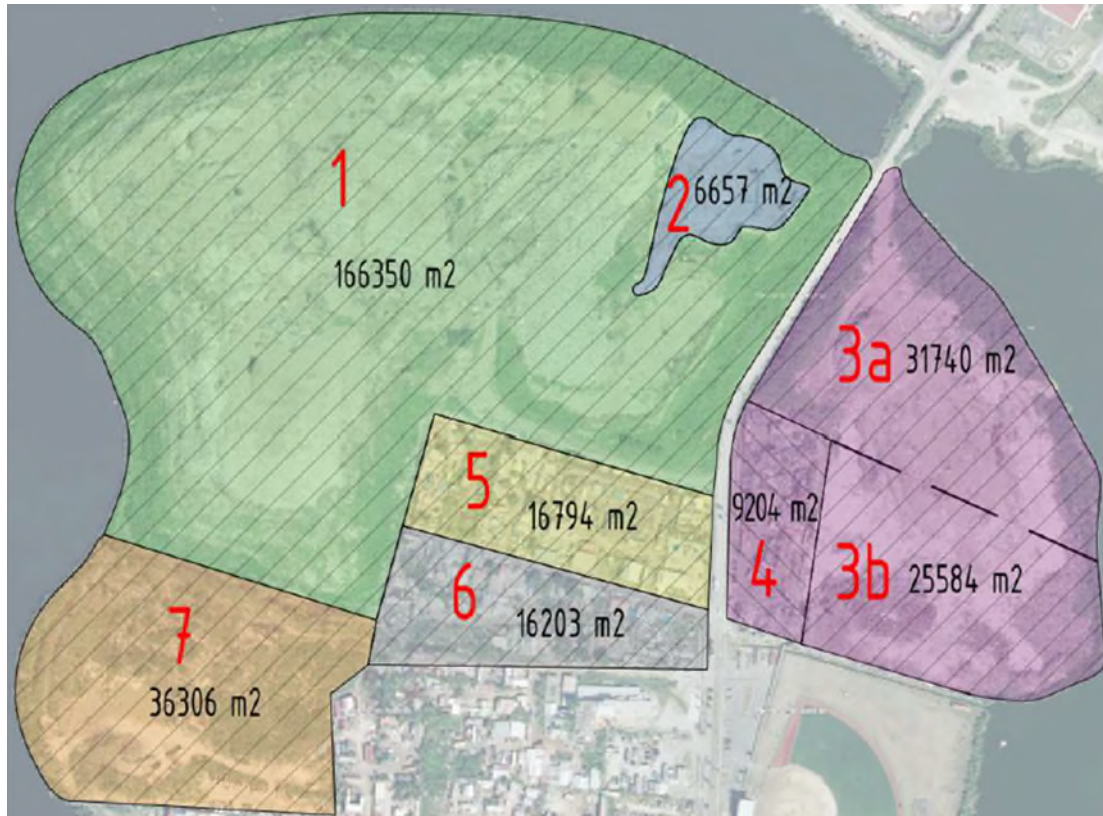


Figure 3.1 Site Layout indicating the different areal units, with 1) Solid Waste Disposal Site, 2) Construction and Demolition Processing area of Windward Roads N.V, 3a) Irma Disposal Site (no limitations), 3b Irma Disposal Site, Long Lease Sint Maarten Soccer Association, 4) Long lease Steel Crushers B.V. 5) and 6) Previous Resettlement area of impact, , and 7) VROMI Yard

### 3.1.1 Maximum Crest level

The current landfill has a maximum height of 42 m above the average level of the Great Salt Pond. The highest point being located on the North-western side of the MSWDS.

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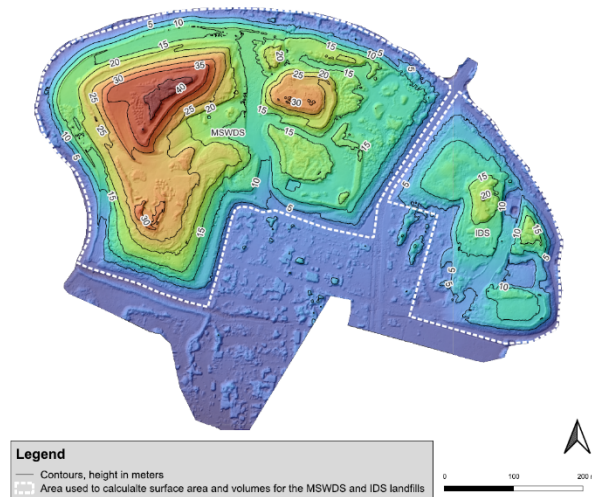


Figure 3.2 Digital Elevation Model of the MSWDS mapped in September 2024

The maximum crest level denotes the highest allowable elevation of accumulated waste within the Municipal Solid Waste Disposal Site (MSWDS). We propose maintaining **a maximum height of 40 meters above Sint Maarten Peil (S.M.P.)**. This limitation is crucial, as any further increase of the current height may negatively impact the social acceptance of the landfill site. Moreover, the existing height already presents operational challenges that must be addressed. In addition to the maximum crest level, it is essential that this height adheres to Health, Safety, and Environmental (HSE) practices, ensuring geotechnical stability and operational manageability.

### 3.1.2 Setback Distance

The setback distance is the required distance between residential developments and the perimeter of the proposed landfill cell to minimize potential health and environmental risks, particularly the migration of underground gaseous emissions. The nearest residential area to the landfill is located along Pendant Cactus Road, approximately 200 meters to the northeast of the Integrated Disposal Site (IDS). To the south of the landfill, there is an area officially designated as mixed residential and commercial area centrally situated on Pond Island although primarily serving as commercial area. No other residential zones are present further to the south, as this area is predominantly utilized for commercial and institutional purposes.

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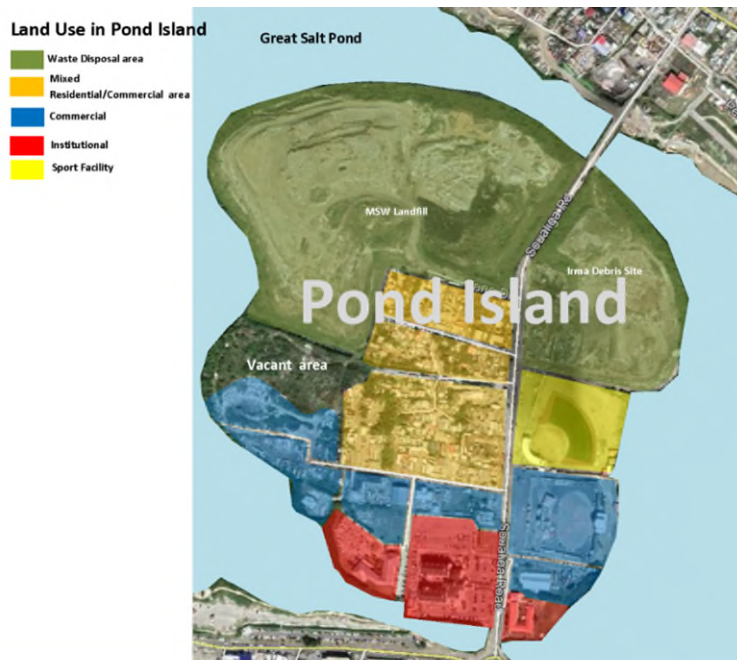


Figure 3.3 Land-use in Pond Island

According to the World Bank's Sanitary Landfill Design and Siting Criteria, residential development should not occur within 250 meters of the perimeter of the proposed landfill cell. However, setback distances can vary significantly; for example, some states in the U.S. enforce a minimum distance of 30 meters, while in Canada, it can extend up to 450 meters. Given the spatial constraints in Sint Maarten, where no other suitable locations meet this criterion, the World Bank's setback guidelines are deemed infeasible. Thus, a less conservative minimum setback distance should be applied.

