RESEARCH

INTEGRATING GREEN RATING SYSTEMS: A CASE STUDY FOR FERRY TERMINALS

Michael Thompson[1], Dr. Liv Haselbach[1], Dr. Cara Poor[1], and Dr. Michael Wolcott[1]

ABSTRACT

When attempting to achieve sustainability goals for integrated facilities, many green rating systems are available to guide the design, construction, operations and maintenance of a project. Due to the large number of sustainability tools that are available or mandated, it can be confusing to determine which set of guidelines to follow. For the Washington State Ferries (WSF), there is no green rating system which correlates perfectly with the unique intermodal challenges presented by ferry terminals. This paper focuses on five rating systems applicable to WSF: GreenLITES, LEED, Sustainable Sites Initiative, The Port Authority of NY/NJ Sustainable Infrastructure Guidelines (draft), and the draft Marine Vessel Environmental Performance Assessment (MVeP). These rating systems are integrated with a developing set of sustainable ferry guidelines in a green rating integration platform (GRIP). The GRIP readily relates credits and guidelines across multiple systems, aiding WSF in making decisions in accordance with sustainability goals. The GRIP format might similarly be applied to other integrated projects to more effectively and economically address sustainability across all aspects of projects and facility operations.

KEYWORDS

green rating systems, integrated facilities, sustainability

INTRODUCTION

Over the past decade, the concept of sustainability has become a rapidly and widely adopted goal in engineering. When developing new buildings and infrastructure, an emphasis is being placed on environmental, energy, and resource use goals for the design, construction, operations and maintenance of these facilities. To facilitate this focus, several different green rating systems and other forms of guidelines have been produced to provide a framework for the engineering, construction, and maintenance processes associated with infrastructure.

Due to the abundance of these rating systems and tools, there can be confusion in selecting the appropriate set of guidelines to use in any given situation. Gowri (2004) evaluates a variety of rating systems to compare the structure and design criteria between systems. He provides a brief summary of the systems available at that time, but does not evaluate further

[1]Washington State University, Department of Civil and Environmental Engineering, Pullman, WA, michael.thompson.gocougs@gmail.com.

recommendations for decision making amongst the many options. Fowler and Rauch (2006) summarized sustainable building rating systems for the U.S. General Services Administration to help keep pace with the constantly changing and improving green building rating systems. Their work focused on federal building projects for which a specific set of criteria might be met, including applicability and quantifiable results. Their work is very comprehensive, but with the recent growth of rating systems, and the addition of infrastructure tools in recent years, would now need to be expanded upon and updated. Using a different approach, Fenner and Ryce (2008) compared two different rating systems applied to the same construction project and found that despite differing in application style and ranking format, the two systems provided similar assessments of the building. Each of these papers emphasize the fact that there are many green rating systems, and that it is useful, in some way, to determine which of them might be applied to attain specific goals or meet specified criteria. There is also a desire to determine how they might interrelate which each other, or be used conjointly. These studies also show that the depth of work that needs to be done in order to comprehensively compare each individually is large. Therefore there is a need to easily compare rating systems and facilitate the decision of choosing which green rating system or group of systems to follow for a specific project. The objective of this research is to develop a metric with which rating systems can be more easily compared and integrated to help facilitate green building goals.

Ferry terminals, like those owned and operated by Washington State Ferries (WSF) present multiple challenges to address unique site conditions, proximity to endangered aquatic species, service to communities, while accommodating multi-modal transportation systems. These conditions force WSF to address multiple environmental, social, and economic impacts relating to the design, construction, and operation of its facilities. In the near future, WSF will be challenged to address stormwater, site development, green building, and vessel operation goals that are all governed by different standards. Addressing these infrastructure goals will be directed by a set of sustainable ferry guidelines currently under development (De Sainte Marie D'Agneaux 2009).

