DEVELOPMENT OF SUSTAINABILITY GUIDELINES FOR INFRASTRUCTURE AND THEIR APPLICATION TO PASSENGER FERRY TERMINALS

By

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DEVELOPMENT OF SUSTAINABILITY GUIDELINES FOR INFRASTRUCTURE AND THEIR APPLICATION TO PASSENGER FERRY TERMINALS

Abstract

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The first definition of sustainability appeared in 1987 in the Brundtland report, as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," and is now described as the balance between society, economy and environment. This thesis is to sustainably improve passenger ferry terminals, which are complex facilities with various activities, impacts and issues. Current sustainability knowledge and expertise are not reflected in infrastructural facilities. This gap between possibilities and reality might be solvable by providing information and guidance to decision-makers. To aid decision-makers in the green movement, many tools have been created and implemented to develop sustainable infrastructure. Existing rating systems or guidelines are not applicable to passenger ferry ports which are at the intersection of land and sea handling vehicles from bikes to cars, buses and vessels; include parking lots, roads, buildings and docks to serve employees, passengers and community; and are regulated and restricted by governments and agencies. This thesis develops a process to help decision-makers reduce the negative impacts of infrastructure while ensuring economic viability and prosperity. The process proposed to develop guidelines consists of: (1) identifying the stakeholders of infrastructure sustainability to

work on the creation and implementation of the system, (2) listing all current and foreseen issues, (3) reaching consensus on goals sought after, (4) defining the specific targets, means and timelines towards these goals, (5) defining indicators to monitor the performance and provide a basis for analysis for decision-making, (6) and applying planned actions while rectifying them depending on the feedback provided by the indicators. This process is then applied to ferry terminals, for which involved interests, applicable regulations, and specifics were determined. The proposed guidelines address the seven categories which encompass the identified issues: traffic and parking; integration in the community; energy management; water management; materials management; site selection and air quality. These guidelines supply passenger ferry ports designers and owners as well as other decision-makers with clear and easy-to-use guidelines to aid them in realizing current and foreseen issues and providing possible solutions.

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CHAPTER 1 INTRODUCTION

1.1. History of sustainability

The concept of sustainability first appeared in 1980 at "The World Conservation Strategy - Living Resource Conservation for Sustainable Development" (IUCN et al. 1980). This notion was conceived to address the need to maintain a stable economy (Daly 1973) while assuring natural resource availability (Becker 1997) in a lasting balance between humans and their environment. In 1987, the World Commission on Environment and Development (WCED) qualified this concept as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN 1987). In the 1992 United Nations (UN) conference on environmental development, the concern for sustainability led to the creation of the Commission for Sustainable Development. As people realized that an acceptable environmental behavior has to seek the benefit of human kind, it became linked to social and economic issues. In the past two decades, the focus has moved past the simple concept of "green" to include the broader notions of "sustainable". The complex nature of this concept has since been articulated in the "triple bottom line" (Elkington 1997), environment protection, social progress, and economic growth (Annan 2002). In the construction field, which this study will focus on, aspects of the concept of sustainability are omitted since the building codes only address structures and technique.

1.2. Current problems in the sustainable balance

1.2.1. History of economic metrics

Since the early part of the 20th century, the economic component has been of main concern (Snavely 2007). During the Great Depression, the lack of comprehensive data to rely on in policy-making hindered Presidents Hoover and Roosevelt (Bureau of Economic Analysis

2006). Dr. Simon Kuznets was commissioned by the Department of Commerce to create a tool to estimate the national income. He provided a report to the Senate in 1934, entitled "National Income 1929-1932." At the beginning of 1942, the Gross National Product (GNP) index was created to help wartime planning. Its importance and use grew, and the 1965 GNP report was benchmarked to a previous report for the first time. Indicators of worldwide evolutions had started.

1.2.2. Arising problems of the economic focus

As existing indicators illustrate, the health of a country is assessed by economic metrics such as the GNP, Gross Domestic Product (GDP), and Net National Income. Economy is generally the first aspect of the triple bottom line to be addressed, since companies need to make as much profit as possible. However, with limited resources, growth is also limited (Becker 1997), given that while each year the world population increases, the natural resources remain finite. Thus calling for an urgent solution is needed. The UN Brundtland report expressed the idea that with a proactive use of their knowledge, humans could improve the productivity of available resources to eventually remedy this issue – and develop sustainably.

1.2.3. Use of resources

In order to live, humans need natural resources, such as water and air, and produce waste. For these needs, humans have been using the Earth for several million years. Yet within just the past fifty years, the exploitation of the planet's goods has become more important than the pace of regeneration (Chichilnisky 2001). Industrialized countries have been -and are- the main consumers of natural resources, the principal contributors to pollution, yet they represent a minor fraction of the world's population. Why do these nations act in this way? One of the explanations is that they follow economic principles more than anything else, and cleaner air and

water do not have any economic benefit, and the prices of natural resources do not reflect their trend to diminish (Chichilnisky 2001). This does not encourage respectful and efficient use.

1.2.4. Towards sustainability

"I often wake up in the middle of the night," Pope John XXIII said, "and start thinking about grave problems—and decide to talk about them with the Pope. Then I wake up completely and remember that I am the Pope." Industrialized nations have experienced a similar awakening in the past decades, with increasing sustainability concerns (Elkington 1994).

Natural resources or the well-being of society cannot be incorporated into economic indices. The UN Agenda 21 report (1992) affirmed that traditional indicators such as the GNP were not adequate to assess sustainability; rather, comprehensive indicators were needed to aid further policy-making, which will help sustainable development.

1.3. Infrastructures

1.3.1. Necessity and issues

Infrastructures are essential to human kind. They protect occupants' health, and provide them with all their needs: food, water, energy, transportation, etc. They also help improve the use of the Earth's resources, by allowing life on most of the lands. However, infrastructures cause humans to generate waste, for instance factories supply populations with food, which creates garbage from packaging; they also use energy to run and water to be washed, they emit particles into the air, they generate noise in the whole neighborhood, etc. There is a crucial need to reduce the negative impacts of infrastructure while ensuring economic viability and prosperity.

Most of the present systems are outdated and thus not efficient. However, changes need to be made, and they are possible (Nielson 2000).

1.3.2. Need for long-term consideration in infrastructures

Only the short-term expenses are addressed in infrastructures development: construction companies look at what they can improve in order to build the same structure for limited expenses. Firms do not look at what would be less expensive for the owner: how many skyscrapers illuminate our cities from having the lights on when all occupants are gone at nights and weekends? Especially when initially designed for commercial use, buildings' lights should turn off automatically when they are not necessary. Contractors neglect this simple feature too often, because these elements have higher initial price, even though they are widely known to have a positive return on investment over their lifetime. Many similar examples show how short-term economic decisions dominate the construction field, which is still considered traditional, inefficient and wasteful (Walsh 2002). Besides, in countries newly introduced into the European Union, the desire to reach the Western Europe comfort level at all means leads to major impacts on environment and sustainability (Walsh 1998). This has already been shown to lead to performance levels lower than sustainably acceptable, consequence of the overuse and depletion of resources (Hueting et al. 2004).

1.3.3. Green buildings vs. green infrastructures

The green and sustainable movements have been of major concern, and the market is growing at a fast-pace. Metrics have been developed so that experts' knowledge is made available to owners, contractors, or anyone interested. Some of the most popular metrics are rating systems, as they are a public proof of the level achieved by the project, and they are comprehensible bullet points to follow. The US Green Building Council (USGBC) implemented the Leadership in Energy and Environmental Design® (LEED) rating systems, which have been the leader all over the United States and are being used in 91 other countries. Even though these

systems are an important part of the green market and have been adopted by many government agencies as a minimum standard, LEED is not applicable to all types of constructions. Most sustainability guidelines, standards, and rating systems apply to one type of construction, such as commercial buildings (Green Globes), roads (Green Roads) or wastewater systems (Wastewater Sustainability Rating Tool WWSRT). Some facilities are more complex (e.g. communities, campuses, ports). There is a need for a complete tool to help owners and contractors go towards and achieve sustainability.

1.3.4. From an economic focus to a balance between economy and environment

In the current climate of protection of the planet, green design has been the main approach. It is good for the environment, but is it really good for the planet as a whole? The green concept was extended to sustainability for that matter, purposely or not, and the two terms are nowadays interchangeably used. For instance, LEED® addresses short and long term impacts on the environment, which also drive social progress, since protecting the environment improves the quality of life. One example is that people riding their bikes to work in order to produce less pollution, also exercise, which is healthier than driving. To encourage this transportation means, the LEED® rating system for New Construction grants credit points if a certain amount of showers per employee are included in a commercial edifice (USGBC 2002). A feature that was intended to be green actually has a broader impact. However, most of the time, green remains the focus, and the two other pillars of sustainability are left out.

1.4. Objectives

It is widely considered that notions of sustainability will play a strong role in our future. However, no general solution for a unified and efficient movement towards sustainability exists. In the civil engineering field, tools such as rating systems or guidelines for specific types of

construction projects are being created and implemented. However, there is a need for improvements in these systems to promote sustainability in new types of projects and to better seek a comprehensive definition of sustainability as it applies to civil infrastructure.

This Master's thesis will introduce a model of guidelines for the design of sustainable infrastructural facilities such as ferry ports, with a complete definition of sustainability: considering all aspects of the triple bottom line, over the entire life-cycle. After analyzing the existing sustainability tools and proposing a comprehensive tool for infrastructure including guidelines and the process to develop and implement them, this thesis presents guidelines for ferry terminals, and the context in which this system was created.

1.5. Approach

This research was mainly based on literature review to identify issues, current practices, similar tools, and possible solutions. The first aspect of this review regarded the definition of sustainable infrastructures and the development of tools and policies; the second aspect focused on sustainability of infrastructures and their activities, and ferry ports were taken as an example of the application of the general notions developed, which was assisted through the author's interactions with Washington State Department of Transportation (WSDOT) and specifically its ferry division (WSF).

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CHAPTER 2 DEVELOPMENT OF A SUSTAINABILITY TOOL FOR INFRASTRUCTURE

2.1. Abstract

In the construction industry, many tools have been created and implemented to develop sustainable infrastructure. These systems range from rating systems and guidelines for design and construction, to management systems, which carry the high performance onto operational activities, monitoring and maintenance. This study addresses the lack of systems applying to the whole life cycle of complex types of infrastructure and considering all aspects of the triple bottom line (e.g. society, economy and environment). In this paper, we propose a consensus-based process to assist decision-makers to reduce the negative impacts of infrastructure while ensuring economic viability. The proposed process consists of: (1) identifying the stakeholders of the infrastructure's sustainability to work on the creation and implementation of the system, (2) listing all current and foreseen issues, (3) reaching consensus on goals sought after, (4) defining the specific targets, means and timelines towards these goals, (5) defining indicators to monitor the performance and provide a basis for analysis for decision-making, (6) and applying the planned actions while rectifying them depending on the feedback provided by the indicators.

2.2. Introduction

Increasingly, government agencies and non-governmental organizations (NGOs) are influencing practices to seek sustainable solutions in a variety of construction activities. To date, rating systems (e.g. Leadership in Energy and Environmental Design LEED, Green Globes, etc) have been the preferred tool to assist in designing facilities that will, in theory, result in better environmental performance than the required minima by zoning and building codes. Whereas

rating systems have originally been focused on green buildings, these systems are now being developed to address a wide range of infrastructure projects such as roads (Green Roads, Green Leadership In Transportation Environmental Sustainability, GreenLITES), campuses (Sustainability Tracking, Assessment & Rating System STARS, LEED for Schools), communities (LEED for Neighborhood Development LEED-ND), wastewater systems (Wastewater Sustainability Rating Tool WWSRT), and landscapes (Sustainable Sites Initiative SSI). These rating systems are addressing society's desire for a more sustainable infrastructure through their ease of use, their overall assessment of holistic design, and their use in simple comparisons of projects. In addition, use of rating systems may also increase the value of a facility when the tool has gained wide recognition (Fowler et al. 2006). However, numerous criticisms have been noted with these systems, such as additional costs for registration and certification, increased need for documentation, bureaucracy, questionable weighting of the different sustainable elements, their focus on amassing points rather than sustainable solutions (Snavely 2007, Papadopoulos et. al 2007, Smith et al. 2006, Kats 2003). Projects not reaching a high score on the rating scale may appear not to be sustainable for being the least improved projects among all projects applying for rating. Because of the voluntary nature of these green building programs, the traditional projects may not be considered in the rankings; however, projects at the low end of the scale should be valued compared to most of these traditional projects not applying. In addition, recent research has shown that the design focus of the LEED system has led to buildings that do not necessarily perform better than average buildings in terms of energy efficiency. This finding has been attributed to the fact that operation and maintenance of these buildings contribute little to the point systems. Moreover, the weighting of a credit is considered by some to not correspond to the life cycle impact generated (Soderlund et al. 2007,

Scheuer et al. 2002). In response, LEED has included more credits for operations in the most recent version LEED-v3 (USGBC 2009). The USGBC states that the new weights attributed to credits were developed under the EPA's Tools for the Reduction and Assessment of Chemicals and other Impacts (TRACI) (USGBC 2008). These EPA tools analyze the entire life-cycle of the building and are intended to improve overall performance. To facilitate the adoption of the rating systems, the baseline credits are now found in all the different rating systems, and regionalization of specific credits was conducted.