The current landfill configuration has the advantage of most of its mass being situated above the saturated liquid level, which minimizes landfill gas generation and the underground migration of gaseous emissions. However, while it is not possible to completely eliminate risks associated with odorous nuisances (including odours, vectors, and smoke) or contaminant migration (such as emissions, leachate, and landfill gas), it is essential to ensure that residents living in close proximity to the site are at a safe distance in the event of geotechnical failures. Therefore, a minimum setback distance should be a function of geotechnical stability. For this, for planning purposes, **the setback distance should at least be equal or higher than the closest crest level of the landfill.**

### 3.1.3 Horizontal Extension into the Great Salt Pond

The Great Salt Pond historically used for salt mining by means of evaporation of sea water, now serves as a hydrological buffer for stormwater discharges and is an important birding habitat. Key stakeholders, including a representative the Ministry of Public Housing, Spatial Planning, Environment, and Infrastructure (VROMI), have emphasized the significance of preserving the Great Salt Pond and expressed a strong preference against any expansion into this area.

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Conversely, the previous ring dike surrounding the Municipal Solid Waste Disposal Site (MSWDS) has been buried under waste, resulting in substantial portions of the site becoming inaccessible and contributing to geotechnical instability. The steepness of the current slopes necessitates significant volumes of waste to be relocated, thereby reducing the overall net capacity of the (extended) landfill. To enhance slope stability and improve access for fire suppression and maintenance operations, the rehabilitation of the previous ring dike or the construction of a new ring dike along the landfill toe is essential.

In conclusion, horizontal expansion into the Great Salt Pond should be minimized to preserve this area as an open and recognizable feature of Sint Maarten's landscape and heritage. Any expansion should be **limited to supporting structures necessary on the side of the Great Salt Pond**, such as the ring dike or collection systems, rather than for the purpose of waste disposal. Furthermore, it is crucial to ensure that the water-bearing capacity of the Great Salt Pond remains intact, and any environmental impacts resulting from the expansion are adequately mitigated.

#### 3.1.4 Future Land-uses of Irma Disposal Site (IDS), Resettlement area of impact, and VROMI yard.

There are three (3) areas where possible expansion of the municipal solid waste operations is possible; Irma Disposal Site (IDS), Resettlement area of impact, and VROMI yard, respectively, which are characterized with:

- The Prefeasibility Study and Temporary Debris Storage and Reduction Site (TDSR) conducted by EE&G and SGS Engineers in 2018 emphasized the necessity for the complete removal and remediation of IDS, more specifically cadastral plots 191/2016 and 190/2016, because among other the long term lease of this plot from Sint Maarten Soccer Association
- The former Resettlement area of impact has been vacated, and plans are in place to clear any remaining structures. This area encompasses approximately 30,000 m<sup>2</sup> and is situated between the landfill and the commercial buildings to the south
- The current VROMI yard, covering an area of approximately 36,000 m<sup>2</sup>, is designated for low-value activities. These include the storage of materials, small soil and sand depots, and unused VROMI equipment. The VROMI Yard is located away from the main road, situated behind a commercial area

It is recommended to explore the option of utilizing these areas for any **industrial activities**, specifically those associated with municipal solid waste operations and landfilling. For the IDS no new waste disposal shall take place on this side of the landfill.

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## 3.2 Socio-Economic Viable Options

### 3.2.1 Allocation of Soualiga Road

Soualiga Road serves as the primary transportation artery of the island and is essential for maintaining access to Philipsburg as well as to various institutes and commercial activities at Pond Island. It is crucial that this road remains open to traffic to support the ongoing operations and economic activities on Pond Island. However, the current configuration of the road divides the landfill area into two sections, which significantly reduces the available landfill capacity and complicates operational efficiency. This division necessitates two separate entrance areas and restricts the movement of equipment between the Irma Disposal Site (IDS) and the Municipal Solid Waste Disposal Site (MSWDS).

It is proposed that **the re-location of Soualiga Road within the boundaries of Pond Island is permitted**; however, it is imperative that the road remains intact, at the same capacity and operational on the island to facilitate effective landfill operations and ensure continued access for Philipsburg and across Pond Island.

### 3.2.2 Relocation of On-site Processing Facilities

Currently, there are two external contractors utilizing parts of the landfill area: Steel Crushers BV and Windward Roads N.V. Windward Roads N.V. operates a construction waste processing facility on the Municipal Solid Waste Disposal Site (MSWDS) but does not hold an official land title, while Steel Crushers B.V. has a long-term lease agreement for cadastral plot 192/2017. The activities of Steel Crushers B.V. and Windward Roads N.V. are well-suited for incorporation within the future landfill area; if relocating their operations creates the necessary space for future landfilling, their current location should not be viewed as a restriction. Therefore, It is proposed to have **no limitations on relocating the activities of Windward Roads N.V.**, in accordance with the terms of their agreements whereas this is yet to be confirmed by Client for the activities of Steel Crushers B.V.

## 3.3 Health, Safety and Environmental Boundary Conditions

The following Health, Safety and Environmental Boundary conditions will be taken into account, including the international best practices, geotechnical stability, stormwater management, landfill gas, and fire suppression.

### 3.3.1 Best Available Techniques (BAT) and Best Environmental Practice (BEP)

Full compliance with World Bank's and International Standards would necessitate the recovery of the entire landfill mass and its relocation to a newly installed landfill cell, which requires an excessive investment and could result in significant and irreversible environmental impacts.

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Therefore, a **risk-based approach**, instead of complete compliance with the World Bank's and International BAT/BEP Guidelines, will be considered acceptable for the design of the upgrade, extension, reconditioning/rehabilitation and (partial) closure of the landfill facilities to avoid detrimental effects on the environment. For the landfill design a Environmental and Social Impact Assessment according to the IFC standards is required.

### 3.3.2 Geotechnical Stability

The Geotechnical and Geographical Survey Report (TAUW, 2024) indicates that both the Integrated Disposal Site (IDS) and the Solid Waste Disposal Site (SWDS) currently exhibit instability on both macro and micro slope scales. This instability is primarily attributed to the inadequate geotechnical strength of the geological base, steep slopes, and the considerable weight of accumulated waste.

According to the Geotechnical Assessment, there is a significant risk of macro-scale failure in the landfill in the event of an earthquake, stemming from the unstable basal structures. Completely eliminating the risk of geotechnical failure would necessitate either a very long toe or substantial subsurface strengthening, both of which are not economically feasible given current budgets and space constraints. The potential for **macro slope failure under earthquake conditions** is considered unavoidable, but only in areas where such failure would not result in significant impacts. However, no geotechnical failure under normal operational conditions is permitted.