As intermodal transportation facilities, ferry terminals present unique challenges in designing marine structures to accommodate buildings, automobiles, pedestrians, bicyclists and marine vessels. The facilities can be built over land, water, or a combination of both. Many of the sustainability challenges relate to the various transportation modes and the stormwater issues at the land/water interface. No single rating system specifically applies to the unique intermodal and structurally diverse situations occurring at ferry terminals, but several can be related to them in some form or fashion. While many rating systems may be partially applicable, the necessity to examine each one individually for every situation could become overwhelming. To integrate the use of different green rating systems and the proposed sustainable ferry guidelines, a *Green Rating Integration Platform* (GRIP) has been proposed in this research. The intended use of the GRIP is to aid strategic decision-making. According to Schwenk (1988), strategic decisions are for long-term objectives of an enterprise. They are often complex, ill structured, non-routine, and important to an organizational mission. Addressing these decisions might involve large resource commitments, but offer large gains or losses depending on the success of the outcome. These critical strategic operations cannot focus on only one functional area and therefore the approach must often be holistic in nature to achieve success. Thus, the GRIP provides a platform for integrating green rating systems to address organizational strategies for improving an enterprise's performance and public perception, while also considering sustainability and other facility goals.

While approaching an overall goal of developing fully harmonized integration tools to facilitate the use of multiple green design systems, we address two main objectives in these initial steps of the research: 1) Propose a simplified qualitative methodology for integrating rating systems and strategic decision categories or guidance for intermodal and multi-purpose facilities; 2) Apply this methodology for the development of a GRIP for ferry terminals.

BACKGROUND ON SUSTAINABILITY RATING SYSTEMS

There are many tools related to sustainability. These include rating systems, guidelines, regulations or codes and standards. Green rating systems are tools that are used to confirm a building or infrastructure project is being designed and built sustainably. They provide a metric to assess how sustainable a building or project is by assigning a representative value. This semi-quantitative metric will increase as more sustainable practices are implemented. The value of this metric is typically assigned based on how many credits or criteria the project meets. These credits often fall into a wide range of categories including site selection, water conservation, energy use, materials selection, and operations and maintenance. Each credit implemented earns points towards the value, which represents a sustainability measure for the project.

Guidelines differ from green rating systems. For guidelines, there is no metric established to rate the sustainability of the project. Guidelines are in place simply to establish guiding principles and suggest courses of action to meet the goal of building more sustainably. The Washington State University (WSU) Ferry Guidelines used in the GRIP provide a framework of sustainability practices specifically tailored for passenger ferry terminals. These guidelines will assist in allowing WSF to achieve their sustainability goals by identifying preventative or corrective measures in areas where sustainability can be improved.

Regulations are laws established by the government and must be followed regardless of the green design tools implemented. In the case of WSF, Washington State Department of Transportation (WSDOT) establishes the overriding regulations for permitting. Other sources of regulations may be imposed by the King County Surface Water Design Manual (King County 2009) and the Stormwater Management Manual for Western Washington (Seattle 2009). Finally, design standards such as applicable sections of the Washington State Public Building Requirements (SBCC 2009), the International Building Code (ICC 2009), and the International Green Building Code (ICC 2012) must be followed.

Consensus standards such as the American Standards for Testing and Materials (ASTM) or International Organization for Standardization (ISO) are sometimes referenced by green rating systems such as LEED to establish methods for assigning credits. These standards may be procedures used for quantifying measures of sustainability (e.g. energy use, carbon emissions, etc) and are used to ensure the common methods are universally employed. ISO has created series of environmental standards to provide a framework for organizations when they are creating environmental policy, plans, and actions (ISO 2011). This directly applies to WSF because the Safety Management System (SMS) employed by WSF has incorporated the environmental management system portion of the ISO 14000 set of standards. Complementary research is ongoing which includes the integration of the current WSF SMS with the current GRIP developed in this paper, but is not presented herein.

The focus of the GRIP methodology is to integrate green rating systems, which might be applicable to intermodal ferry facilities. A brief review of applicable systems is provided in the following.

One of the best-known green design ratings systems is Leadership in Energy and Environmental Design for new construction and major renovation (LEED NC), which has been developed by the US Green Building Council (USGBC 2009). This rating system applies primarily to conventional buildings, making it useful for the land side of a ferry terminal. LEED for retail is a subset of the LEED new construction system that is currently under pilot and presents a methodology for handling standard designs while providing additional guidance to parking issues and other criteria that address the site issues at a customer focused facility such as a WSF terminal.