In addition to rating systems, other tools are available to encourage operation of infrastructure to promote various sustainability goals. For instance, an Environmental Management System (EMS) is used by organizations to develop planning, monitoring, and action processes aimed at improving environmental performance around metrics are often set by governmental regulation or policy. Another system, Health Impact Assessment (HIA) use qualitative research techniques to query the needs of stakeholders and develop specific focus areas for a project's impact on public health. In essence, these focus areas provide an avenue towards setting sustainability metrics when ones do not exist or to tailor a list of metrics to focus more specifically on the needs of a stakeholder group. Both the EMS and HIA processes, while presenting advantages to aid in assessing sustainability, do not provide guidance on how to improve existing projects. The nature of these two systems also requires the development of a new EMS or HIA for each new project.

Modern infrastructure is essential to supply society with food, water, energy, and transportation, to protect health, as well as to improve resource use by accommodating humans with all the necessities for life on most of the land surface. However, these activities can also have a profound influence on the environmental, economic, and social fabric of our

communities. There is a crucial need to develop a process to aid decision-makers in reducing the potential negative impacts of infrastructure while ensuring economic viability and prosperity. The objective of this paper is to (1) demonstrate the need for the development of a sustainability tool, (2) investigate the different existing tools, to determine essential attributes, and (3) to propose a sustainability system.

2.3. Which tool for sustainable infrastructure?

Sustainability has become a recent focus in several areas of policy following the rapid increase in market demand for green buildings over the past decade. It is estimated that the US green buildings market has increased from $10 billion in 2005 to $36-49 billion in 2008. These statistics represent an increase from 2% to 15-20% of the total construction market (McGraw-Hill Construction 2009). Green constructions are often claimed to have further benefits than limited impacts on the environment. First, sustainable construction may show lower life-cycle costs. Projects following the US Green Building Council's rating system LEED claim to generate lifetime savings of about ten times the initial extra costs (Soderlund et al. 2007). The enhanced working conditions of employees may also increase productivity (Aye et al. 2006), contributing to additional economic advantages.

However, a study conducted on 121 new LEED construction projects showed that measured energy performance is lower than that of traditional designs for 21% of the cases. This discrepancy may be explained by the misinformation about the systems, which may lead to users not following the expected use for which the project was designed, possibly causing a non-efficient use of the technology (Turner et al. 2008). Since an obvious market exists for green buildings, it is assumed that owners would desire to maintain the initial performance levels during the life of the building. The decrease in performance may be due to an insufficient

operation and maintenance knowledge or understanding of the owner or the occupant for individual building elements as well as the whole system (Haselbach 2008). Therefore, it would be essential to develop establish mechanisms to set actions towards predefined performance goals on a prescribed timeline over the life of the building. A study conducted in 2003 showed that the presence of improvement systems often bring unexpected enhancement beyond their initial goals because of the general sustainability atmosphere developed (National Database on EMSs 2003). Several tools used for that matter are presented hereafter, with the characteristics that would contribute to a successful sustainability system.

2.3.1. Rating systems

Engineering firms follow building codes and allied standards when designing facilities. Those systems may not address all three components of sustainability, as they are mainly to ensure a certain level of safety. Some agencies have created rating systems to assist contractors to incorporate sustainable measures, and to have an additional motivation for it: a gratification title, which may increase the value of the construction (Snavely 2007).

2.3.1.1. Categories

Fowler's report (Fowler et al. 2006) has defined rating systems as "tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings." Rating systems facilitate comparisons between projects through bullet points that provide owners and designers with organized categories of solutions and recommendations to approach sustainability issues.

2.3.1.2. Possible certification

In order to increase reliability of the assessment, many rating systems have third-party certification processes, which may be part of a marketing strategy to show concern for users'

health (visitors and employees) and for environment. However, the added bureaucracy of a mandatory certification process may be an obstacle to the broad adoption of the system (Soderlund et al. 2007).

2.3.1.3. Specific types of projects

Most current rating systems are not general but rather address issues of a specific project, such as a residential building (National Association of Home Builders NAHB), a highway (GreenRoads), or most often, a commercial facility (LEED, Green Globes). However, many projects include several types of constructions together, such as a campus or a port, with roads, parking lots, docks, boats, buildings, etc. Some rating systems are currently being developed (e.g. STARS for campuses, LEED for neighborhoods) but these still require multiple certification processes, such as for the overall master plan, roads, individual buildings, etc. To avoid mounting bureaucracy and costs while facilitating adoption, a sustainability tool incorporating different infrastructural aspects would be beneficial to owners, designers, builders, and facility managers.

2.3.1.4. Continuous monitoring and operations aid

Rating systems may also not provide a complete tool for continuous sustainability in all phases of a project. As one of the LEED 2009 minimum program requirements (MPR), energy data of all projects submitted must be made available to the USGBC. Despite this obligation should help to encourage performance improvements and data collection, however, discontinuities remain in the operational and monitoring requirements for the energy credits of the LEED rating system for New Construction and Existing Construction (Table 2.3.1.4). For instance, a green power contract is only required for 2-years for projects applying to Energy and Atmosphere credit 6, the mandatory commissioning (prerequisite 1) does not require

performance assessment, and enhanced commissioning (credit 3) requires this monitoring for 10 months after occupancy, when certification is valid for 5-years. This table shows that some gaps could be filled in the LEED process.

Table 2.3.1.4 Operational plans and performance monitoring in LEED

LEED New Construction, Energy and Atmosphere category, credits of the 2009 version	Post-Occupancy operational plan years 1-5		Post-occupancy performance monitoring & assessment, years 1-5		For Existing Building
	Continuous	present, but not continuous	Continuous	present, but not continuous	after 5 years, if applying for recertification
EAp1 Fundamental Commissioning of Building Energy Systems	to be decided		no	no	1-5 years sequence repeated
EAp2 Minimum Energy Performance	no	no	no	no	1-5 years sequence repeated
EAp3 Fundamental Refrigerant Management	no	until expected CFC phase-out	no	no	until expected CFC phase-out
EAc1 Optimize Energy Performance	no	no	no	no	during performance period (3 months min)
EAc2 On-site Renewable Energy	no	no	to be decided		during performance period (3 months min)
EAc3 Enhanced Commissioning	to be decided		no	after 10 months	Yes
EAc4 Enhanced Refrigerant Management	no	no	no	no	at EB certification
EAc5 Measurement and Verification	to be decided		no	for one year	2-years prior to EB application
EAc6 Green Power	no	2-years	no	no	Yes

2.3.1.5. Voluntary

Many rating systems are voluntary in nature: project managers take the initiative to apply the system to their projects (Gowri et al. 2004). Traditional plans might not apply for certification, as well as smaller projects with few employees, restricted budgets, or those that need to be realized rapidly. These impediments mean that benchmarking might, therefore, be

biased towards projects at the upper end of the distribution (AASHE 2007). Finally contractors and designers may focus on obtaining credits rather than efficient design, whereas performance rather than compliance should be the goal of sustainability practices.

2.3.1.6. Definitive tool

Any assessment conducted for the purpose of rating sustainability is only neutral to some degree. Therefore, evaluations of issues and solutions conducted during the development of the rating system might not be applicable everywhere and for every project (Bossel 2001). For that reason, LEED has added regional credits in the new version. But another method of developing local context for a project would be to facilitate stakeholders and interested parties to input their values and needs in a consensus process.

2.3.2. Indicator and system of indicators

2.3.2.1. Indicators

Indicators of sustainability can be tracked throughout history: for instance, some of the main environmental concerns the world is facing today (e.g. erosion from water and wind, nutrient balance, hygiene, biodiversity) are described some 4000 years ago by a Chinese philosopher and agriculturalist (Freebairn et al. 2003). An indicator is a single variable to document past evolutions. Indicators allow quantification of a non-measurable feature; for instance, a possible indicator for the quality of life in a city is the number of people moving into the city compared to the number of people moving out (SustainableMeasures 2009). Sustainability indicators as introduced by O'Connor (1995) are complex because a need exists to link and equate the economic, social, and environmental progress, whereas indicators most typically treat one aspect independently.

The main purpose and use of indicators is to present the state of a given attribute in certain locations and times to present the geographical and temporal evolution (Van Gelder 2004) and predict the future trends, which might however be subject to unexpected variations (Segnestam 2002, United Nations 2007). Good indicators provide prompt information showing potential issues, addressing collective values, assisting authorities in making generally-accepted decisions to rectify trends (Innes et al. 1999, Van Gelder 2004, Portney 2009, United Nations 2007). At the 1992 Earth Summit, Agenda 21 stated (Capello et al. 2002): "Indicators of sustainable development need to be developed to provide solid basis for decision making at all levels." Indicators do not directly improve sustainability, but represent powerful tools to picture the situation and follow its evolution, and thus for policies and decisions more relevant and efficient.

2.3.2.2. System of indicators

Gathering data for projects with many diverse sets of sustainability indicators may become expensive and tedious. Yet a single indicator by itself may be insufficient to address all three aspects of sustainability everywhere (Bossel 2001, Walsh et al. 2002). A system of indicators should be monitored, with sufficient indicators all contributing to the comprehensive sustainability assessment of the project (Krebs et al. 1997). These indicators should be decided upon with regard to the project and purpose aimed at (Levett 1998).

2.3.3. Environmental Management Systems

2.3.3.1. Management and monitoring

Environmental Management Plans (EMPs) and Environmental Management Systems (EMSs) are possible tools to manage and monitor the environmental quality of the project after construction. An EMP is a set of goals and associated actions, linking all the environmental

issues that have been identified and addressed in the original design (Kollamthodi et al. 2005). An EMP is the first step of an EMS, which is commonly referred to as "plan, do, check, act" models, and includes a continuous evaluation of the reality to determine when the goals fixed in the EMP are achieved (EPA 2009). By evaluating potential situations, EMSs allow organizations to make the best decisions to meet regulations, avoid risks and save money.

2.3.3.2. Communication of the information

EMSs insure that the data can be made available for objective evaluation and comparison, which is recognized by the United States Environmental Protection Agency (USEPA) and many state agencies (National Database on EMSs 2003). This accessibility to information might reduce the costs of inspections for the government, and therefore the costs and delay in enforcement by the organizations. EMS' certification is voluntary. The National Database on EMSs' study showed that third-party certified EMSs does not significantly improve the performance of facility that employ an EMS but are not independently certified. Therefore, the certification process may thus be considered as simply a marketing tool rather than a means to improve performance. In 2004, the International Organization for Standardization (ISO) published the ISO 14001 standard on EMS, which requires that environmental policy of the organization utilizing the EMS be made public, thereby increasing reliability and transparency.

2.3.4. Impact assessments

2.3.4.1. Strategy

The International Association for Impact Assessment defines Environmental Impact Assessment (EIA) as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." This strategy consists in identifying the framework of the

project, in terms of regulations and existing state, and before assessing the plan first established, in terms of its foreseen impacts on the environment.

2.3.4.2. Environment, economy and society

Even though EIAs remain most common, improving resources use is an insufficient part of a sustainable concern, thus other types of Impact Assessment (IA) have been created and implemented. With the increased emphasis on health and wellness, Health Impact Assessments (HIAs) are being created with a similar concept to that of traditional EIAs (Lock 2000). To this day, HIA is the most complete IA in terms of sustainability, because of the broad definition used for "health," defined by the World Health Organization as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." Dalgren et al.'s definition of the main influences on health was adapted as presented in Figure 2.3.4.2 in the SR250 Replacement HIA report (Fleming et al. 2008).