### 3.3.3 Stormwater Management

Pond Island experiences flooding during heavy rainfall events, necessitating effective stormwater management strategies. One of the key drainage systems is located south of the Solid Waste Disposal Site (SWDS), and given the existing flooding issues, this drainage system is deemed essential for managing stormwater across Pond Island.



Figure 3.4 Channel to the South of the MSWDS

Future redevelopment plans must prioritize the proper drainage of the Municipal Solid Waste Disposal Site (MSWDS) as well as the areas currently served by the existing drainage systems. The precise location of the drainage infrastructure will depend on the final design of the landfill upgrade. Therefore, all design alternatives must ensure that the **drainage capacity remains the same or is improved** for the landfill and surrounding areas, with the precise drainage layout to be determined based on the final design specifications.

### 3.3.4 Landfill Gas

Currently, there is no landfill gas collection or treatment system in place at the site. Observations indicate that no significant landfill gas generation occurs from the existing landfill, primarily due to aerobic conditions, previous fires, and a high content of construction waste.

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As a result, the current waste body does not exhibit substantial landfill gas formation. In addition, the absence of liners or impermeable covers restricts the efficiency of any potential gas collection.

Given these conditions **landfill gas collection** is primarily seen as a requirement from health and safety operations needed for managing the existing landfill mass and future landfill cells. It is important to note that, as outlined in section 3.3.1, for any new landfill extension landfill gas management is to be considered for environmental, health and operational safety purposes.

### 3.3.5 Fire safety

Frequent landfill fires occurring until 2018 significantly affected the air quality in the surrounding area. In response to these challenges, renewed efforts by VROMI have demonstrated that effective management strategies can lead to improved control and mitigation of fire incidents. To further enhance fire safety, operational controls must be implemented to minimize fire hazards and promote a safe working environment. This includes sufficient **accessibility of the entire landfill site for emergency response to landfill fires**.

## 4 Feasibility Criteria

In evaluating the existing proposal, alteration(s) and alternative for the **Municipal Solid Waste Disposal Site (MSWDS) on Pond Island in Sint Maarten**, a comprehensive set of **feasibility criteria is essential to ensure that the project meets its objectives effectively, as stipulated in Section 2.1**. These criteria encompass various dimensions, including **technical feasibility, socio-economic viability, environmental, health, and safety considerations (see Figure 4.1)**. Criteria can be either **quantitative, where set criteria are expressed in numerical terms, allowing for objective comparisons and evaluations or, in case no hard numbers can be attributed, qualitative, where non-numerical standards are used to evaluate characteristics based on expert knowledge of the project team**.

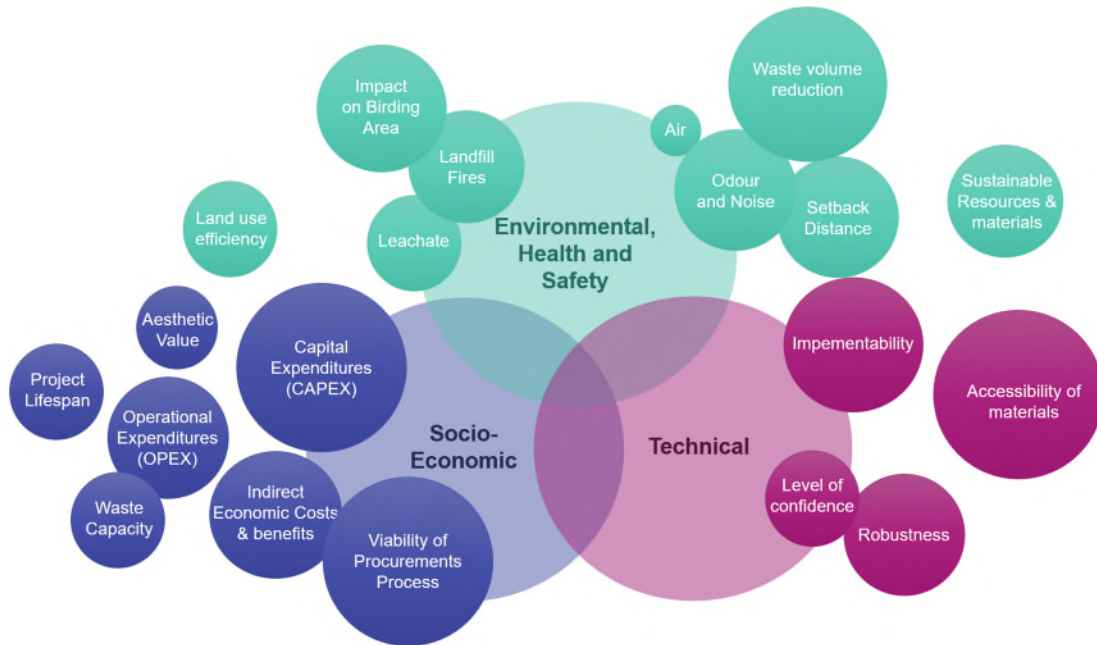


Figure 4.1 Overview of Feasibility Criteria

#### 4.1 Technical Feasibility

Technical feasibility assesses the practicality of implementing the proposed design and technologies for the MSWDS upgrade. It evaluates the compatibility of the proposed solutions with existing infrastructure, the availability of necessary resources, and the expertise required for execution. In addition, the selected technical feasibility criteria are aligned with the objective that the most feasible design must prioritize robustness, considering the difficulties to quickly import materials into Sint Maarten.

##### *Robustness (Qualitative)*

The technical design of the upgrades to the Municipal Solid Waste Disposal Site (MSWDS) must prioritize low maintenance requirements and high reliability. This criterion emphasizes the importance of utilizing durable materials and efficient systems that minimize operational costs and reduce downtime. By adhering to robust design principles, we can significantly enhance the longevity of the facilities, decrease the frequency of repairs, and ensure consistent performance in waste management processes. This approach not only boosts operational efficiency but also fosters the long-term sustainability of the waste management system.

This criterion includes a classification system that ranges from **Not Robust** (Very Poor) to **Extremely Robust** (Very Good). Materials and technologies categorized as Not Robust are prone to failure and necessitate constant maintenance or replacement, resulting in an unreliable system. Conversely, Extremely Robust materials and technologies are characterized by exceptional durability, designed to withstand extreme conditions, and backed by a proven track record of longevity.

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#### *Accessibility of Materials and Equipment (Qualitative)*

This criterion evaluates the ease with which materials can be sourced for the project, taking into account factors such as local or regional availability, supplier networks, lead times, and potential procurement challenges that may affect project timelines and overall costs. The classification system ranges from **Unavailable** (Very Poor) to **Readily Available** (Very Good). Materials are classified as Unavailable when they cannot be sourced within the region, necessitating significant time and investment for procurement; an example of this would be certain specialized wastewater treatment installations. Conversely, materials are deemed Readily Available when they are easily accessible from reputable aftermarket servicing company with the expectation of longevity, ensuring consistent availability and competitive pricing.

#### *Constructability (Qualitative)*

This criterion assesses the technical “Constructability” of proposed techniques, emphasizing their practicality and compatibility with existing infrastructure. The classification system ranges from **Not Constructable** (Very Poor) to **Highly Constructable** (Very Good). Not Constructable indicates that the proposed solutions are infeasible due to significant technical barriers, including incompatibility with existing systems and geological challenges. For example, the Constructability of sheet piling may be compromised if the sheet piles need to be driven through waste material. Conversely, Highly Constructable signifies that the technical solutions are straightforward and fully compatible with existing systems, allowing for seamless implementation without the need for significant modifications.