Another rating system, which was developed by the Green Building Initiative, is Green Globes (GBI 2011). Green Globes easily applies to different project sizes, and both new and existing buildings. It has been specifically used for several public buildings. For ports, the most applicable sections are those that address building design and maintenance and operations. However, the similarly applicable LEED system is more commonly used in the United States.

The Sustainable Sites Initiative (SITES) is an interdisciplinary effort that provides guidelines for sustainability in the areas of land design, construction, and management (SSI 2009). It specifically addresses issues than may enhance social and community benefits of site development. When transferring the ideas presented in SITES to a WSF terminal, it is mainly applicable to the land side.

A good guidance for intermodal transportation issues is the Port Authority of NY and NJ Sustainable Infrastructure Guidelines (Port Authority). These guidelines are being developed for the purpose of addressing projects that occur outside the building envelope (TPA 2010). Due to this intermodal approach, the Port Authority applies quite well to the WSF system. The Port Authority is currently still in draft status and is still under development and review.

The New York State Department of Transportation has a rating system known as GreenLITES, designed to address multiple forms of transportation. GreenLITES lists different techniques used to measure sustainability performance in addition to promoting stormwater best management practices (BMPs), and possible areas of improvement in the planning, design, and construction phases. The main areas of focus are sustainable sites, water quality, materials and resources, and energy and atmosphere (NYDOT 2011). The tool is more readily applied to highways. GreenLITES use at WSF may be most applicable to the transportation network upland of the ferry terminal.

Another land side application which focuses on roads and highways is the Greenroads rating system. This system, like others, does a good job addressing stormwater treatment on roads which could apply to the landside area of a ferry terminal. In addition to stormwater, Greenroads also focuses on sustainable materials for new construction (Greenroads 2011). However, since the GreenLITES system is already being interfaced with the Port Authority of NY and NJ Sustainable Infrastructure Guidelines, and GreenLITES and Greenroads are very similar, GreenLITES was used for this case study.

The Federal Highway Administration of the US Department of Transportation has its own sustainability tool known as the Infrastructure Voluntary Evaluation Sustainability Tool (IN-VEST). As of this writing it is in the pilot test phase with version 1.0 scheduled to be released in 2012. This tool is expected to be available nationally and currently has three main sections focusing on systems and project planning, project development, and operations and maintenance (FHWA 2011). This tool is mainly focused on state and highway systems but may apply to the interface at the terminal including the upland roadway leading to the ferry terminal. When available, future research might bring this tool into the proposed platform format.

The Institute for Sustainable Infrastructure recently released version 1.0 of EnvISIon for feedback. EnvISIon is expected to be approved and available for use in early 2012. According to their announcement, EnvISIon evaluates the sustainability of a wide range of infrastructure projects vital to our communities, to economic competitiveness, and to protecting the environment (ISI 2011). When available, future research might also incorporate this tool into the proposed platform format.

Another sustainability checklist referring to transportation was developed by Lochner and is known as Sustainable Transportation Environmental Engineering and Design (STEED) guidelines. These guidelines mainly cover roadways and are separated into four stages: processing, planning, design, and construction (Lochner 2011). The State of Illinois also has a guidance which lists practices that bring sustainable results to highway projects known as the Illinois Livable and Sustainable Transportation (ILAST). However, as the GreenLITES system already covers most of the aspects represented in both of these highway rating systems (STEED and ILAST), and is being integrated with the Port Authority efforts, it remains the example system for this research.

The Marine Vessel Environmental Performance Assessment (MVeP), which is under development by the Society of Naval Architects and Marine Engineers (SNAME), applies to the waterside of WSF (SNAME 2010). MVeP is expected to be an excellent set of guidelines for marine vessels and can be implemented specifically for the ferries at WSF.

APPROACH

The first part of the research was outlining a methodology for GRIP development and future deployment. This was then followed by a case study application of the development portion of a GRIP for a ferry facility.