Figure 2.3.4.2. The main determinants of health (Fleming et al. 2008)

Figure 2.3.4.2 shows that health is impacted at four different levels, which strive to: (1) encourage healthy political decisions and major agreements regarding economic strategies and

policies, (2) improve living and working conditions, which are at a national or local level, through healthy business strategies, (3) strengthen social and community support, (4) promote individual choices. These health-focused concerns are similar to sustainability matters. A HIA is indeed a "combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population," according to the World Health Organization (Gothenburg consensus paper 1999). The goal of an HIA is to provide data on predicted impacts of a given project to decision-makers (Quigley et al. 2006). HIAs may be carried into the project or program once realized, to see whether expected performance is met. Improved HIAs are implemented within a Strategic Environmental Assessment (SEA), which is a proactive tool that addresses EIAs' limitations, mainly their observant nature and their segregation of environment from economic matters (WHO 2001).

2.3.5. Conclusion of the tools

Table 2.3.5 presents a summary of the characteristics of the tools presented in this section and the enhancements suggested by the author to develop a sustainability tool.

Table 2.3.5. Summary of the contributions from existing models to a proposed tool

Existing systems	Examples	Definition	Example Contributory Attributes	Proposed Enhancements
Rating System	LEED, Green Globes, BREEAM	"Tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings" (Fowler et. al 2006)	- Recommendations given for each issue identified/each possible improvement - Organization in categories - Possible certification by third-party - Marketing advantages, sparking off the interest in sustainability	- Apply to complex infrastructure - Improve lifespan continuity - Incorporate continuous monitoring system - Limit bureaucracy (cost,time) - Encourage stakeholders' decisions beyond the sustainability system - Enhance beneficial performance, not compliance - Include all interests in the decision processes
Indicators	Wait time (in boat loads), Energy consumption, Port revenue	variables quantifying and recording what has happened previously and what is expected to happen in the future	- Quantification of non-measurable aspects of sustainability - Data collection and analysis - Trends available to decision-makers - Set of indicators to monitor all identified sustainability aspects	- Sustainability goes beyond any single variable - Give recommendations to solve identified/foreseen issues - Adaptability of the set to observed trends
Environmental Management System (EMS)	Specific to company, policy, program or project. Typically, ISO 14001. Environmental Management Audit Scheme (EMAS)	"continual cycle of planning, implementing, reviewing and improving the processes and actions that an organization undertakes to meet its business and environmental goals" (EPA 2009)	- Set goals and timelines - Identification of regulations - Monitoring facilitates identification of potential risks - Communication tool - Possible third-party certification if wanted	- Extension of environmental to sustainability focus - Relation with a planning and design system - Adaptability without having to create a whole new system
Impact Assessment (IA)	Environmental IA (EIA), Health IA (HIA), Strategic Environmental Assessment (SEA), Life-Cycle Assessment (LCA), Life-Cycle Cost Analysis (LCCA)	"Process of identifying the future consequences of a current or proposed action." (IAIA 2009)	- Analysis of potential impacts before project is done, allowing for corrective actions or annulations of project	- Give recommendations to solve identified/foreseen issues if expected results not attained - Propose alternatives to not satisfying elements - Adaptability without having to create a whole new system
Consensus-based standard	ASTM International, ANSI	Transparent decision-making process joining all interests in a consensus	- Open participation - Transparent process - International recognition	

2.4. Suggested characteristics of a sustainability tool

2.4.1. Format of the tool

Ridley et al. (2003) suggested that each tool manual include explanations justifying why it could be helpful, its overall goal and the method to follow, along with an example. This might be a format to adopt for the sustainability system.

2.4.2. Need for an adapted tool

There is no international or national code describing how to develop a neighborhood, a city, or a ferry terminal. Rather, every city is responsible for approving construction projects within its jurisdiction, usually seeking to improve life for its community (San Diego Municipal Code 2009; Bellingham Municipal Code 2004) and can easily account for potential economic advantages. However, the potential benefits of the other two sustainability metrics (social and environmental) are more difficult to assess. Therefore, it would help to find objective tools on which to base projects, possibly using indicators to monitor performance. Optimally, these tools scale over developments of varying sizes.

2.4.3. Participation of interests

Stakeholders participation in the creation process of the tools has been widely shown to be the key for acceptance, mainly because this cooperation leads to compromises that are likely to be understood and based on broad knowledge (Riley 2001, Bell et al. 2002, Gunderson et al. 2002, Ridley et al. 2003, Reed et al. 2002, Reed et al. 2005). There are two primary methods in developing tools or standards: (1) by experts or (2) by stakeholders (e.g. material manufacturers, designers, contractors, governments, and clients) (Van Gelder 2004). Experts are needed for the tools to be accurate, but without stakeholder representation, critical interests might be neglected, leading to disagreement with the tools' basic premise or concept, thereby jeopardizing long-term

acceptance (Innes et al. 1999, Ridley et al. 2003), the sustainability tool should thus be a continuous collaboration between experts and interested parties (Innes et al. 1999, Freebairn et al. 2003, Ridley et al. 2003, Wooldridge et al. 2008).

Some of the most widely recognized standards are consensus-based with open and transparent processes. One example of such a tool is the American Society for Testing and Materials (ASTM) sustainability standard addressing minimum standards for green buildings, which is currently under development (ASTM 2009). Integration into this standard might help to provide a wide recognition and relevance, because ASTM standards benefit from the participation of a wide range of experts and have an established methodology that encourages and favors external comments. The American National Standards Institute (ANSI) also offers a similar open and transparent decision-making process, leading to consensus standards, such as the National Association of Home Builders (NAHB) and Green Globes, two systems competing with LEED.

2.4.4. Simple system for a wide adoption

To facilitate wide acceptance, the system should be simple, and understandable. With a simple and accepted tool, sustainable features would be available for big projects as well as smaller ones, with minor tailoring to adapt to the specifics of the project. There would thus be no need for a specialist or an additional working team. Moreover, a simpler process could promote low cost and rapid implementation.

2.4.5. Need for a life-long sustainability

Once sustainability certification is reached for a building or an urban plan, more should be done. As a matter of fact, leaving the site as delivered without proper maintenance does not

ensure its long-term sustainability. If the air filter is plugged, the indoor air quality may not meet the initial design, which was the reason why the building was rated as sustainable.

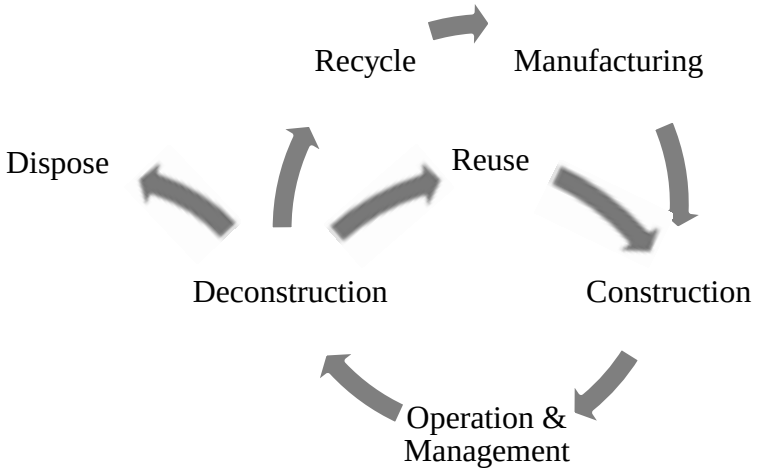

Figure 2.4.5. Life-cycle of building products

Figure 2.4.5 explains the successive phases in the life-cycle of buildings. Life-cycle Analysis (LCA) in construction looks at this whole chain, also called "cradle-to-grave." LCA is defined by the ISO 14040 standard as "a compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle." Sustainability can be defined as quality over the period of time impacting the surroundings of the matter, which explains the interest for life-cycle analysis, consisting in an assessment over the whole life of the building, including management, operation and maintenance.

2.4.6. Proposed tool and process

Table 2.4.6 shows the different characteristics that are suggested to be adopted in a sustainability tool, in which systems these aspects are already employed, and finally, which benefits are expected from these characteristics.

Table 2.4.6. Overview of the guidelines' categories and their issues

CHARACTERISTIC	DESCRIPTION	EXISTING MODELS WHICH EMPLOY THIS CHARACTERISTIC	EXPECTED BENEFITS
SIMPLE	- Categorized by issues	- Rating system	- User-friendly - Clear - Widely available
CERTIFICATION FLEXIBILITY	- Not mandatory - Possible third-party certification	- ISO 14001	- Limit bureaucracy if no third party certification wanted - Limited additional cost and delay - Possible marketing tool
VOLUNTARY	- Not mandatory	- Rating system - EMS - Impact Assessment	- Depend on interested parties' agreements
SUSTAINABILITY	- Address environment, economy and society concerns - Address phases of the project from planning and design to construction, operation and maintenance	- Life-Cycle Assessment (LCA) - Life-Cycle Cost Analysis (LCCA)	- Integrated elements for sustainable infrastructure - Comprehensive solutions - Durability of the solutions
PROACTIVE	- Give recommendations to address identified issues	- Rating system - EMS	- Provide knowledge and tools to any stakeholder - Provide solutions to identified issues
ADAPTABLE	- Improved periodically - Applicable to different types of projects in different places, with minor tailoring of the system	- Rating system and EMS are improved periodically - Rating system might be applicable with minor tailoring	- Tool addresses current needs - Sustainability available to all types of projects in all places
CONTINUOUS PERFORMANCE ASSESSMENT	- Continuous monitoring and management tools during the operational phase	- Environmental Impact Assessment (EIA) - Health Impact Assessment (HIA) - Strategic Environmental Assessment (SEA) - Indicator - System of indicators	- Identification of potential future impacts - Prediction of future trends
CONSENSUS-BASED	- Encourage all interested parties to take decisions beyond the sustainability system	- ASTM International - ANSI	- Comprehensive and relevant expertise - Wide acceptance by interested parties -Recognition of the system

2.5. Process to develop sustainability guidelines for infrastructure

In this section, a process is proposed to aid developing and using the sustainability tool whose characteristics were described above.