#### *Level of Confidence (Qualitative)*

This criterion evaluates the uncertainty and evidence surrounding the effectiveness of the techniques implemented in the landfill upgrade. It assesses the level of confidence that these techniques will achieve their intended outcomes based on scientific evidence, historical performance, and stakeholder input. A higher level of confidence suggests a greater likelihood of success, while a lower level of confidence indicates potential risks or uncertainties in implementation.

**Very Low Confidence** (Very Poor) signifies that there is no substantial evidence to support the technique's effectiveness, resulting in a very low level of confidence and high uncertainty regarding its success. In contrast, **Very High Confidence** (Very Good) indicates that there is substantial evidence and a proven track record supporting the effectiveness of the technique, resulting in a high level of confidence in its success. For instance, techniques that have been extensively tested and validated in similar contexts demonstrate clear positive outcomes, thus instilling confidence in their application within the project.

## **4.2 Socio-Economic**

The socio-economic feasibility criteria assess the potential economic impacts and benefits associated with the upgrades to the Municipal Solid Waste Disposal Site (MSWDS).

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These criteria consider a range of factors, including local business opportunities and the overall effect on the community's economic landscape. A viable project will not only yield direct economic benefits through improved waste management practices but also enhance the quality of life for residents by fostering sustainable tourism and encouraging community engagement.

The criteria are aligned with two primary objectives for the upgrade, expansion, and closure of the MSWDS: first, ensuring that the upgraded site has sufficient waste disposal capacity; and second, transforming the MSWDS into a more visually appealing site. By enhancing the aesthetic value of the site, the social acceptance among residents can be improved and sustainable tourism growth is promoted in Sint Maarten. The following sections will detail the specific socio-economic feasibility criteria, including Capital Expenditures (CAPEX), Operational Expenditures (OPEX), Indirect Economic Costs and Benefits, Project Lifespan, Viability of the Procurement Process, Waste Disposal Capacity, and Aesthetic Value of the Site. Each criterion will be evaluated according to defined classes to facilitate a comprehensive analysis of their feasibility and impact.

#### *Capital Expenditures (CAPEX) (Quantitative)*

This criterion evaluates the expected capital costs associated with the design and implementation of the landfill upgrade, emphasizing cost-effectiveness, financial feasibility, and alignment with budgetary constraints. As described in section 3.2.1, the boundary conditions for CAPEX for this project is USD 29,000,000. **Excessive CAPEX** (USD 29,000,000 in a positive scenario) signifies that the total capital expenditures are prohibitively high, rendering the project financially unviable and necessitating a reevaluation of design and implementation strategies. In contrast, **Low CAPEX** (USD 20,000,000 in conservative scenario) indicates that the total capital expenditures are significantly below budget expectations, reflecting efficient design and cost-saving measures in place.

#### *Operational Expenditures (OPEX) (Qualitative)*

This criterion evaluates the future operational costs associated with the landfill's operation and maintenance, emphasizing cost-effectiveness and alignment with budgetary constraints. The current OPEX is approximately **USD 2,000,000 USD** per year, as outlined in the annual budget of the Government of Sint Maarten for 2024. **Low OPEX** indicates that operational expenditures are at a substantially improved level as current figures, while improvements in operations—such as sanitized landfilling for new waste—demonstrate efficient practices and cost-saving measures that enhance financial sustainability. In contrast, **Excessive OPEX** signifies that total operational expenditures are prohibitively high, threatening the landfill's financial sustainability and necessitating a comprehensive review of operational practices. This is reflected in ongoing operational issues and inefficiencies, leading to an OPEX which is not financially viable.

#### *Indirect economic costs and benefits (Qualitative)*

This criterion evaluates the secondary economic effects resulting from the new landfill, focusing on changes in spending, employment, and income within the community. It considers both the potential costs and benefits associated with the landfill's operation.

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For example, while the landfill may create jobs and stimulate local spending, it could also lead to infrastructure strain from longer transport routes and increased traffic.

**Detrimental** (Very Poor) indicates that the landfill has severe negative economic consequences, resulting in substantial job losses, significant infrastructure degradation, and local business closures. The overall economic landscape deteriorates, exemplified by major infrastructure issues that lead to business shutdowns and widespread unemployment in the area due to the landfill's operation. Conversely, **Highly Beneficial** (Very Good) signifies that the landfill generates substantial positive economic impacts, including significant job creation, increased local spending, and minimal adverse effects on infrastructure. Local businesses thrive, and the community experiences economic diversification.

#### *Project Lifespan (Quantitative)*

The landfill upgrade must be fully completed by June 2028, which necessitates that the construction phase of the contract does not exceed 24 months. This timeline is critical for ensuring that the project remains within the established funding and operational frameworks.

The class **Very Short Duration** (Very Good) signifies that implementation can be completed in less than 6 months, involving straightforward processes with minimal complexities. In contrast, class **Extended Duration** (very poor) indicates that implementation is expected to exceed 24 months, facing substantial challenges that complicate the timeline. An example of this might include major reconstruction projects requiring significant changes to infrastructure and prolonged permitting processes.

#### *Viability of Procurements Process (Qualitative)*

This criterion evaluates the appeal and attractiveness of alternative solutions within the procurement process for the landfill upgrade. It assesses how these alternatives align with contractor capabilities and preferences, particularly in the context of international competition for knowledge, resources, and expertise. A viable procurement process is essential for attracting qualified contractors and ensuring the successful execution of the project. Class **Not Appealing** (Very Poor) indicates that the alternatives lack appeal and are unlikely to attract contractors, resulting in minimal interest that could lead to uncompetitive bidding or project delays. An example of this might be alternatives perceived as overly risky, complex, or not aligned with contractor capabilities, which deter participation in the procurement process. Conversely, Class **Highly Appealing** (Very Good) signifies that the alternatives presented are exceptionally attractive to contractors, ensuring strong interest and competitive bids due to their alignment with industry standards and contractor capabilities. An example would be well-defined project specifications and solutions that resonate with a broad range of qualified contractors.

#### *Waste Disposal Capacity (Quantitative)*

An important criterion to evaluate for each landfill alternative is the created additional waste disposal capacity. As highlighted during stakeholder consultations, more specifically the NPRB and World Bank, the project must provide at least ten (10) years of solid waste disposal capacity.

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Sufficient waste capacity is crucial to facilitate the government's transition to a zero waste economy, making it beneficial to have extended capacity to accommodate this shift. The classification system ranges from **less than 7 years of waste capacity** (Very Poor) providing insufficient capacity support the transition to **more than 15 years of waste capacity** (Very Good) that significantly supports the transition to a zero waste economy.

#### *Aesthetic Value of the Site (Qualitative)*

The MSWDS should be transformed into a visually appealing site that improves aesthetic value. Enhancing the site's appearance promotes social acceptance among residents and supports sustainable tourism growth in Sint Maarten. The classification system ranges from **No Aesthetic Improvements** (Very Poor) to **Highly Enhanced Aesthetics** (Very Good). The class No Aesthetic Improvements indicates alternatives with no enhancements to its appearance, while Highly Enhanced Aesthetics showcases alternatives with significant options for future landscaping are re-use of the area, including visual appeal and community engagement.