GRIP Methodology

The intention of the proposed GRIP methodology is to simplify the methodology and formatting that support strategic decision making related to sustainability decisions for intermodal facilities or any other development at the nexus of processes, projects, operations or facilities. For instance, there might be a GRIP developed for a building and the infrastructure servicing it, or for an airport with retail, security, buildings, supporting infrastructure, and multimodal transportation accessing the facility. The format used in the development of a GRIP, and then its synchronization techniques in order to facilitate application and use, are as listed in the following. This paper focuses on the first four steps, with an example given for the ferry intermodal facility application. Work on applying the fifth step for actual deployment for WSF is part of an ongoing continuation of the research.

1. Research and compile a set of applicable rating systems around the intermodal/multi-purpose facility.
2. Either based on previous studies, or through a combination literature review or focused study on the intermodal/multi-purpose facility, develop a preliminary set of GRIP categories.
3. Synchronize rating system categories to a preliminary set representing the intermodal/multi-purpose facility
4. Synthesize all credits to finalized GRIP categories

To achieve a fully harmonized version of GRIP, the various credits must be normalized to an equivalent basis to support comparative decisions. However, this step is beyond the scope of the current manuscript.

Ferry Facility Case Study

1: Rating Systems Chosen for WSF

As noted in the previous sections, five of the rating systems detailed in the sustainability rating systems literature review section were chosen as being applicable to WSF (Table 1). The GreenLITES system was chosen to focus on the area upland of the ferry terminals due to its applicability to multiple forms of transportation and its focus on highways, as well as its availability compared to many of the other rating systems with a focus on transportation. The next rating system was the LEED retail system for new construction. As one of the most well known and recognizable systems, it was important to include LEED. The LEED system is focused more on the landside of the ferry terminal, and also any terminal building that may be located on the trestle (overwater structure). Sustainable Sites Initiative was the third rating system chosen due to its excellent focus on stormwater management as well as integration of a construction project into a community. This rating system will also be more focused on the land side of the ferry terminal.

TABLE 1. Rating systems chosen for the Green Rating Integration Platform.

Rating System	Focus Area	Source
GreenLITES	Upland	New York DOT
LEED retail	Landside	US Green Building Council
Sustainable Sites Initiative	Landside	American Society of Landscape Architects; University of Texas; United States Botanical Garden
Sustainable Infrastructure Guidelines	Intermodal	Port Authority of NY/NJ
MVeP	Waterside	Society of Naval Architects and Marine Engineers

The draft Port Authority of NY/NJ Sustainable Infrastructure Guidelines was chosen due to its intermodal focus and thereby relevance to WSF. While they are still in draft status and not completely comprehensive, their focus on construction projects outside the building envelope make them valuable when developing a system for WSF. Finally, the MVeP guidelines were chosen for the marine side of ferry trestles due to their focus on water vessels.

2: Preliminary Ferry Guidance Category Selection

The sustainability guidance that the five rating systems were then integrated with was based on categories developed in previous work performed by Washington State University in 2009 for WSF (De Sainte Marie D'Agneaux 2009). This previous work focused on defining sustainable ferry infrastructures based on current practices, tools and policies, and activities performed; mainly through a literature review and interactions with WSF. In order to help ease understanding, the sustainable practices discussed in this previous work were divided into seven categories. Not all seven categories were given the same level of importance, but all categories

were considered to have a significant impact on ferry terminal sustainable infrastructure. The seven focus areas developed in this previous work are:

- *Traffic and Parking*
  This section focuses on increasing capacity and customer satisfaction while decreasing the negative impacts of vehicles on the surrounding area.
- *Integration in the Community*
  This category focuses on practices which supports positive impacts on the surrounding community in order to increase general acceptance. Some examples include reducing light and noise pollution and improving aesthetics of the terminal.
- *Energy Management*
  This category focuses on reducing energy use and energy related pollution while limiting the dependence on the energy grid.
- *Water Management*
  This section focuses on both the use of potable water as well as limiting stormwater runoff.
- *Materials Management*
  This focus area attempts to limit the overall use of resources, and replace materials with reused and recycled options when possible.
- *Site Selection*
  This area focuses on the use of grayfield or brownfield sites where appropriate.
- *Air Quality*
  This section focuses both on limiting the air pollution produced from the site as well as improving indoor air quality in any buildings on the site.