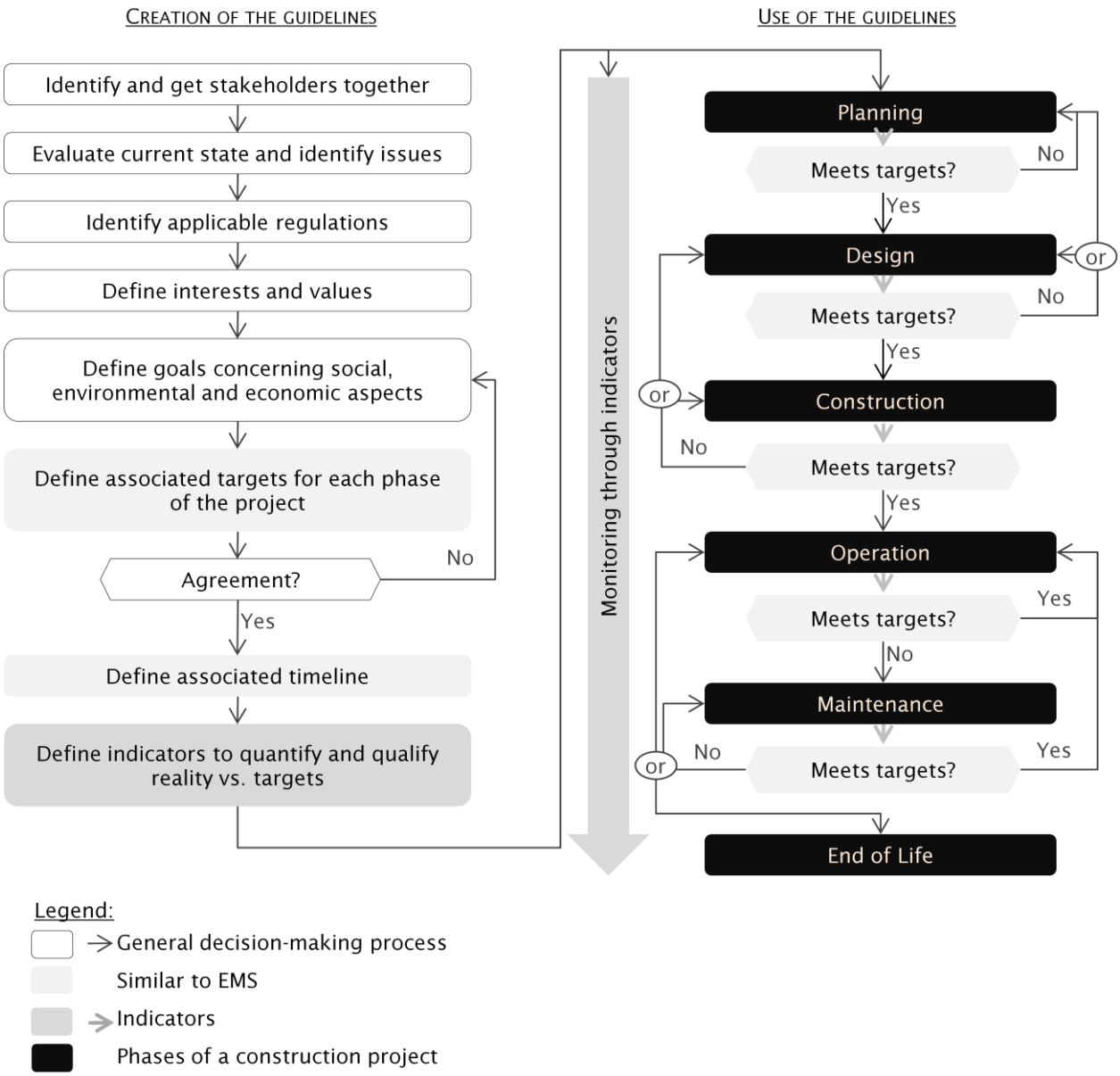

Figure 2.5. Diagram of the process to develop and use sustainability guidelines

The diagram in Figure 2.5 shows how the different tools presented in section 2.3 can be put in one single model avoiding potential overlapping and contradictions. During the creation

of the guidelines, stakeholders come together to agree on targets and goals for a sustainable infrastructure, in the same process as EMSs applied to the triple-bottom line of sustainability. This participatory process follows a consensus-based methodology similar to that of ANSI or ASTM. Indicators are defined to quantify and qualify the results compared to the targets, and identify risks, which is similar to an EMS process. The monitoring process starts, and the guidelines are passed onto the users: contractor, owner, etc. The five phases are provided with guidelines on actions suggested to be done, similarly to the recommendations found in rating systems. After each phase, using the indicators, an assessment is realized to determine whether targets were met or not. This assessment might take the form of an HIA expanded to complete sustainability. Depending on the answer, different paths are taken. The first time a "No" path a followed, going to the lower alternative (i.e. avoiding going too far back which would add a lot of work, and cost time and money) should be chosen. However, in case of deadlock, the solution might be to revise an earlier step. For instance, if the construction phase does not meet the performance expected, a solution might be found still in the construction works. If not, then the design might be reevaluated to find an alternative. After construction is completed, the project goes onto activities and maintenance, and should not go back to design and construction without reevaluating what the interests are and what the indicators to meet targets should be. Thus in the maintenance phase, if targets are not met, a possible outcome is the end of the life of the infrastructure. The site might need to start all over again to fit the needs of populations better, protect the environment and be economically profitable.

2.6. Conclusion

Modern infrastructure is essential to the current health and lifestyle of society. While buildings facilitate human activities and comfort, these constructions may also be a source of

environmental, economic and societal issues. When sustainability is commonly accepted, the restraint is that interests differ on how to implement this concept. Several tools have therefore been created and used, including rating systems, indicators, EMSs and HIAs. This paper has presented existing systems and their characteristics to find the characteristics that might be beneficial to a sustainability tool. These were: (1) simplicity, (2) certification flexibility, (3) voluntary adoption of the suggestions, (4) sustainability, (5) proactive recommendations, (6) adaptability, (7) continuity of the performance assessment, (8) consensus decisions. This study then demonstrated how a combination of these existing systems might be used in a process towards sustainability. Based on indicators reflecting and monitoring the evolution of the project, the system should address issues with agreed-upon solutions from planning and design to construction, operation and maintenance.

2.6.1. Limitations

An objective tool is sought, but the decision is embedded in a given environment. Subjectivity of the choices may arise because of divergence in knowledge and conception of the system, in the future goals sought as well as their timelines, and the interests of each involved party. Organizing the group of decision-makers with individuals of a broad range of interests might involve a long process to reach consensus but the sustainability will also most likely be more complete, as different persons bring different knowledge, conception, values and goals (Mayer 2004), and durable, as agreement on the tool leads to adoption of the projects using it. For this main concern of acceptance, if the parties involved determine that another type of tool would be more efficient, these guidelines should not be used. Guidelines might in this sense be more appropriate than a code: the tool is to help the movement towards sustainability, for which

only the interested parties know what would be useful. The tool created here is a suggestion, not an obligation.

Seeking a universal system is the ultimate goal, but it most likely will not be applicable and accepted worldwide because of differences and divergences in practices, traditions, values, as well as knowledge, means, and stages of development (Hueting et al. 2004). Actors and policy makers have to go beyond these limits, because sustainability is not a matter of world views, but rather of quality of life and resources fate.

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CHAPTER 3 PASSENGER FERRY PORTS: A MODEL FOR GUIDELINES

3.1. Abstract

Passenger ferry terminals are complex facilities that generate various activities, impacts and issues. Current sustainability knowledge and expertise are not always reflected in the reality of infrastructural facilities. This gap between possibilities and reality is commonly accepted to be solvable through the proposition of information and guidance to decision-makers. Many existing rating systems or guidelines are not applicable to these facilities which are at the intersection of land and sea handling vehicles from bikes to cars, buses and vessels, include parking lots, roads, buildings and docks to serve employees, passengers and community, are regulated and restricted by governments and agencies.

As an application of de Sainte Marie (2009), this paper determines the interests involved in passenger ferry terminals as well as the applicable regulations. It then proposes guidelines addressing the seven categories encompassing the identified issues: traffic and parking, integration in the community, energy management, water management, materials management, site selection and air quality. Numbers were attributed to each item of these categories, to highlight what the author found were the main improvements necessary to implement.

This paper supplies passenger ferry ports designers and owners as well as other decision-makers with clear and easy-to-use guidelines to aid them in realizing current and foreseen issues of the implementation of sustainability principles and in providing possible solutions for these issues.

3.2. Introduction

Adoption of green building practices is rapidly expanding in both the commercial and residential sectors (McGraw-Hill Construction 2008). This movement has been fed by both

societal demand and governmental regulation. As these practices continue to expand with time, especially as carbon regulations become a reality, a need will exist to expand to a variety of facilities (for instance train stations and ports) that are not currently served by rating systems such as the Leadership in Energy and Environmental Design (LEED) systems (USGBC 2009). This expansion also provides us with the ability to develop tools and standards that address deficiencies in the current rating systems. Aided by indicators, guidelines that simultaneously address the planning, design, construction, operation, and maintenance phases of a facility would improve our ability to maintain sustainability throughout the life span of the project (de Sainte Marie 2009).

Passenger ferry terminals are facilities that are subject to scrutiny by government agencies, non-governmental organizations (NGOs), port authorities, communities, and citizens, because of the impact on the activities of those groups, in terms of society, economy and environment. By their very nature, ferries must address multi-modal transportation needs across both terrestrial and marine ecosystems. Sustainability guidelines for port development would be a first important step to provide an improved sustainability performance for this type of facility. Several guidelines, rating systems and environmental management systems are currently implemented (USGBC 2009, Fleming et al. 2008) in the construction industry in most parts of the world, but none of these existing tools focus specifically on passenger ferry ports. The objective of this paper is to provide additional guidance for this type of complex facility.

This paper applies the process determined in a previous study to develop a sustainability system for infrastructure (de Sainte Marie 2009). After identifying the factors influencing the sustainability of ferry ports, it presents an audit of existing sustainability tools that are relevant

but not necessarily sufficient. Finally, it presents the resulting sustainability guidelines attached in Appendix A.

3.3. Passenger ferry ports

This section first presents the general ports' activities and the current state of sustainability, and then analyzes the specifics of passenger ferry ports, including activities, goals, infrastructure and interests involved.

3.3.1. Background ports issues

The volume of imported cargo in the United States is expected to grow three times bigger between 2000 and 2020 (Wooldridge 2008). To accommodate this increase, many U.S. ports are improving their efficiency and increasing their capacity to handle goods and passengers (EPA 2007). Their challenge is to strengthen the economic activity while respecting the needs of both the environment and society. Sustainability is increasingly accepted as the path that development should take, but the implementation of these concepts still requires refinement. Many places around the world have chosen to regulate ports to promote sustainable actions (New Hansa 2006, Sydney Ports Corporation 2006, PTI 2007). However, the real issue is that a diverse infrastructural entity, like a port, involves various competing interests including ship owners, fishermen, transportation agencies, cities, neighborhoods, and users. Moreover, different kinds of ports have to be considered. Fishing ports are primarily for commercial fishing, and thus facilitate food products, marinas are recreational areas for personal boats, cargo ports handle containers of goods. These diverse activities result in different issues needing to be addressed.

3.3.2. Specifics of passenger ferry ports

Passenger ferry ports, which this paper focuses on, have specific issues that other ports may not have. Passenger ferry terminals may have vast parking lots, and at specific times, long lines of cars and high traffic flows (when the ferry comes in and out), which cause air pollution, runoff pollution, and might contribute to congestion near the ports and dissatisfaction of users. This section consists of the beginning of the process proposed by de Sainte Marie (2009), applying this process to passenger ferry terminals.

3.3.2.1. Goals of ferry ports

Ferry terminals share many attributes of the larger, more common shipping ports. These facilities have goals that are comparable to the three economic aims of ports as described by Grosdidier de Matons (1999). The first goal of all ports is competitiveness on all three aspects of sustainability: high volume of passenger transit (i.e. societal benefits), high economic efficiency, and low impact on the environment. In addition, each type of port strives for relevance in a niche sector, where it seeks to be widely accepted for offering a cost-effective means of transportation, thereby becoming a critical link in the circulation of goods or people. Finally, the third goal is a positive impact towards local, regional and national economy and transit.

3.3.2.2. Different types of constructions on a single project

Most existing strategies and rating systems apply to specific building types, for instance Leadership in Energy and Environmental Design (LEED®) and Building Research Establishment Environmental Assessment Method (BREEAM) are most commonly applied to commercial buildings (WTC 2004). However a ferry port is distinct from these usual facilities since it is not limited to a building or a few buildings with common purposes but instead is a multi-modal transportation facility with docks, roads, parking lots, buildings, and passenger accommodations.

Relevant guidelines must integrate commercial, transportation, marine and neighborhood concerns.

Ferry ports are designed to service people more than commercial buildings are, thus sustainability beyond simple green (i.e. environmental) concerns is crucial: the social and economic sides of sustainability have to be specifically considered.

Finally ferry ports are public facilities. Sustainable techniques are still developing, and there might therefore be a lack of knowledge all along the construction chain: from the designer to the worker. Additional factors of safety might be included, partly because of the scrutiny the project is subject to, and each step of the process takes longer than traditional projects to complete.

3.3.2.3. Relation with the area

Ports are different from traditional constructions, first because of the increased interaction with surroundings compared to that of traditional buildings. At the intersection of several disciplines, ports present several challenges, including transportation, buildings, freight, storage, water, noise, air pollution, and sediments. Ports are at the intersection of sea and land, impacting both. Therefore, a holistic team is required to create, implement and manage the guidelines and monitoring system (de Sainte Marie 2009).

Ports have a large impact on the city, and ferry terminals show a particular effect on the community and its citizens. In comparison, a commercial building is constrained by its surroundings, whereas a ferry port tends to define its surroundings since it often dictates the layout and size of adjacent roads required to maintain traffic at a reasonable level. The new transportation system will attract people to the city, either to live, because commuting to work is possible, or to work, because commuting from a broader area is possible. Tourists, commuters

and port employee will participate in the local economy for items such as meals and shopping. All have a significant impact on local economy: ferry ports attract visitors who constitute potential customers for restaurants and shops. The terminals thus impact a number of supporting facilities and stimulate the development of the waterfront, adding up to the attractiveness as well as improving the economy of the city (Estrada-Llaquet 2005). Overall, the port is a focus that may enlarge the exposure of a city to the public, increasing value and wealth.