#### *Need for resettlement and relocation (Qualitative)*

The transformation of the MSWDS can affects businesses and operations on or in the direct vicinity of the landfill. Examples are the businesses of Steel Crushers Bv or Windwards Roads that are current on or close to the MSWDS. Movement of businesses, due to the upgrade should be limited where possible and, if required viable alternatives should be provided. The classification system ranges from **Business and/or residents are relocated without alternative location** (Very Poor) to **No need for resettlement and relocation of Business and/or residents** (Very Good).

### **4.3 Environmental, Health and Safety (EHS) Criteria**

The environmental, health, and safety criteria focus on the implications of the MSWDS upgrade for the ecosystem, public health, and community well-being. This aspect examines potential impacts on air and water quality, resource conservation, and the risk of exposure to harmful substances. A successful upgrade will not only implement EHS impact prevention and mitigation but will also prioritize the selection of locally sourced materials. Risk based decisions on EHS impact and mitigation will need to be made within the design to ensure safety and minimize adverse effects to an acceptable level on both the environment and human health.

#### *Setback Distance (Quantitative)*

This criterion evaluates the necessary distance between residential developments and the perimeter of the proposed landfill extension to mitigate potential health and environmental risks, particularly those related to the migration of underground gaseous emissions. In accordance with international standards, such as those established by the International Finance Corporation (IFC), residential developments should ideally be situated at least 250 meters from the landfill perimeter. However, given the constraints of the current situation and low underground migration of gaseous emissions, a minimum setback distance of 30 meters must be maintained at all times, as detailed in Section 3.1.2.

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Setback distances between 30 to 50 meters are regarded as Moderate, **Compliant**, as they may pose minor risks to human health and safety due to gaseous emission and noises, but will provide sufficient safety in the event of geotechnical failures. Conversely, a setback distance exceeding 250 meters from the landfill perimeter is deemed **Fully Compliant** (Very Good), aligning with international standards and effectively safeguarding public health and the environment.

*Air quality Greenhouse Gasses (Qualitative)*

This criterion assesses the effects of landfill operations on air quality, concentrating on greenhouse gas emissions after construction activities. It evaluates the effectiveness of measures implemented to mitigate greenhouse gas formation, collection and processing. Class **Significant Deterioration** (Very Poor) signifies that greenhouse gasses increase and not processing takes place. In contrast, Class **Significant Reduction** (Very Good) indicates that greenhouse gasses are effectively collected from the entire MSWDS comprehensive strategies in place process collected greenhouse gases.

*Air quality Dust and other emissions (Qualitative)*

This criterion assesses the effects of landfill operations on air quality, concentrating on dust generation during and after construction activities. It evaluates both the direct emissions resulting from landfill operations and the effectiveness of measures implemented to mitigate air quality degradation, in line with international air quality management standards. Class **Significant Deterioration** (Very Poor) signifies that air quality is negatively impacted, characterized by substantially increased dust emissions. In contrast, Class **Excellent Air Quality Management** (Very Good) indicates that dust and other emission are effectively controlled, with negligible emissions and comprehensive strategies in place to ensure adherence to international air quality standards.

*Landfill fires (Qualitative)*

This criterion evaluates the risk of landfill fires associated with the operations and activities at the landfill site. It assesses how various activities may influence fire risk levels, considering the effectiveness of mitigation measures and operational techniques in place to manage and reduce this risk. The classification system ranges from **Significantly Increased Risk** (Very Poor) to **Negligible Risk** (Very Good). Significantly Increased Risk indicates that risk of landfill fires is markedly heightened due to ongoing activities, whereas, Negligible Risk indicates that the risk of landfill fires is neglectable.

*Reduction of toxicity, mobility or volume of leachate migration into Great Salt Pond (and groundwater) (Qualitative)*

The leachate and shallow groundwater at the Municipal Solid Waste Disposal Site (MSWDS) landfill are contaminated with heavy metals, and to a lesser extent, with aromatic hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons according to Dutch Standards for Groundwater Quality. BOD, COD, total nitrogen, and total coliform are above the standard for the discharge of a wastewater treatment plant in Sint Maarten.

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Elevated concentrations of several per- and polyfluoroalkyl substances (PFAS), Total Coliform, and E. Coli are also present in the leachate and groundwater. The highly permeable beach sands at the base of the landfill facilitate a strong interchange between the leachate/groundwater and the Great Salt Pond, while thick clay layers at greater depths limit the vertical migration of the contaminated leachate.

The significantly elevated levels of contaminants present unacceptable risks to human health, particularly for individuals engaging in activities such as swimming or fishing in the affected waters. However, due to the low concentrations of volatile compounds, no unacceptable health risks from the leachate are anticipated for those in close proximity to the Great Salt Pond and the Municipal Solid Waste Disposal System (MSWDS). This indicates that, under current conditions, no imposed or mandatory exposure is expected. To further mitigate any potential for non-imposed exposure, effective communication on safe practices to the public could be sufficient. It is important to note that this assessment does not account for any risks to the ecosystem in the Great Salt Pond.

This criterion evaluates the effectiveness of measures implemented in the landfill upgrade aimed at reducing the toxicity, mobility, and/or overall volume of leachate migrating into the Great Salt Pond and the surrounding shallow groundwater.

The classification system for leachate reduction ranges from **Mandatory Human Health Risks** (Very Poor) to **High Effective Risk Reduction Measures** (Very Good). The **Mandatory Human Health Risks** class signifies unacceptable imposed exposure risks exist for individuals near the Great Salt Pond due to leachate migration in the Great Salt Pond or Groundwater. In contrast, the **Highly Effective Reduction Measures** class indicates that majority of the leachate contaminant load is successfully collected and treated, and/or that effluents do not exceed the established effluent standards for Municipal Solid Waste (MSW) landfills in the United States, as prescribed by the International Finance Corporation (IFC). Examples of this category include state-of-the-art liner systems combined with advanced leachate treatment technologies that effectively minimize leachate migration.

#### *Odour and Noise (Qualitative)*

This criterion evaluates the potential effects of the proposed alternatives on odour and noise nuisance during and after the construction and operational phases of the landfill upgrade. The classification system ranges from **Severe Odour and Noise Issues** (Very Poor) to **Negligible Odour and Noise** (Very Good). Severe Odour and Noise Issues indicate that the alternatives cause significant disturbances to the surrounding community, leading to considerable discomfort and potential health concerns. In contrast, Acceptable Levels of Odour and Noise (Moderate) suggest that while there may be some disturbances, these levels are manageable and only cause occasional discomfort to the community. Finally, Negligible Odour and Noise (Very Good) signifies that the alternatives effectively minimize disturbances, resulting in no reported issues within the community.

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*Impact on bird areas of Great Salt Pond (Qualitative)*

This criterion assesses the effectiveness of techniques employed in the landfill upgrade to ensure that operations do not negatively affect the resident and migratory bird population and, where possible, contribute positively to their habitat. The classification system ranges from **Detrimental to Birdlife** (Very Poor) to **Highly Supportive of Birdlife** (Very Good). Class Highly Supportive of Birdlife indicates that the techniques implemented significantly enhance the habitat for local bird species, promoting biodiversity and providing new nesting and feeding opportunities. For example, creating green spaces and wetland areas can attract and support a diverse range of bird populations, fostering a healthier ecosystem. Conversely, Detrimental to Birdlife signifies that the techniques used are harmful to the local bird population, leading to serious declines in species or degradation of habitat quality. This could occur through activities that result in the loss of essential habitats or significant pollution that adversely affects bird health.