3: Category Synchronization and Synthesis of Credits

The GRIP methodology now synchronizes the categories from the five rating systems and the sustainability guidance format as developed for WSF in previous work. This synchronization was done in conjunction while evaluating each credit and prerequisite within the rating systems to determine a possible first best fit for each. In addition, there are often credits which may not directly fit into guidance categories as first developed, and expansion or modification of such categories might be necessary for synchronization. In this process, all credits and prerequisites in all the rating systems were maintained, although their distribution in focus categories may have changed. Table 2 has an overall listing of the rating systems and guidance, and the final category designations, which resulted from this process. The details for each major decision and overviews of the credit designations used in these determinations are described in more detail in the following paragraphs. Table 2 also includes a reference to spatial application of the rating system or guidance with respect to the facility, i.e. upland, landside, intermodal or marine side.

For the green rating integration research, the previously mentioned site selection category from the guidance work performed at WSU (De Sainte Marie D'Agneaux 2009) was renamed construction phase and expanded to include all aspects of construction instead of only being limited to site selection. The five rating systems were then separated into the aforementioned categories to help ease the integration across the systems. The process for re-categorization for each of the five rating systems in order to facilitate integration follows.

The GreenLITES rating system is divided into the five categories of sustainable sites (S), water quality (W), materials and resources (M), energy and atmosphere (E), and an unlisted

TABLE 2. Summary of Rating Systems, Guidance and Synchronized Categories.

	Upland GreenLites	Land Side LEED Retail	Land Side Sustainable Sites Initiative	Intermodal Port Authority	Intermodal WSU Ferry Guidelines	Marine Side MVeP
Traffic/Parking	Credit and Prerequisite Integration Field					
Community/ Social						
Energy						
Water						
Materials						
Air Quality						
Construction Phase						

innovation category. One of the sustainable sites credits fit well into the construction phased category while the other four address community/social aspects. The water quality and materials and resources sections transposed well into the water management and materials management sections of the GRIP respectively. Finally, the energy and atmosphere section has two credits that may correlate with the energy management section, two fit with traffic and parking, and two deal with community/social aspects. GreenLITES lacks credits that fit specifically into the air quality section (Figure 1).

The LEED retail system is divided into seven separate categories. The five main categories of sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR), and indoor environmental quality (IEQ) are joined by two other areas of innovation and regional priority. These two additional categories provide for flexibility and local needs in design and criteria and as such, when credits are established, they will fit into one of the five main categories. The sustainable sites category has credits applicable to four different sections outlined in the WSU Ferry Guidelines. Three of the credits address pollution prevention. Site selection fit well with the construction phase category. One credit addressing transportation went into the traffic/parking section while two stormwater credits fit best in the water management category. The majority (five) of the sustainable sites credits were placed in the community and social section. All four of the water efficiency prerequisites and credits transferred

FIGURE 1. GreenLITES credits organized by previously developed WSU Ferry Guidelines.

	Upland GreenLITES
Traffic/Parking	♦ E-1: Improve Traffic Flow ♦ E-4: Bicycle /Pedestrian Facilities
Community /Social	♦ S-2: Context Sensitive Solutions ♦ S-3: Land Use Planning ♦ S-4: Protect Wildlife Habitat ♦ S-5: Protect Plant Communities ♦ E-5: Noise Abatement ♦ E-6: Stray Light Reduction
Energy	♦ E-2: Reduce Electrical ♦ E-3: Reduce Petroleum
Water	♦ W-1: Stormwater Management ♦ W-2: BMPSs
Materials	♦ M-1: Reuse of Materials ♦ M-2: Recycle content ♦ M-3: Locally Provided Material ♦ M-4: Bioengineering Techniques ♦ M-5: Hazardous Minimization
Air Quality	
Construction Phase	♦ S-1: Alignment Selection

FIGURE 2. LEED Retail credits organized by previously developed WSU Ferry Guidelines.