The city-port relation can also be considered the other way, the port being influenced by the city. The success of the terminal depends on the need for a transportation line, on the connectivity to major lines such as highways and trains, on the waterfront area, and on the location in the city (Estrada-Llaquet 2005). Harbors are in this sense not masters of their success because of a dependence on the surroundings.

3.3.2.4. Stakeholders

To improve relevance and acceptance, guidelines should be developed by a holistic team of stakeholders in order to reach agreement for a future application with limited discussions, therefore reducing the time and cost of implementation (de Sainte Marie 2009). This section defines which stakeholders should be involved.

Technical work team

Technical expertise is needed for the guidelines. The technical work team could be divided into different subject matters, such as terminal design standards, evolution of demand forecast, evolution of environment forecast (groundwater level, sea level), construction, operations, maintenance, and finances. For the guidelines to be applicable in ports with differing specifics and in various regions, there might be a need for a group to be in charge of the development and improvement of the guidelines. This technical team could be the moderator of

the stakeholders and be responsible for the tool, as the interest and affiliation to a specific port is less likely to be biased than any of the groups mentioned below.

Port authorities

Port authorities are the experts in ports operations and will eventually run the port. These groups need to understand and accept the guidelines in order to actually see this tool being followed and ports being improved. Port authorities might be the first user of the guidelines, requiring designers and contractors to use this tool.

Governmental interests

Some of the main political entities include:

- Federal, State, County and City authorities,
- Army Corps of Engineers, for hydraulic permits
- Federal Transit Administration (FTA)
- Federal Highway Administration (FHWA)
- Environmental Protection Agency (EPA) for the National Environmental Policy Act (NEPA)
- And others, specific to the area or the project (e.g. Department of Ecology for National Environmental Policy Act in Washington State, and Fish and Wildlife from the Department of Interior concerned by birds disturbance during pile driving for instance)

Tribal interests

In the Puget Sound, Washington State Ferries (WSF), a division of the DOT, has developed a project to modify the Mukilteo ferry terminal, which is currently too small to handle the demand. The goal of the project is to connect several transportation systems together,

including a railroad system from Canada down along the coast. This multi-modal connection would facilitate alternative transit modes, thus reduce the amount of cars, which presently causes noise, air pollution, overall congestion of the city, etc. Artifacts and other archeological interests were noted around the current site. The existing port site and activities resulting from a treaty signed between the tribe running the city and WSF, the new project is a matter of discussion between the two authorities, and the outcome is unsure. This example illustrates the need for tribes to be involved in the guidelines process, to develop the need and manner for how the port might change, discuss their interests, and then participate in the general agreement on the guidelines. This participation may alleviate the need for changes to projects that are already far into the planning and designing phases.

Public involvement

A similar case to the port of Mukilteo happened in Edmonds, Washington. The project was rejected, wasting time and funds to finally leave the city with the same issues. Environmentalists and other community activists represent entities of public interest that require process involvement, thereby avoiding future discussions by solving the problems beforehand.

In the Puget Sound area for instance, Ferry Advisory Committees are consulted regularly to give input to Washington State Ferries, in terms of schedules, customer satisfaction and regional issues (WSDOT, 2009).

3.4. Existing applicable framework

The process developed by de Sainte Marie (2009) specified that the next step after gathering all stakeholders is to identify all applicable regulations and standards, which are presented in this section.

3.4.1. Law and regulations

The sustainability guidelines for infrastructures do not replace existing rules, laws or regulations, which constitute a baseline (Wooldridge 2008; de Sainte Marie 2009), a requirement in the design and construction, as well as in short and long-term operations.

3.4.1.1. Ferry terminals in the United States

A ferry terminal has to meet the requirements of the Department of Transportation (DOT) of the United States as well as that of the state, and all construction codes, from the federal level to the municipal level. In many places around the United States, state agencies currently require their buildings to obtain LEED certification. As state facilities, ferry terminal designs might, therefore, also have to comply with LEED where applicable. However, the sustainability metrics set by the stakeholders should maintain precedence when selecting among the many routes to obtain points within the LEED process.

Since the federal government will most likely be part of any public transportation project, one of the major laws applying is the National Environmental Policy Act (EPA 1970), developed by the EPA (Environmental Protection Agency). In order to show that the project is in compliance with this regulation, an Environmental Impact Statement (EIS) must be prepared and submitted to the EPA. In Washington, the SEPA (State Environmental Policy Act, Department of Ecology 1971), developed by the Department of Ecology has to be followed.

3.4.2. Relevant assessment systems and guidelines

If pre-existing systems apply, a very different work has to be done than if nothing exists, it is thus important to analyze the applicability of existing tools. For instance, if several current rating systems contain the same categories, or share some categories, there is no need to reassess these parts in this study: companies developing these categories probably have more experience,

expertise, time and funding. The commonly accepted sustainability elements should be included in the guidelines proposed here.

Existing sustainability tools exist, but often focus on typical commercial or residential buildings (LEED, BREEAM, Green Globes…). These tools are thus not directly applicable to ferry terminals (de Sainte Marie 2009). Other tools address general ports, which are also significantly different from ferry terminals, and may not address adequately all phases the life of a facility (planning, design, construction, operation and maintenance). Nonetheless, some sections of existing systems might apply to ferry ports. For instance, credits concerning pavement might be found in a rating system such as Green Roads (Soderlund 2007) or in LEED for the use of permeable surfaces. Credits regarding recycling and reusing materials are also developed in a thorough manner in these two rating systems. The following section introduces some tools selected for their relevance which may be useful for ferry terminals.

3.4.2.1. Overview of relevant tools

❖ LEED New Construction rating system™ (USGBC 2009)

This rating system includes guidelines for new construction and major renovations. This tool is nowadays widely recognized as a leader in the United States; LEED certification is mandatory in many government buildings. The system is used overseas as well, along with other rating systems such as BREEAM. LEED for New Construction addresses seven categories of green concerns in new construction. The existent categories in the 2009 version are Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design, and Regional Priority. Although useful, the current rating system is not comprehensively applicable to ferry terminals for the following reasons:

- It is design oriented, not fully addressing long term operational and maintenance phases;
- It is a green tool, privileging environment over economy and society;
- It addresses a specific type of buildings and some site issues, but a ferry terminal is a project involving buildings, parking lots, docks, boats, etc.

❖ World Trade Center Commercial Design Guidelines (WTC 2004)

This manuscript was written in 2004 by the Lower Manhattan Development Corporation and the Port Authority of New York and New Jersey, to facilitate the redevelopment projects of the World Trade Center after the destructive events of September 11th, 2001. The commercial sustainability guidelines presented in this paper do not directly apply for ports: the issues specific to ferry ports compared to commercial buildings and general ports (e.g. passenger-oriented activity, large economic, environmental and social impacts) are not fully addressed. The guidelines developed in this thesis will also be more specific in the recommendations given, where these WTC recommendations might suggest implementing a plan, which might require additional work, costs and delay.

❖ Sustainable and green ports: application of sustainability principles to port development and operation (Abood 2007)

This paper was written by Abood after the American Society of Civil Engineers (ASCE) Ports 2007 Conference. According to this study, sustainable elements might involve a higher initial cost, but the lower operation and maintenance costs and higher productivity and health will largely compensate for such expenses. This paper presents the Port of New York and New Jersey's initiatives to explain this statement. All of the issues of ports and ferry ports are not addressed in Abood's study. The study mainly looks at the different credits of the LEED rating

system and shows how these are applicable to ports. The findings show that LEED is not fully applicable to ports. The guidelines proposed in our study also reference LEED and other systems and suggest that these systems be used in the port improvement process.

❖ Green Port Guidelines: sustainable strategies for port developments and operations (Sydney Ports Corporation, 2006)

These guidelines were written by the Sydney Ports Corporation in 2006, to encourage sustainable practices and innovations in design and operation of ports serving cargo and passenger vessels. The categories are not specific to ferry ports, but specify which point relates to which part of a project, among design, interior, construction activity, and operation. Each point is also given a grade reflecting the benefits, ease of implementation and return on investment. The idea of separating phases is included in the guidelines created here.

3.5. Sustainable passenger ferry ports guidelines

3.5.1. Philosophy of the guidelines

The scope of this study provides a vision for a sustainability system specific to passenger ferry ports. The proposed system is composed of a design guideline that provides the general framework for developing and tracking relevant sustainability metrics throughout the various stages of establishing and operating a proposed facility. The guidelines compile relevant metrics and considerations gleaned from the literature and interviews with WSDOT officials. The goal of these guidelines is to assist ferry port developers, contractors and owners in moving towards sustainability, pointing out issues identified in current ferry terminals' facilities and suggesting preventive or corrective measures for these issues. These guidelines are intended to be used over the whole life span of a port. This tool consists of general suggestions that may be considered by relevant stakeholders prior to application. This tool is not a code, is not mandatory and does

not pretend to give the best solution for every case. This document was developed to the best of the author's knowledge but there might be shortcomings that are specific to a particular project. This system should be taken as the beginning of a work in progress.

The phases covered by the proposed guidelines are the following:

- Planning: it is the process of deciding how the space shall be used to improve functionality for occupants and users, including vehicles (vessels, cars, motorcycles, bikes, etc.).
- Design: it consists of the technical data (drawings, specifications, etc.) needed for the realization of the plan determined above.
- Construction: it is the physical realization of the plan, using the design.
- Operation: this is the use of the facilities for their intended purpose, here transit on vessels. This phase also includes passenger activities, such as all transit modes on the site, waiting, purchase in the facilities (food or goods), ticketing, vending, etc.
- Maintenance: this consists of the actions taken to maintain the safety and keep the facilities at expected levels.

Planning and design have to be separated in ferry terminal projects, because communities get involved in the planning processes, which may be lengthy and may become a limiting factor, such as in the Mukilteo case, where the project is currently on hold because of the Snohomish Tribe's interests. The plan can thus be discussed and agreement can be reached before any time and money is put into design.

The guidelines sought in this project are to address planning, design, construction, operation and maintenance (de Sainte Marie 2009). According to Tom Bertucci (Bertucci 2009),

employee of Washington State Department of Transportation (WSDOT), new construction design, renovation and maintenance are projects handled by the State DOT, but the construction phase is subcontracted to independent contractors, whose objective is to meet the technical requirements for the best price. To a certain extent, contractors will choose sustainable measures, for instance limiting construction waste, because it reduces the purchase of material; economics are driving these choices. The contract may limit certain impacts and enforce the owner's decisions towards sustainable practices. The guidelines developed in this thesis seek sustainability over the whole project, which is why construction is included in this tool even though independent contractors may have significant flexibility in the implementation.

As mentioned before, the scope of this thesis is the creation, not implementation, of comprehensive guidelines for sustainability.

3.5.2. Categories

The guidelines are divided into categories reflecting ferry ports issues. All categories do not have the same importance, but all have a certain impact on sustainability. The different categories presented hereafter are the following: traffic and parking, integration in the community, site selection, energy management, water quality and management, air quality, and material management. Habitat destruction is also an issue in ferry terminals, whether caused by destruction, erosion, air pollution, water pollution, disturbance, noise, or vibrations. These impacts are often attributed to the port, but are consequences of issues mentioned in the above categories, thus there is no category titled "habitat destruction."

In order to show where to start using this guide, a number is attributed to the different issues identified. These are from 1 to 5, with 5 corresponding to the most important items, which should be addressed first. These values were estimated to the best of the author's knowledge but

should be re-evaluated by the stakeholders and decision makers. The weights should not be added in each category to find their relative importance; rather the average may reflect the significance of the issue.

Table 3.5.2. Overview of the guidelines' categories and their issues

No.	Category Title	Issue	Importance
1	Traffic and Parking	Quantity	5
		Distribution	4
2	Integration in the Community	Light pollution	2
		Noise pollution	3
		Vibrations	2
		Habitat restoration	3
		Aesthetics	1
		Culture and Education	1
3	Energy Management	Renewable	2
		Consumption and Efficiency	5
4	Water Management	Pollution	5
		Consumption and Efficiency	3
		Storm Water Management	4
		Ballast Water Management	2
5	Materials Management	Quantity	4
		Quality	3
6	Site Selection	Availability	2
		Future changes	2
		Dredging	3
7	Air Quality	Infrastructure Emissions	3
		Indoor Comfort	3
		Activities on the Dock	5

Table 3.5.2. shows that traffic and parking are a priority in ferry terminals, followed by air quality, energy, water, and materials management. Finally, site selection and integration in the community are to be addressed. This ranking is justified by the fact that traffic is the main activity of the port; without traffic issues being addressed, the economic viability of the terminal is not sound. As a significant impact according to most current sustainability tools, natural environment aspects follow. Lastly, site selection and integration in the community are essential

to the acceptance of the port and its success. The following sections introduce each of the categories.