*Land Use Efficiency (Qualitative)*

This criterion evaluates the design and implementation of the landfill upgrade in terms of its ability to optimize land use, focusing on minimizing the operational footprint while effectively managing waste. Considering the challenges of land scarcity in Sint Maarten, this criterion aims to identify solutions that maximize the functionality of the site without encroaching on additional land areas. The classification system ranges from **Inefficient** (Very Poor) to **Highly Efficient** (Very Good).

Inefficient indicates that the design utilizes excessive land area for operations, failing to effectively address land scarcity, which results in significant concerns regarding land use. An example of this would be a design that expands the operational area beyond current limits without adequate justification, exacerbating land scarcity issues and leaving insufficient space for future initiatives, such as Material Recovery Facilities (MRF) or Waste-to-Energy (WtE) systems, thereby compromising the potential transition to an integrated waste management system. In contrast, Highly Efficient signifies that the design incorporates innovative solutions that substantially reduce land use while ensuring optimal functionality within a minimal footprint. For instance, a waste processing facility located on a previous landfill cell that maximizes space utilization.

*Sustainable resources and raw materials (Quantitative)*

This criterion evaluates the impacts and benefits associated with the use of waste and raw materials, specifically focusing on the quantity and sources of cover materials required for landfill operations. It considers the sustainability of these resources, including their origins, availability, and the potential for recycling or repurposing materials to minimize environmental impact. The classification system ranges from **Not Sustainable (< 20% recycled materials)** (Very Poor) to **Highly Sustainable ( $\geq 80\%$  recycled or repurposed materials)** (Very Good).

**Not Sustainable (< 20% recycled materials)** indicates that less than 20% of raw materials are sourced from virgin materials, with no recycling or sustainability considerations. The quantity required is substantial, and the sourcing practices contribute to significant environmental degradation.

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An example of this would be the use of materials transported over long distances without regard for environmental impacts or sustainability. In contrast, **Highly Sustainable (≥ 80% recycled or repurposed materials)** signifies that at least **80%** of the raw materials used are sourced from recycled or repurposed waste, significantly reducing the demand for virgin materials. The quantity required is minimal, and the origins of these materials are well-documented and environmentally friendly. An example of this would be the utilization of processed construction and demolition debris as cover material.

## 5 Conclusions

The overall objective of the project is the development of a contract aimed at developing a sustainable long-term solution for the Municipal Solid Waste Disposal Site (MSWDS) and the Irma Debris Disposal Site (IDS) in Sint Maarten. This undertaking will focus on enhancing and upgrading the landfill through improvements in site facilities and operational practices.

In assessing the existing proposals, alteration(s), and alternative(s) for the upgrading, extension, reconditioning, rehabilitation, and closure of the MSWDS in Philipsburg, Sint Maarten, it is crucial to employ a comprehensive set of boundary conditions and feasibility criteria to ensure that the project effectively meets its objectives. A summary of the boundary conditions is given in Table 5.1, while the feasibility criteria—including technical feasibility, socio-economic viability, environmental impact, and health and safety considerations—are summarized in Table 5.2. Additionally, the evaluation matrix for the feasibility criteria can be found in Appendix 1.

Table 5.1 Boundary Conditions

Criteria	Boundary Condition
<i>Spatial Boundaries</i>	
Maximum crest level (m)	No exceedance above 40 meters
Setback distance between landfill and residential areas	The setback distance should at least equal or higher than the most nearby crest level.
Horizontal expansion into the Great Salt Pond	No expansion of landfilling into the Salt Pond; limited expansion is allowable for supporting structures (i.e. ring dike, leachate treatment or collection, etc.). Water bearing condition of the Salt Pond needs to remain the same.
Future Land-uses of Cadastral Plot 190 and 191 at Irma Disposal Site (IDS)	Industrial, including Landfilling of municipal solid waste ( <i>to be confirmed</i> )
Future land-use of VROMI yard	Industrial, including municipal solid waste operations and landfilling ( <i>to be confirmed</i> )
Future land-use former Resettlement area of impact	Industrial, including municipal solid waste operations and landfilling ( <i>to be confirmed</i> )
<i>Socio-Economic Viable Options</i>	

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Criteria	Boundary Condition
Maximum Capital Expenditure (CAPEX)	29,000,000 USD
Maximum duration of the construction phase	24 months
Allocation of Soualiga Road	Allocation on Pond Island is not restricted
Relocation of On-site Processing Facilities	The current operations can be freely relocated ( <i>to be confirmed</i> ).
<b>Environmental, health, and Safety Boundary Conditions</b>	
Geotechnical Stability	The potential for macro slope failure under earthquake conditions is considered unavoidable. No geotechnical failure under normal operational conditions is permitted.
Stormwater management	The stormwater drainage capacity must remain the same or should be improved for the MSWDS and surrounding areas
Landfill Gas	A passive landfill gas venting system is deemed sufficient for managing the existing landfill mass.
Fire Safety	The site must be accessible for emergency response teams and fire suppression systems must be in place.

Table 5.2 Overview of Feasibility Criteria

Criteria	Description
<b>Technical Feasibility Criteria</b>	
Robustness	The likely life-span of the technology and its proneness for extreme conditions
Accessibility of materials	The easiness of materials to be sourced, considering factors such as local availability, supplier networks, lead times, and potential procurement challenges
Constructability	This criterion assesses the technical “constructability” of the techniques, including the practicality and compatibility with existing infrastructure
Level of confidence	This criterion evaluates the uncertainty and evidence surrounding the effectiveness of the techniques, including the available input data.
<b>Socio-Economic Criteria</b>	
Capital Expenditures (CAPEX)	This criterion evaluates the expected capital costs associated with the design and implementation of the landfill upgrade. The total available CAPEX for this project is \$29,000,000 USD.
Operational Expenditures (OPEX)	This criterion evaluates the future operational costs associated with the landfill's operation and maintenance, focusing on cost-effectiveness and alignment with budgetary constraints. The current OPEX is approximately \$2,000,000 USD per year
Indirect economic costs and benefits	The criteria consider secondary economic effects from the new landfill, such as changes in spending, employment, and income.
Project Lifespan	The landfill upgrade must be fully completed by June 2028, necessitating that the construction phase of the contract not exceed 24 months.