	Land Side LEED retail		
Traffic/Parking	♦ SSc4–Alternative Transportation		
Community/Social	♦ SSc2–Community Connectivity ♦ SSc5.1–Protect or Restore Habitat ♦ SSc5.2–Maximize Open Space ♦ SSc7–Heat Island Effect ♦ SSc8–Light Pollution Reduction ♦ EAp3–Refrigerant Management ♦ EAc4–Refrigerant Management ♦ IEQc6–Controllability of Systems ♦ IEQc7–Thermal Comfort ♦ IEQc8–Daylighting and Views	**Materials**	♦ MRp1–Recyclables ♦ MRc1.1–Building Reuse–Exterior ♦ MRc1.2–Building Reuse–Interior ♦ MRc2–Waste Management ♦ MRc3–Materials Reuse ♦ MRc4–Recycled Content ♦ MRc5–Regional Materials ♦ MRc6–Rapidly Renewable Materials ♦ MRc7–Certified Wood ♦ IEQc4–Low-Emitting Materials
Energy	♦ EAp2–Minimum Energy Performance ♦ EAc1–Optimize Energy ♦ EAc2–On-site Renewable Energy ♦ EAc5–Measurement and Verification ♦ EAc6–Green Power	**Air Quality**	♦ IEQp1–Minimum IAQ ♦ IEQp2–ETS control ♦ IEQc1–Outdoor Air Monitoring ♦ IEQc2–Increased Ventilation ♦ IEQc5–Indoor Pollutant Control
Water	♦ SSc6.1–Stormwater Quantity Control ♦ SSC6.2–Stormwater Quality Control ♦ WEp1–Water Use Reduction ♦ WEc1–Water Efficient Landscaping ♦ WEc2–Innovative Technologies ♦ WEc3–Water Use Reduction	**Construction Phase**	♦ SSp1–Pollution Prevention ♦ SSc1–Site Selection ♦ SSc3–Brownfield Redevelopment ♦ EAp1–Fundamental Commissioning ♦ EAc3–Enhanced Commissioning ♦ IEQc3–Construction IAQ

over into the water management section. A majority of the energy and atmosphere credits went into the energy management section with the two atmosphere focused credits placed instead in the community/social section. Similar to the water efficiency section, all of the materials and resources credits fit into the materials management category. Finally, LEED indoor environmental quality was divided into five credits fitting into the air quality category, three fitting into community/social, and one credit in each of the material management and construction phase categories (Figure 2). Note that the LEED items in Figure 2 are also prefixed by either 'p' or 'c' after the two or three letter category reference. This represents prerequisite and credit respectively. Every single prerequisite is required for achieving a green rating system certification, while each project can use different combinations of credits to achieve the required number of points for certification.

Sustainable Sites Initiative (SITES) has the most categories in which the credits are divided into. The eight categories in the SITES rating system are: site selection (SS), assessment and planning (PD), water (W), soil and vegetation (SV), materials selection (MS), human health and well being (HH), construction (C), and operations and maintenance (OM). Similar to GreenLITES, the site selection category contains elements that transfer to both the community/social and construction phase sections of the WSU Ferry Guidelines. The assessment and planning category is technically pre-design but was included in the construction phase category. The water, materials, human health and well being, and construction sections transfer completely to the water management, materials management, community/social, and construction phase categories respectively. The soil and vegetation section contains elements which fit in each of the community/social, energy management, and construction phase categories. Finally, the operations and maintenance category contains BMPs involving energy management, water management, materials management, and air quality. The major-

ity of credits for the Sustainable Sites Initiative fit in the community/social category and none fall into the traffic/parking category (Figure 3). As in the LEED rating system, items in Figure 3 are also prefixed by either 'p' or 'c' after the category reference, standing for prerequisite and credit respectively.