3.5.2.1. Traffic and Parking

Issues

Four-wheel vehicles are the limiting factor in the activity of ports: walk-on passengers, bikers and motorcyclists rarely have to wait and see a ferry leave full, whereas cars and buses often have to wait more than a boat load before being able to transit. As an example, the commuter trip from Seattle to Bainbridge at 5pm sees passengers waiting for a boat load every morning and every night. Around mid-day on Saturday, it is common to see the ferry from Mukilteo to Clinton having and from Edmonds to Kingston having a few boat loads wait (Bertucci 2009). This wait also has consequences on the surrounding area, with traffic jam caused by car remaining outside the site limits (Belford Ferry Terminal; Macau's Second Ferry Terminal; South Ferry Terminal Project). The amplitude is significantly higher at peak periods. Evident solutions might be to develop facilities large enough to handle the peak correctly and therefore oversized the rest of the time, or to increase the number of boats but this additional activity must be approved by involved interests. However improving the use of restricted areas and boat activities is possible and feasible as it relies on the port authorities themselves.

Objectives

The goal of this section is to increase activity capacity, passenger satisfaction and decrease the negative impact of vehicles on surrounding neighborhoods. This improvement goes through an optimization of the capacity of vehicles handled for a given site area and vessel activity, which would increase the number of customers, as well as a shift of the peak demand and an improvement of the distribution and flow of passengers.

3.5.2.2. Integration in the community

Issues

Terminals have impacts on the surrounding community which may be of various importances, but are to be addressed nonetheless. Ferry terminals have an important impact on their surroundings, which implies that the community gets involved in projects. The main problem is that communities tend to be dissatisfied with these impacts, and become reluctant to approving extensions or modifications of the terminal and/or its activities. Resulting negotiations add costs and delays to projects, and limit the innovations and improvements.

Objectives

The goal of this section is to limit negative impacts on the neighborhood and on passengers in order to increase acceptance, which may increase projects' feasibility. These improvements include reducing vibrations, light and noise pollution, implementing a habitat restoration plan, improving the aesthetics of the terminal, and promoting the port and its activities.

3.5.2.3. Energy Management

Issues

Energy use is an important source of pollution as well as operational costs. Centralized energy systems require distribution, involving energy losses and cable lines to install, operate and maintain. Nowadays, the energy demand is close to the grid capacity in some places especially during peak periods, where black-outs might sometimes occur. As consumption increases, prices rise and energy availability diminishes (DOE 2009). The dependence of the port activity on the municipal system is therefore a concern, because of significant bills and possible failures.

Objectives

The goal of this section is to reduce the energy consumption and limit the dependence of the activity of the port on the energy grid. This solution should improve the profitability and reliability of the port and improves the grid from fluctuating important demands. Energy-related pollution can significantly be lessened.

3.5.2.4. Water Management

Issues

Water is an essential resource. Today's water supplies are threatened and it is crucial to reduce consumption and pollution.

Objectives

The goal of this section is to limit the consumption of potable water for non-drinking purposes, to treat water to limit pollution, to make use of all available water to limit purchase and dependence from the city, and finally to limit runoff damages.

3.5.2.5. Materials Management

Issues

As human activity increases, material resources decrease and landfills cannot handle all the waste. The environmental impact is considerable. Increasing costs are associated with purchasing materials as well as dumping wastes.

Objectives

The goal of this section is to limit the use of resources, to increase reused and recycled materials, and to improve waste management.

3.5.2.6. Site Selection

Issues

As an element of a multi-modal transportation system, the location of a ferry terminal is a key to its success. The ideal site would be close to downtown, to allow easy and convenient commute; however there will most likely not be a clean and unused site that is availablefor port use in these locations.

Objectives

Sites needing more work might be available, such as gray- or brownfield sites, and/or with a polluted water area. The goal of this section is to suggest ways to enable the durable use of water/land sites that appear unusable at first.

3.5.2.7. Air Quality

Issues

Most of the activities in the port generate emissions polluting the air. The facility itself also influences air quality with its ventilation system and emitting materials, which has a direct impact on the health and comfort of passengers, employees, and neighborhood residents.

Objectives

The goal of this section is to limit the air pollution caused by the port and its activities, and improve the indoor environment.

3.6. Conclusion and further work

3.6.1. From guidelines to rating and management system

As an application of de Sainte Marie (2009), the process to develop sustainability guidelines for infrastructures was applied to create a first version of guidelines for passenger ferry terminals. Involvement of interested parties and regulations were identified as part of a structure in which the system should be developed and implemented. Because current

sustainability systems and standards apply to specific infrastructural projects and do not fully account for the impacts caused over the entire projects' life spans, these existing systems are not directly applicable to ports. Passenger ferry terminals are indeed at the intersection of water and land; they include parking lots, public facilities, commercial facilities, vehicles and individuals, customers and employees. The activity on the dock and around the site goes in cycles, regularly peaking (e.g. commutes in the mornings and evenings, beginning and end of nice-weathered weekends). The terminal impacts the whole neighborhood and city, and these impacts can be positive or negative. Traffic and parking are the first direct impacts to be addressed: improved handling has the potential to increase the transit capacity without negatively affecting the city, thus servicing more passengers and increasing revenues. Economic activity is facilitated by this new transit system and the attraction it brings, but this activity also uses resources (e.g. materials, energy) and creates pollution (i.e. water, air). The comfort of the surroundings is also a concern, because of noise, vibration, light and aesthetics matters. Considering all of these identified issues, the guidelines were created by categories, with a system of points showing what the author considered to be the most urgent to be addressed. This system is to be looked at as a work to be furthered, and this point system should be the consequence of stakeholders' consensus. The next section presents the author's recommendations for the ultimate use of the guidelines

3.6.2. Integration with existing plans

The United States Green Building Council (USGBC) introduced a global environment for all of the different LEED rating systems, which share basic sustainable construction principles, while being specific to homes, new constructions, core and shell, etc (USGBC 2009). The proposed ferry ports rating and management system should be integrated into a similar bigger scale system, so that uniformity over the whole construction field is reached. This integration

would also cut down the cost and time involved in implementing and changing the system, since several systems include the general construction laws as well as basic sustainable designs. For that reason, adopting the format of the system aimed for will attract the relevant organizations more easily, and therefore facilitate inclusion. For the ferry ports' sustainable rating system, a format similar to that of a consensus-based standard such as American Society for Testing and Materials (ASTM) or American National Standards Institute (ANSI) has been suggested in de Sainte Marie (2009).

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CHAPTER 4 CONCLUSION

4.1. Conclusion

Sustainability is commonly accepted as the path development should take, but the restraint is that interests differ on how to implement this concept. In the construction industry, the green movement has been gaining ground over the past decade, but environment is only one aspect of sustainability, which also includes social progress and economic profit. Several tools have been created and used, including rating systems, indicators, EMSs and HIAs. Current systems present three main shortcomings: (1) specificity for one particular type of project, (2) bias towards the environmental aspect of sustainability and (3) focus on certain phases of the project versus its entire life span. Chapter 2 of this thesis demonstrated how a combination of these existing systems might be used in a process towards sustainability. Based on indicators reflecting and monitoring the evolution of the project, the sustainability system should be consensus-based and address agreed-upon issues from planning and design to construction, operation and maintenance.

These findings were then applied in developing guidelines for passenger ferry ports. To the author's knowledge, this type of infrastructure has, to this day, not been addressed as a whole in any system. The development of these guidelines consisted of identifying the interests involved, the applicable regulations, and the current or possible issues. The issues were organized in seven categories: (1) traffic and parking, (2) integration in the community, (3) energy management, (4) water management, (5) materials management, (6) site selection, (7) air quality. Some solutions were suggested for each category, but ports are encouraged to implement any further features they might find useful and feasible. These guidelines are to be considered as an aid for decision-makers in port development - mainly designers and owners -

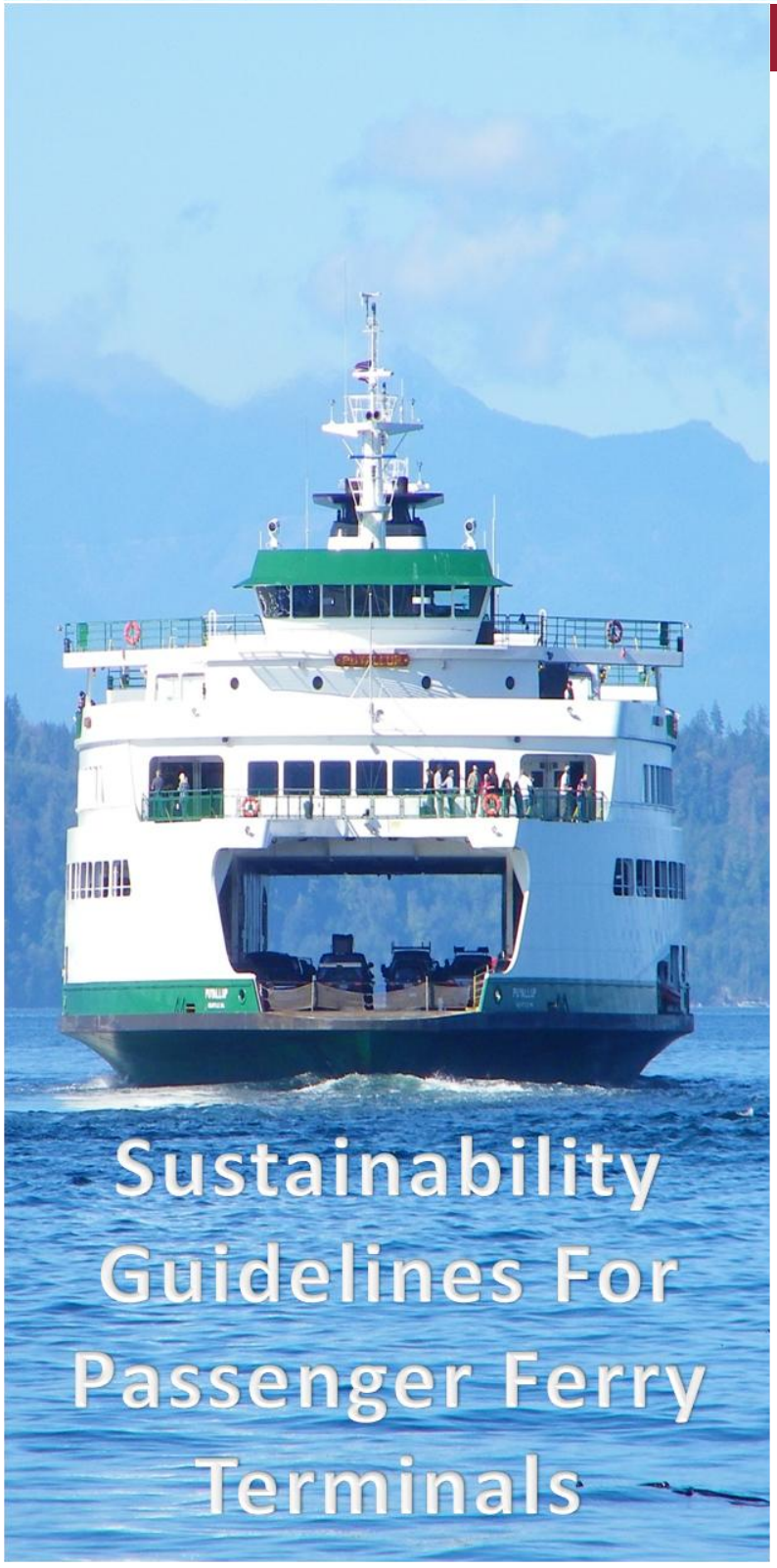
who remain the authority and should seek the most appropriate tool and solutions for the sustainability performance of their facilities.