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Criteria	Description
Viability of Procurements Process	The appeal of alternatives for the procurement process and their attractiveness to contractors amid international competition.
Waste Capacity	Sufficient waste capacity is crucial to facilitate the government's transition to a zero waste economy, making it beneficial to have extended capacity to accommodate this shift.
Aesthetic value of the site	The MSWDS should be transformed into a visually appealing site that integrates green spaces and improves aesthetic value. Enhancing the site's appearance promotes social acceptance.
<i>Health, Safety, and Environmental Criteria</i>	
Setback Distance	This criterion evaluates the required distance between residential developments and the perimeter of the proposed landfill cell to minimize potential health and environmental risks, particularly the migration of underground gaseous emissions.
Air quality	The effects of the alternatives on the quality of the air through greenhouse gas emissions, dust formation during and after the works.
Landfill fires	This criterion evaluates the risk of landfill fires associated with the suggested technique and alternatives.
Reduction of toxicity, mobility or volume of leachate migration into Great Salt Pond (and groundwater)	This criterion evaluates the effectiveness of measures implemented in the landfill upgrade to reduce the toxicity, mobility, and overall volume of leachate migrating into the Great Salt Pond and the surrounding groundwater.
Odour and noise	The effects of the alternatives on odour and noise nuisance during and after the works.
Impact on bird areas of Salt Pond	Effects of the alternatives on ecology with special focus on birdlife of the Great Salt Pond.
Land Use Efficiency	This criterion evaluates the design and implementation of the landfill upgrade in terms of its ability to optimize land use, minimizing the footprint of operations while effectively managing waste.
Sustainable resources and raw materials	This criterion evaluates the impacts and benefits associated with the use of waste and raw materials. It considers the sustainability of these resources, including their origins, availability, and the potential for recycling or repurposing materials to minimize environmental impact.

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## Appendix 1 Feasibility Evaluation Framework

Our reference R004-1293149IKR-V01-mvg-NL

Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
<i>Technical Feasibility</i>							
Robustness	Qualitative	The likely life-span of the technology and its proneness for extreme conditions	Technology is prone to failure and require constant maintenance or replacement, making them unreliable.	Technology has limited durability and may require frequent replacement or repairs under regular use.	Technology has reasonable durability but may experience wear under heavy use or harsh conditions.	Technology is very durable under typical operating conditions, with strong expectations for lifespan and performance.	Technology is exceptionally durable, designed for extreme conditions with a proven track record of longevity.
Accessibility of materials	Qualitative	The easiness of materials to be sourced, considering factors such as local availability, supplier networks, lead times, and potential procurement challenges	Materials are not available within the region and would require significant time and investment to procure.	Materials are difficult to source and may require long lead times or international shipping, leading to increased costs and delays.	Materials are available but are sourced from limited suppliers or locations, leading to potential delays in procurement.	Materials are mostly available but may require lead time for procurement from suppliers.	Materials are easily accessible from multiple local and regional suppliers, ensuring consistent availability and competitive pricing.
Constructability	Qualitative	This criterion assesses the technical constructability of the techniques, including the practicality and compatibility with existing infrastructure	The proposed solution is not feasible due to significant technical barriers.	The technical solutions face considerable challenges, such as substantial modifications to existing infrastructure or high likelihood	The technical solutions present some compatibility issues or require substantial adjustments, necessitating further planning.	The technical solutions are mostly compatible but may require minor adjustments or additional technologies for successful implementation.	The technical solutions are straightforward and compatible with existing systems
Implementation Duration	Quantitative	The landfill upgrade must be fully completed by June 2028,	Implementation is expected to exceed 24	Implementation is projected to take	Implementation is anticipated to last	Implementation is expected to take	Implementation can be completed in less than 6

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Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
		necessitating that the construction phase of the contract not exceed 24 months.	months, facing substantial challenges that complicate the timeline.	between 18 to 24 months, involving complex processes, multiple stakeholders, and potential delays.	between 12 to 18 months, requiring significant planning and coordination.	between 6 to 12 months, involving moderate complexity but manageable within the timeline.	months, with straightforward processes and minimal complexities.
Level of confidence	Qualitative	This criterion evaluates the uncertainty and evidence surrounding the effectiveness of the techniques, including the available input data.	There is no substantial evidence to support the technique's effectiveness or used data.	There is little evidence supporting the effectiveness of the technique, leading to a low level of confidence in its success.	There is some evidence supporting the technique's effectiveness, but notable uncertainties remain.	There is strong evidence supporting the technique's effectiveness, although some uncertainties may exist.	There is substantial evidence and a proven track record supporting the effectiveness of the technique.
<i>Socio-Economic Viability</i>							
Capital Expenditures (CAPEX)	Quantitative	This criterion evaluates the expected capital costs associated with the design and implementation of the landfill upgrade. The total available CAPEX for this project is \$31,000,000 USD.	The total capital expenditures of design/technique are prohibitively high, making the project likely financially unviable.	The capital expenditures are substantially above budget expectations, raising concerns about financial feasibility and potential project delays.	The capital expenditures exceed budget expectations, indicating potential financial challenges or unforeseen costs that may impact project viability.	The capital expenditures are within budget expectations, reflecting a well-planned financial approach with reasonable costs for implementation.	The capital expenditures are significantly below budget expectations, with efficient design and cost-saving measures in place.
Operational Expenditures (OPEX)	Qualitative	This criterion evaluates the future operational costs associated with the landfill's operation and maintenance,	Ongoing operational issues and inefficiencies leading to substantially	The operational expenditures are slightly above current levels, necessitating	The operational expenditures are approximately	The operational expenditures are slightly lower than current levels, through to	The operational expenditures are substantially reduced compared to current

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Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
		focusing on cost-effectiveness and alignment with budgetary constraints. The current OPEX is approximately \$2,000,000 USD per year.	increased OPEX raising concerns about financial viability.	additional cost management strategies (	maintained at current levels	improvements in operations.	OPEX level through effective resource management and regular maintenance routines.
Indirect economic costs and benefits	Qualitative	The criteria consider secondary economic effects from the new landfill, such as changes in spending, employment, and income.	The implementation of the technique has severe indirect negative economic consequences,	The technique does result in more negative indirect economic impacts than benefits	The economic effects of the technique are balanced, with both positive and negative impacts that largely offset each other.	The technique provides notable economic benefits, but might also introduce minor indirect costs	The landfill generates substantial positive economic impacts.
Viability of Procurements Process	Qualitative	The appeal of alternatives for the procurement process and their attractiveness to contractors amid international competition.	The alternatives lack appeal and are unlikely to attract contractors, resulting in minimal interest and potentially leading to uncompetitive bidding or project delays.	The alternatives are of limited appeal to contractors, resulting in low interest and potential challenges in attracting competitive bids due to significant barriers or requirements.	The alternatives present moderate appeal, with potential interest from contractors but also notable barriers that may limit competition or engagement.	The alternatives present moderate appeal, with potential interest from contractors but also notable barriers that may limit competition or engagement.	The alternatives presented are exceptionally attractive to contractors, ensuring strong interest and competitive bids due to their alignment with industry standards and contractor capabilities.
Waste Capacity	Quantitative	Sufficient waste capacity is crucial to facilitate the government's transition to a zero waste economy, making	Insufficient capacity to support the transition (Less than 7 years)	Limited capacity that may require urgent action to ensure a smooth transition	Adequate capacity that supports the transition (between 9 and 12 years capacity)	Strong capacity that provides a solid foundation for the transition (between 12	Excellent capacity that significantly supports the transition (more than 15 years capacity)