The draft Port Authority of NY/NJ Sustainable Infrastructure Guidelines (Port Authority) has similar sections to the WSU Ferry Guidelines. This rating system is divided into six categories of site (IS), water (IW), energy (IE), materials (M), construction (IC), and maintenance and operations (IO). The site section is the only section of the six to be divided when transferred into the WSU Ferry Guidelines format. The Port Authority site section has credits which fall into the categories of traffic/parking, community/social, water management, materials management, and construction phase. The Port Authority water, energy, material, and construction sections fit into the water management, energy management, materials management, and construction phase categories in the WSU Ferry Guidelines. Finally, the maintenance and operations category deals with watering landscaping and is therefore placed in the water management category. The Port Authority rating system also does not have credits which fit directly into the air quality category (Figure 4).

FIGURE 3. Sustainable Sites Initiative credits organized by previously developed WSU Ferry Guidelines.

	Land Side Sustainable Sites Initiative		
Traffic/Parking		**Water**	♦ Wp3.1–Reduce landscape irrigation ♦ Wc3.2–Reduce landscape irrigation ♦ Wc3.3–Protect/Restore buffers ♦ Wc3.4–Rehabilitate streams ♦ Wc3.5–Manage stormwater on site ♦ Wc3.6–On-site water resources ♦ Wc3.7–Use stormwater for landscape ♦ Wc3.8–Maintain water features ♦ OMp8.1–Sustainable maintenance
Community/Social	♦ SSp1.2–Protect floodplain functions ♦ SSp1.3–Preserve wetlands ♦ SSp1.4–Preserve endangered species ♦ SSc1.6–Select sites in communities ♦ SSc1.7–Accessible to public transit ♦ SVp4.1–Control invasive plants ♦ SVp4.2–Use non-invasive plants ♦ SVp4.3–Soil management plan ♦ SVc4.5–Preserve special status veg. ♦ SVc4.6–Daylighting and Views ♦ SVc4.7–Use native plants ♦ SVc4.8–Preserve native plants ♦ SVc4.9–Restore native plants ♦ SVc4.12–Reduce heat island effect ♦ SVc4.13–Reduce wildfire risk ♦ HHc6.1–Equitable site development ♦ HHc6.2–Equitable site use ♦ HHc6.3–Sustainability education ♦ HHc6.4–Protect historical places ♦ HHc6.5–Optimum site accessibility ♦ HHc6.6–Outdoor physical activity ♦ HHc6.7–Views of vegetation ♦ HHc6.8–Outdoor spaces ♦ HHc6.9–Reduce light pollution	**Materials**	♦ MSp5.1–Eliminate threatened wood ♦ MSc5.2–Maintain often ♦ MSc5.3–Design for deconstruction ♦ MSc5.4–Reuse salvaged materials ♦ MSc5.5–Recycled content materials ♦ MSc5.6–Use certified wood ♦ MSc5.7–Use regional materials ♦ MSc5.8–Reduce VOC emissions ♦ MSc5.9–Sustainable plant production ♦ MSc5.10–Sustainable manufacturing ♦ OMp8.2–Collect recyclables ♦ OMc8.3–Recycle organic matter
Energy	♦ SVc4.10–Minimize heating ♦ SVc4.11–Minimize cooling ♦ OMc8.4–Reduce energy consumption ♦ OMc8.5–Use renewable energy	**Air Quality**	♦ OMc8.6–Minimize tobacco smoke ♦ OMc8.7–Minimize greenhouse gases ♦ OMc8.8–Reduce emissions
		Construction Phase	♦ SSp1.1–Limit farmland development ♦ SSc1.5–Select brownfields ♦ PDp2.1–Pre-design assessment ♦ PDp2.2–Integrated site development ♦ PDc2.3–Engage users in site design ♦ SVp4.4–Minimize soil disturbance ♦ Cp7.1–Control construction pollutants ♦ Cp7.2–Restore disturbed soils ♦ Cc7.3–Restore disturbed soils ♦ Cp7.4–Divert materials from disposal ♦ Cp7.5–Reuse soil ♦ Cp7.6–Minimize emissions

FIGURE 4. Port Authority of NY/NJ Sustainable Infrastructure Guidelines credits organized by previously developed WSU Ferry Guidelines.