4.2. Further work

These guidelines are a work in progress. More work needs to be done in the development of these guidelines:

- Organize a task force including all relevant stakeholders and experts to work on the guidelines development.
- Develop empirical evidence of each component, showing how it is actually an issue.
- Develop solutions for each component, with an analysis of each solution presenting pros and cons so that in each specific case, the most appropriate one can be chosen.
- Analyze case studies to determine how the guidelines would impact lifecycle analysis of ferry ports that incorporate them, and modify the tool according to the results. Conduct this analysis after realization of the project, possibly in the form of a pilot phase.
- Incorporate the system in a consensus-based recognized standard such as ASTM to ensure its relevance, pertinence, recognition and wide use.

APPENDIX A: PASSENGER FERRY PORTS GUIDELINES



Contents

Introduction

The volume of imported cargo into the United States is expected to grow by a factor of three between 2000 and 2020 (Wooldridge, 2008). To accommodate this increase, many U.S. ports are improving their efficiency and increasing their capacity to handle goods and passengers (EPA, 2007); the challenge is to respect environment and society. It is commonly accepted that sustainability is the path that future development should follow, but how we attain and implement it is still a work in progress. It may be effected by a combination of regulatory and voluntary programs.

Passenger ferry ports have specific issues that other marine ports would not have (marina, fishing port, etc.). They have long lines of cars, vast parking lots and high traffic flows at specific times (when the ferry comes in and out), which cause air and runoff pollution, congestion, dissatisfaction...

These guidelines are intended to improve ferry ports in a sustainable manner, representing a balance between economic, social and environmental issues. The objective of a port is to increase its profit by servicing customers without harming habitat or neighborhoods, polluting air or water, etc. Addressing one of these aspects often addresses another simultaneously. For instance, treating stormwater to reuse it for non-potable uses may decrease the water bill of the facility. Thus, seeking sustainability is not incompatible with looking for port profitability.

Guidelines or code?

This document is not a code. It is not mandatory and does not pretend to give the best solution for every case. It was developed to the best of the author's knowledge but there might be shortcomings that were not identified or that are specific to a singular project. These guidelines are general suggestions that may be considered by relevant stakeholders before being applied.

Who should use these guidelines?

This documents points out the issues that were identified in current ferry terminals and suggests preventive or corrective measures. The goal of these guidelines is to assist ferry port owners in their process towards sustainability; they might require developers and contractors to use this document.

Wooldridge, C.F., Wakeman, T.H., & Theofanis, S., 2008. Green Ports and Green Ships. Intelligent Freight Transportation, pp.285-312.
EPA Environmental Protection Agency, 2007. An Environmental Management System (EMS) Primer for Ports: Advancing Sustainability. Interim Final Draft

Use of the guidelines

How to use these guidelines?

This documentis structured around seven categories representing the major issues on ferry terminals. They are as follow:

TP: Traffic and Parking
IC: Integration in the Community
EM: Energy Management
WM: Water Management
MM: Materials Management
SS: Site Selection
AQ: Air Quality

When to use these guidelines?

These guidelines are intended to be used over the whole life span of a port. The phases covered by the guidelines are:

P Planning: the items showing this icon concern the process of deciding how the space shall be used to make it functional for its occupants and users, including the vehicles (vessels, cars, bikes, etc.).

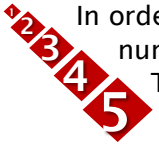
D Design: this icon is for items needing technical data and choices (drawings, specifications, etc.).

C Construction: this icon shows that the item has to be addressed during construction.

O Operation: this icon points out the items which come under the use of the facilities for their intended purpose. It includes vessels, passenger activities, transportation and parking on the site, sales in the facilities (food or goods), ticketing, vending, etc.

M Maintenance: this is the actions taken to keep the safety and satisfaction to their expected level.

Where to start?



In order to show where to start using this guide, a number is attributed to the different issues identified. These are from 1 to 5, with 5 corresponding to the most important items, which should be addressed first.

How to measure progress?

The last column references applicable tools such as standards and rating systems, which were developed with relevant expertise. The referenced qualitative or quantitative measurements will help the user of this document measure their progress and see where their effort has to be expanded. The references are presented on the next page.

How to keep track of progress?

The last section of these guidelines is a progress table to complete as elements adressing the issues are incorporated into the project. Updating this table ensures that most issues are addressed. It also facilitates an overview of the situation.

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Traffic and Parking

Traffic and Parking are the main activities at a ferry terminal. Four-wheel vehicles are the limiting factor in the activity of ports: walk-on passengers, bikers and motorcyclists rarely have to wait and see a ferry leave full usually they can take the first ferry leaving.

The goal of this section is to increase activity capacity, especially vehicular capacity, passenger satisfaction, and improve the impacts of the vehicles on the neighborhood.

Issue	Purpose	Suggested actions	Phases
5 Quantity	Optimize the capacity of passengers handled for a given site area and vessel activity	Promote High Occupancy Vehicles (HOVs) by preferred rates or faster access	P O
		Encourage walk-on passengers by improving the multi-modal connectivity	P O
		Encourage bicycle use	P O
		Facilitate drop-off	P O
		Implement a shared-car or renting car program	P O
		Implement a park-and-ride program	P O
		Optimize traffic flow with path finders and signals implemented around the site	P O
4 Distribution	Reduce peak demand and improve distribution	Implement a reservation system	O
		Increase peak periods prices	O

Environmental benefits	Economic benefits	Society benefits	Applicable references
Air pollution reduction, noise pollution reduction	More passengers revenues	Less traffic and wait (satisfaction of neighborhoods and passengers)	LEED-NC SSc4.4
Air pollution reduction, noise pollution reduction	More passengers revenues	Less traffic and wait, might improve life style and health	LEED-NC SSc4.1,4.2, SSI 1.7, WTC UEQ2, UEQ4
Air and noise pollution reduction, fewer parking stalls, reduced stormwater issues	More passengers revenues	Less traffic and wait, might improve life style and health	SSI 1.7, WTC UEQ2
Need fewer parking stalls, reduced stormwater issues	More passengers revenues	Less wait and cheaper transit (walk-on's fare vs. vehicles' fare)	WTC UEQ7, UEQ8
Need fewer parking stalls, reduced stormwater issues	Less vehicles, new business opportunities	Less wait, more convenient to go to areas without public transit	WSF, FHWA
Air pollution reduction, noise pollution reduction	More passengers revenues	Less wait and cheaper transit, more convenient for areas without public transit	LEED-NC SSp1, IEQc3.1, EPA 1992, ASHRAE 52.2-1999, WTC SEQ5, IEQ7
Air pollution reduction, noise pollution reduction, need less roads, reduced stormwater issues	Less employees needed for traffic	Optimized and safer traffic (satisfaction of neighborhood and passengers)	SSI 6.5, WTC UEQ4, UEQ7, UEQ8
Air pollution reduction, noise pollution reduction	Easier to predict demand	Less wait (passengers) and less traffic (neighborhood)	WTC UEQ8
Air pollution reduction, noise pollution reduction	Higher revenues	Improved distribution of demand, which decreases the wait and the peak traffic	WTC UEQ8

Integration in the Community

Ferry terminals have an important impact on their surroundings, which implies that the community gets involved in projects.

The goal of this section is to limit negative impact on the neighborhood and on passengers in order to increase acceptance and thus project possibilities.

Issue	Purpose	Suggested actions	Phases
2 Light pollution	Limit the light pollution brought to the neighborhood and the water life	Limit interior lighting exiting buildings and boats	D O M
		Limit exterior lighting to areas where needed for safety or comfort	P C O M
		Limit all lightings to brightness needed (comfort and safety)	D C O M
3 Noise pollution	Limit the noise brought to the neighborhood and the water	Use bubble curtains during pile installation	C
		Use noise barriers around site	P D C M
		Adjust the fog horn noise level to the conditions	O
		Limit noise level, especially during construction works	C O M
2 Vibrations	Limit water and land vibrations		C O M
3 Habitat restoration	Implement a habitat restoration plan	Use lights under docks for fish	P D M
		Create fish paths (higher currents) around the facilities	P D C M
		Include nesting platforms	P D M
		Include plants (non-invasive and native)	P D M
1 Aesthetics	Limit the visual impact of the terminal	Architecturally blend the infrastructure into its area	P
1 Culture and education	Advertise the port's visions and activities and get more costumers	Create a visitor center about the activity and infrastructures of the port	P O
		Include guided tours on trips	O

Environmental benefits	Economic benefits	Society benefits	Applicable references
Energy use reduction, habitat disturbance reduction	Energy use reduction	Less visual impact	LEED-NC SSc8, SSI 6.9
Energy use reduction	Energy use reduction	Less visual impact	ANSI 90.1-2007, IESNA RP-33, SSI 6.9, WTC IEQ11
Energy use reduction	Energy use reduction	Less visual impact	LEED SSc8, ANSI 90.1, SSI 6.9, WTC SEQ4, IEQ12
Less fish disturbance			WTC SEQ5
Less habitat disturbance		Better comfort	SSI 6.7, WTC SEQ5, IEQ11
Less habitat disturbance		Better comfort	LEED-NC SSp1, IEQc3.1, EPA 1992, ASHRAE 52.2-1999, WTC SEQ5, IEQ7
Less habitat disturbance		Better comfort	SSI 6.7, WTC IEQ11
Less habitat disturbance			WTC SEQ5, IEQ11
Less fish disturbance			America's Green Ports
Less fish disturbance			SSI 1.4, America's Green Ports
Less bird disturbance			SSI 1.4, America's Green Ports
More habitat, Air cleansing, water runoff control	Less damages from water	Improved visual comfort	SSI 1.4, 3.3, 4.2, 4.8, 4.9, WTC UEQ5, SEQ3, America's Green Ports
		Better acceptance from neighborhood, better attractivity for passengers	SSI 3.7, WTC UEQ6
	Potentially bring new passengers, who are also consumers in the local businesses	Better understanding and acceptance, cultural and recreational activities	SSI 2.3, 6.3, 6.4, WTC SEQ13
May help demand distribution if guided tours are off-peak	Potentially bring new passengers, who are also consumers	Cultural and recreational activities	SSI 2.3, 6.3, 6.4, WTC SEQ13

Energy Management

Energy use may be an important source of pollution as well as a contributor to operation costs.

The goal of this section is to reduce the energy consumption and the dependence of the activity of the port on the energy grid. This improves the profitability and reliability of the port and frees the grid from fluctuating demands. Energy-related pollution can significantly be lessened.

Issue	Purpose	Suggested actions	Phases
2 Renewable	Autonomy in terms of providing energy	Produce renewable energy with marine potential (tides, waves, currents), solar panels, wind	P D O M
		On boats, heat up water through the waste heat from engines' exhaust	D O M
5 Consumption and efficiency	Reduce energy consumption	Use local material for construction and renovation, and local products for usual activity (food etc.)	C O M
		Use materials with minimal embodied energy	D C O M
		Incorporate passive design, such as daylight harvesting	D M
		Incorporate high-efficient systems	D
		Use individual control of temperature, ventilation and light in offices	D O M
		Use automatic control of temperature, ventilation and light in public areas	D M
		Automatically turn off unnecessary lights when there is no activity or when the environment is bright enough	D C O M

Environmental benefits	Economic benefits	Society benefits	Applicable references
Avoid fossil fuel sources. Less transport of energy needed hence less energy losses	Reduced energy consumption costs. Availability of energy is secure (if the system temporarily does not provide enough, always possible to buy externally) Rebates may also be available	No major activity added on the power grid (availability of energy more secure). Might get more energy if extra energy produced is brought back to the grid.	LEED EAc2, SSI 8.5, WTC SEQ1, SEQ10, EEQ5
Reduced energy use	Reduced energy bill		US Patent
Reduced energy use	Reduced energy bill. Increased local activity	Reduced shipment (transit of trucks…)	LEED-NC MRc5, SSI 5.7
Reduced energy use, might reduce wastes	Reduced life-cycle costs	Might reduce maintenance needs, thus limiting impairing construction operations	SSI 5.10, WTC MEQ5
Reduced energy use	Reduced energy bill	Might provide better comfort and health	LEED-NC IEQc8, WTC SEQ9, WTC IEQ2
Reduced energy use	Reduced energy bill	Might provide better comfort and health	LEED-NC SSp1, IEQc3.1, EPA 1992, ASHRAE 52.2-1999, WTC SEQ5, IEQ7
Reduced energy use	Reduced energy bill	Better comfort and satisfaction	LEED-NC IEQc6, IEQc7, ASHRAE 55-2004, WTC IEQ10
Reduced energy use	Reduced energy bill	Better comfort and satisfaction	LEED-NC IEQc6, IEQc7, ASHRAE 55-2004, WTC IEQ3, IEQ4, IEQ8
Energy use reduction	Energy use reduction	Less visual impact	LEED-NC IEQc6, ASHRAE 55-2004, SSI 6.5

Water Management

Water is an essential resource. Today's water supplies are threatened and it is crucial to reduce consumption and pollution.