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Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
		it beneficial to have extended capacity to accommodate this shift.		(between 7 and 9 years)		years to 15 years capacity)	
Aesthetic value of the site	Qualitative	The MSWDS should be transformed into a visually appealing site that integrates green spaces and improves aesthetic value. Enhancing the site's appearance promotes social acceptance.	The site remains unchanged with no enhancements to its appearance.	The site lacks substantial aesthetic improvements, with little to no integration of green spaces or visual enhancements.	The site has minimal aesthetic enhancements, with limited green spaces or other methods to improve visually appealing.	The site includes notable improvements, such as some green spaces and landscaping.	The site features extensive green spaces, art installations, and landscaping or other methods that significantly improve visual appeal.
Need for resettlement and relocation	Qualitative	As part of the design, some of the operations on or close to the landfill will be affected (Steel Crushers Bv, Windwards Roads). The impact to them should be limited. .	Businesses and or residents residing on or very close to the MSWDS are removed without alternative location	Business and/or residents requiring relocation can only be provided with alternatives that are equally or less suitable than their current location	Businesses and/or residents requiring relocation can be provided with viable alternative locations improving their opportunities not in the vicinity of the MSWDS	Businesses and/or residents requiring relocation can be provided with viable alternative locations, improving their opportunities in the direct vicinity of the MSWDS	The is no need to relocate businesses and or residents
<i>Environmental, Health, and Safety Criteria</i>							
Setback Distance	Quantitative	This criterion evaluates the required distance between residential developments and the perimeter of the proposed	Less than 30 meters and setback distance less than the nearest crest level	Less than 30 meters but setback distance is more than the nearest crest level	The residential area is located between 30 to 100 meters from the landfill perimeter,	The residential area is located between 100 to 250 meters from the landfill perimeter,	The residential development is situated more than 250 meters from the landfill

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Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
		landfill cell to minimize potential health and environmental risks, particularly the migration of underground gaseous emissions.			providing likely adequate protection, but is on the lower end of recommended distances.	providing adequate protection.	perimeter, fully adhering to international standards
Air quality – Greenhouse gasses	Qualitative	The effects of the alternatives on the formation, collection and processing of greenhouse gas emissions after the installation of the new MSWDS.	Air quality is adversely affected, with increased emissions greenhouse gases, with no further control or collection in place	There is a moderate impact on air quality, with increased greenhouse gas emissions but collection of part of the greenhouse gasses is in place	The effects on air quality are minimal, with passive measures implemented to collect and vent greenhouse gasses from the existing and new landfill	Active measures are in place to collect and process greenhouse gasses	Air quality is effectively managed, with negligible emissions and comprehensive strategies implemented to ensure compliance with international air quality standard. Greenhouse gasses are use for secondary purposes (i.e. electricity generation)
Air quality	Qualitative	The effects of the alternatives on the quality of the air through greenhouse gas emissions, dust formation during and after the works.	Air quality is adversely affected, with increased emissions of landfill gases and greenhouse gases.	There is a moderate impact on air quality, with either increased landfill gas emissions or no significant change	The effects on air quality are minimal, with passive measures implemented to vent gas emissions and reduce dust formation	Active measures are in place that significantly reduce emissions and improve air quality	Air quality is effectively managed, with negligible emissions and comprehensive strategies implemented to ensure compliance

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Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
Landfill fires	Qualitative	This criterion evaluates the risk of landfill fires associated with the suggested technique and alternatives.	The risk of landfill fires is heightened due to ongoing activities, posing serious safety and environmental concerns.	The risk of landfill fires is temporarily elevated due to specific activities but can be managed with appropriate measures.	The risk of landfill fires remains stable, with effective mitigation measures in place to prevent fire incidents.	The risk of landfill fires is diminished due to improved operational practices and effective fire prevention techniques, contributing to enhanced safety.	with international air quality standard The risk of landfill fires is minimal, thanks to comprehensive fire management strategies and best practices in place, ensuring a safe operational environment.
Reduction of toxicity, mobility or volume of leachate migration into Great Salt Pond (and groundwater)	Qualitative	This criterion evaluates the effectiveness of measures implemented in the landfill upgrade to reduce the toxicity, mobility, and overall volume of leachate migrating into the Great Salt Pond and the surrounding groundwater.	Only unacceptable human health risks in the situation of non-imposed exposure to leachate (e.g., swimming in Great Salt Pond, Fishing)	only non-imposed exposure to leachate is possible. Possible non-imposed exposure pathways are cut-off; for instance, information signs will indicate that swimming is prohibited in the Great Salt Pond.	Low to Moderate reduction of toxicity, mobility or volume of leachate. Some mitigation measures are implemented to improve the leachate and water quality.	Significant reduction of toxicity, mobility or volume of leachate (e.g., active leachate collection and treatment).	All leachate is collected and treated, from both existing and new MSWDS, discharge according to limit values
Odour and noise	Qualitative	The effects of the alternatives on odour and noise nuisance during and after the works.	Severe odour and noise issues, causing significant disturbances to the	Noticeable odour and noise problems that are disruptive but manageable.	Acceptable levels of odour and noise that may cause occasional discomfort	Minimal odour and noise issues, with most community members expressing satisfaction.	Negligible odour and noise, with no reported disturbances.

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Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
Impact on bird areas of Great Salt Pond	Qualitative	Effects of the alternatives on ecology with special focus on birdlife of the Great Salt Pond.	surrounding community. The techniques used are expected to be harmful to the local bird population, causing serious declines in species or habitat quality.	The techniques are expected to have a considerable adverse effect on local birdlife, leading to habitat loss or disruption of critical behaviours such as nesting and feeding.	The techniques employed may cause some disruption to local bird populations, with temporary effects on nesting or feeding habits.	The techniques likely improve local birdlife, by allowing for increased nesting or feeding areas	The techniques implemented significantly enhance the habitat for local bird species, promoting biodiversity and providing new nesting or feeding opportunities.
Land Use Efficiency	Qualitative	This criterion evaluates the design and implementation of the landfill upgrade in terms of its ability to optimize land use, minimizing the footprint of operations while effectively managing waste.	The design utilizes excessive land area for operations, failing to address land scarcity effectively, resulting in significant land use concerns.	The design presents challenges in minimizing land use, requiring insufficient area for the MFR and	The design utilizes some land use optimization, resulting in sufficient area of MFR and WtE.	The design effectively minimizes land use while maintaining essential operational functions, with clear strategies for space optimization.	The design utilizes innovative solutions that significantly reduce land use, ensuring that the landfilled area remains the same
Sustainable resources and raw materials	Quantitative	This criterion evaluates the impacts and benefits associated with the use of waste and raw materials. It considers the sustainability of these resources, including their origins, availability, and	Less than <b>20%</b> of materials are from recycled/re-used materials. Materials are transported over long distances and/or sourced from virgin	<b>20% to 39%</b> of raw materials have limited sustainability credentials, with a high reliance on virgin resources. The sourcing practices are	<b>40% to 59%</b> of cover raw materials are sourced from sustainable or recycled origins, but a significant portion still comes from virgin	<b>60% to 79%</b> of cover materials are sourced from recycled or sustainable origins, with a moderate quantity required. There is a clear commitment to	At least <b>80%</b> of the raw materials used are sourced from recycled or repurposed waste, significantly reducing the demand for virgin materials.

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Criteria	Qualitative / Quantitative	Description	Very Poor	Poor	Moderate	Good	Very Good
		the potential for recycling or repurposing materials to minimize environmental impact.	materials with no recycling or sustainability considerations.	not well-documented, and the quantity required is substantial.	sources. The quantity used is moderate, and efforts are being made to improve sourcing practices.	reducing environmental impact through responsible sourcing practices.	