The goal of this section is to limit the use of potable water when it is not for drinking purposes, to treat water to limit pollution, to make use of all available water to limit purchase and dependence from the city, and finally to limit runoff damages.

Issue	Purpose	Suggested actions	Phases
5 Pollution	Limit pollution of the port water	Impement a fine and emergency plan in case of spills	P C O M
		Oil separation equipment	P D O M
		Use non toxic paint on boats and facilities	C M
3 Consumption and efficiency	Reduce water consumption	Use high-efficiency fixtures (water closets, urinals, faucets, etc.)	P D O
		Prevent leaks	C M
		Reduce unnecessary potable water use (e.g. irrigation)	P D O
		Reduce city water use by treating port water to use it	P D O
	Reduce wastewater bills	Treat wastewater on-site	P D C O M
4 Storm Water management	Limit stormwater runoffs	Implement Low Impact Development Practices (raingarden, pervious concrete)	P D C O M
		Collect runoff and rainwater	P D C O M
2 Ballast water management	Limit ballast water exchanges impacts	Treat released water on boats	O
		Good housekeeping of ballast tanks	O
		Limit exchanges to off-shore locations	O

Environmental benefits	Economic benefits	Society benefits	Applicable references
Reduced number of cases of spills	Financial benefits from fines pay for the repair needed	Safe recreational activities	SSI 7.1
Reduced quantity of oil slicks	No fine to pay to municipality	Safe recreational activities	UNDS
Reduced contaminants in water	Reduced water treatment needed	Safe recreational activities	LEED-NC IEQc4
Reduced water consumption	Reduced water bills.	More water available on the city system	LEED-NC WEc3, WTC WEQ3
Reduced water losses	Reduced water bills and water damages to fix	More water available on the city system	WTC WEQ3
Reduced water consumption, irrigation more feasible	Reduced water bills. Limited dependence from city	More water available on the city system	LEED-NC SSp1, IEQc3.1, EPA 1992, ASHRAE 52.2-1999, WTC SEQ5, IEQ7
Reduced water consumption, irrigation more feasible	Reduced water bills. Limited dependence from city	More water available on the city system	SSI 3.8
Reduced water consumption, limited transportation of water	Possibility to reuse the treated water reduces the bill; independence from the city	More water on the city system; higher wastewater treatment capacity	LEED-NC WEc2, SSI 3.8, WTC WEQ2
Reduced water pollution (treatment by vegetation or concrete), reduced erosion and runoff	Reduced water damages thus reduced maintenance needs. Reduced needs for active filtration or treatment	Reduced runoff and damages due to stormwater on the neighborhood; better comfort (e.g. visual for raingarden)	LEED-NC SSc5, SSc6.1, SSc6.2, SSI 3.7, America's Green Ports, WTC UEQ5
Reduced water pollution (e.g. water polluted on parking lots), reduced municipal (potable) water consumption	Reduced water damages and maintenance. Reduced water bills. Limited dependence from city	Reduced runoff and damages due to stormwater. More water available on the city system	LEED-NC SSc6.1, WEc1, WEc2, SSI 3.7, America's Green Ports, WTC SEQ2, SEQ6, UEQ2
Reduced water pollution	Reduced mitigation for water pollution	Safe recreational activities	Sydney Ports Corporation
Reduced water pollution	Reduced need for filtration and treatment	Safe recreational activities	Sydney Ports Corporation
Reduced habitat disturbance of shore and bottom of water	Reduced need for habitat restoration	Limited additional water movements (safety)	

Materials Management

As human activity increases, material resources decrease and landfills cannot handle all the waste. The environmental impact is considerable. Increasing costs are associated with purchasing materials as well as dumping wastes.

The goal of this section is to limit the use of resources, to increase reused and recycled materials, and to improve waste management.

Issue	Purpose	Suggested actions	Phases
4 Quantity	Reduce material consumption	Improve reuse and reduce construction waste	C
		Reduce wastes due to activity (food packages…)	O
	Increase recycling	Provide recycling dumpsters during construction, operations and maintenance works, corresponding to what the city recycles	C
		Require boats to sort their solid waste for recycling	O
		Provide recycle bins inside and outside facilities, corresponding to what the city recycles	P O
		Promote the use of high-recycled/recyclable content materials	D C O
3 Quality	Reduce hazards	Implement a hazardous waste handling and storage plan	O M
	Increase use of sustainable material	Promote the use of sustainable materials such as certified food	D C O

Environmental benefits	Economic benefits	Society benefits	Applicable references
Reduced resources use	Reduced quantity of material to buy	Less landfill areas	LEED-NC MRc1, MRc2, MRc3, SSI 5.4, WTC MEQ2, MEQ3
Reduced resources use	Reduced quantity of material to buy and garbage bill	Less landfill areas	WTC SEQ12
Reduced waste and reduced need for natural resources	Reduced garbage bill, reduced quantity of materials to buy	Less landfill areas	SSI 7.4, 7.5, 8.3
Reduced waste and reduced need for natural resources	Reduced garbage bill, reduced quantity of materials to buy	Less landfill areas	LEED-NC MRp1, SSI 8.3
Reduced waste and reduced need for natural resources	Reduced garbage bill, reduced quantity of materials to buy	Less landfill areas	LEED-NC MRp1, SSI 7.5, 8.3
Reduced need for natural resources	Facilitated future adaptation	Less landfill areas	LEED-NC SSp1, IEQc3.1, EPA 1992, ASHRAE 52.2-1999, WTC SEQ5, IEQ7
Reduced hazards	Might reduce costs due to incidents	Reduced hazards	America's Green Ports - Community
Reduced life-cycle impact on the environment	Reduced life-cycle costs	Reduced life-cycle impact on the society	LEED-NC MRc6, MRc7, SSI 5.6, 5.10, WTC MEQ6, MEQ7

Site Selection

As an element of a multi-modal transportation system, the location of a ferry terminal is a key of its success.

The goal of this section is to suggest ways to enable the durable use of water/land sites that appear unusable at first.

Issue	Purpose	Suggested actions	Phases
2 Availability	Make use of available sites	Rehabilitate a grayfield or brownfield site	P C M
		Clean polluted water area	P C M
2 Future changes	Limit the future difficulties due to changes that might be foreseen	Prevent damage from potential flood events and water table changes (climate change)	P D C M
		Allow future growth of the port and/or activities	P D C
		Allow future change in type of activity of the port	P D C
3 Dredging	Limit dredging impact	Monitor dredging	C M
		Perform dredging when no activity	C O M
		Help habitat after dredging	C M
		Treat and use dredged material	P C

Environmental benefits	Economic benefits	Society benefits	Applicable references
Land and water pollution reduction (inflitrating water might be or become polluted)	Site may be cheaper to aquire	Health of the community and aesthetics of the site are improved	LEED-NC SSc3, SSI 1.5, America's Green Ports - Brownfields, WTC UEQ1, SEQ7
Water pollution reduction	Site may gain value	Health of the community is improved	America's Green Ports - Community
Limited unexpected use of the infrastructure, which limits fortuitous pollutions	Reduction of renovation needed, and limited impact of natural events on the port activity	Availability of transit is secure	SSI 1.1, 1.2
Limited construction work needed, which limits pollutions and material usage	Reduced financial and time costs for future changes. Ability to increase activity	Possibility to grow activity or population of the city	SSI 5.2, 5.3
Limited construction work needed, which limits pollutions and material usage	Reduced financial and time costs for future changes. Ability to adapt to the market	Possibility to adapt to the demand	SSI 5.2, 5.3
Reduced frequency, thus reduced impact on natural habitat	Reduced dredging costs since performed less frequently		LEED-NC SSp1, IEQc3.1, EPA 1992, ASHRAE 52.2-1999, WTC SEQ5, IEQ7
Limit human activity during the day	Limited disturbance of the port activities	Reliable ferry service and no disturbance of any other activity in the port or water	Guidelines for dredging
Limited impact on wildlife	Limited impact on fishing activities		America's Green Ports - Dredged Material
Reduction of wastes	Reduction of waste handling costs and may earn money for the material	Less landfill areas	America's Green Ports - Dredged Material

Air Quality

Most of the activities on the port are sources of emissions polluting the air. The infrastructure itself also influences air quality with its ventilation system and emitting materials. This has a direct impact on health and comfort of passengers, employees, and neighborhood.

The goal of this section is to limit the air pollution caused by the port and its activities, and improve the indoor environment.

Issue	Purpose	Suggested actions	Phases
3 Infrastructure impact	Reduce air pollution	No use of ozone depleting substances (e.g. CFC refrigerant)	D O
		Use low-emiting materials and paints	D C M
	Reduce heat island effect	Use surfaces with high reflectance	D
3 Indoor comfort	Improve indoor air quality	Increased outside air intake and natural ventilation	D O M
		Minimize the use of chemical when cleaning	O
5 Activities on the dock	Reduce outdoor air pollution due to activity	Reduce flying dirt, especially during construction works (spray exiting vehicles, gravel pool at the entrance,...)	P D C O M
		Limit the time during which passengers have their engine on.	P O
		Avoid fossil fuel engines	C O

Environmental benefits	Economic benefits	Society benefits	Applicable references
Limited harm to ozone layer	May avoid taxes	Improved environment	LEED-NC WEp3, EPA Greenbook, WTC EEQ4
Limited toxicity of air	Might limit sick days of employees	Improved health and satisfaction level	LEED-NC IEQc4, SSI 5.8, WTC IEQ6
Limited impact on temperature, Reduced energy use and heat island effect	Reduced energy bill with less energy and air conditioning needed	Might provide better comfort and health	LEED-NC SSc7, SSI 4.12, WTC UEQ5, WTC SEQ3
Reduced energy consumption	Reduced energy bill	Improved health and satisfaction level	LEED-NC IEQp1, ASHRAE 62.1-2004, IEQc1, IEQc2, WTC IEQ4
Limited toxicity of air	Might limit sick days of employees	Improved health and satisfaction level	WTC IEQ9
Reduced air and water pollution	Reduced need for filtration and thus the costs associated	Improved health and satisfaction level	LEED-NC SSp1, IEQc3.1, EPA 1992, ASHRAE 52.2-1999, WTC SEQ5, IEQ7
Reduced fossil fuel use	Less transit to regulate	Reduced need to be close to the car when waiting (passengers), reduced noise (neighborhood)	
Avoid fossil fuel sources and fine particle emissions	May avoid taxes	Improved environment	LEED-NC SSc4.3, America's Green Ports AQ

Progress Table

When to fill the table?

This progress table is to be updated regularly with indicators that are monitored, the reference(s) used to measure the issue, actions that are been conducted and how much they address the issues, and finally remaining actions to do with their expected impact.

No.	Category Title	Issue & Importance		Indicator Used
1	Traffic and Parking	Quantity	5	
		Distribution	4	
		Other		
2	Integration in the Community	Light pollution	2	
		Noise pollution	3	
		Vibrations	2	
		Habitat restoration	3	
		Aesthetics	1	
		Culture and	1	
		Other		
3	Energy Management	Renewable	2	
		Consumption and	5	
		Other		
4	Water Management	Pollution	5	
		Consumption and Efficiency	3	
		Storm Water	4	
		Ballast Water	2	
		Other		
5	Materials Management	Quantity	4	
		Quality	3	
		Other		
6	Site Selection	Availability	2	
		Future changes	2	
		Dredging	3	
		Other		
7	Air Quality	Infrastructure Emissions	3	
		Indoor Comfort	3	
		Activities on the Dock	5	
		Other		
8	Other	Other		

Progress Table

How is this useful?

This table is a quick overview of the trend of the sustainable elements incorporated in the project. Sections were the impact achieved is lower than suggested should be addressed first.

Actions				
References	Action taken & its Impact		Next suggested action & Expected	