	Intermodal Port Authority
Traffic/Parking	♦ IS–17: Optimize Traffic Safety ♦ IS–19: Enhance Intermodal Connectivity ♦ IS–20: Transportation System Management ♦ IS–21: Transportation Technologies
Community/Social	♦ IS–5: Protect Ecological Health ♦ IS–6: Maintain Absorbent Landscapes ♦ IS–8: Utilize Appropriate Vegetation ♦ IS–14: Mitigate Heat Island Effect ♦ IS–15: Minimize Light Pollution ♦ IS–16: Optimize Public Environments
Energy	♦ IE–1: Optimize Energy Performance ♦ IE–2: Electrical and Mechanical Systems ♦ IE–3: Utilize End Use Metering ♦ IE–4: Use On-Site Renewable Energy ♦ IE–5: Protect Ozone Layer ♦ IE–6: Provide Alternative Fueling Stations
Water	♦ IS–7: Utilize Pervious Pavement ♦ IS–9: Use Turfgrass Appropriately ♦ IW–1: Implement Stormwater BMPs ♦ IW–2: Implement Rainwater Neutrality ♦ IW–3: Reduce Use of Potable Water ♦ IW–4: Utilize End Use Metering ♦ IO–1: Sustainable Landscape Maintenance ♦ IO–2: Maintain Soil Quality
Materials	♦ IS–10: Amend and Reuse Existing Soils ♦ IS–11: Balance Earthwork ♦ IM–1: Use Recycled Materials ♦ IM–2: Use Local/Regional Materials ♦ IM–3: Reuse Materials ♦ IM–4: Use Durable Materials ♦ IM–5: Sustainably Harvested Wood ♦ IM–6: Minimize Toxic Materials ♦ IM–7: Enhance Pavement Lifecycle ♦ IM–8: Utilize Thin Surface Paving ♦ IM–9: Utilize WMA Technology
Air Quality	
Construction Phase	♦ IS–1: Integrated Team Approach ♦ IS–2: Prepare a Site Assessment ♦ IS–3: Previously Developed Sites ♦ IS–4: Known Contaminated Sites ♦ IS–12: Coordinate Utility Work ♦ IS–13: Utilize Trenchless Technology ♦ IS–18: Roadway Alignment Section ♦ IC–1: Minimize Pollution ♦ IC–2: Protect Existing Natural Systems ♦ IC–3: Transportation Management ♦ IC–4: Green Construction Equipment ♦ IC–5: Reduce Noise and Vibration ♦ IC–6: Waste Management ♦ IC–7: Integrated Pest Management

The MVeP rating system, which is focused on vessels and waterside, is divided into the four categories of energy efficiency (EE), air emissions (AE), water emissions (WE), and general measures (GM). The energy efficiency and water emissions can be placed entirely within energy management and water management respectively. The air emissions category fits mostly into the air quality category with one credit addressing ozone depletion fitting into the community/social category. Finally the general measures section contains credits which fit into the community/social, water management, and materials management categories. There are no credits regarding vessels which fit into traffic/parking or construction phase categories (Figure 5).

Finally, the five ratings systems and the aforementioned credits in the proposed WSF sustainability guidelines were consolidated into the seven tier green rating integration platform as shown in Figure 6 (Thompson 2011). Note that there is still additional detail within each category (row) and each rating system/guidance (column) that is not shown in the consolidated GRIP in Figure 6. These additional criteria, practices or considerations are meant to be applied in detail within each category, and then brought forth into the GRIP for integration across the sustainability goal platform.

Figure 6, the consolidated GRIP, is a visual representation of enterprise or agency goal categories such as energy or material management, with direct view of sustainable achievement potential and a summary listing of typical intents or strategies. Thus, the GRIP is a form of strategic decision-making conceptualization. As previously mentioned, strategic decision-making is not the details of the work, but rather composites of the overall direction.

FIGURE 5. MVeP credits organized by previously developed WSU Ferry Guidelines.

	Marine Side MVeP
Traffic/Parking	
Community /Social	♦ GM 3.1–Aquatic Life Impact
	♦ GM 3.2–Shore Protection
	♦ AE6–Ozone–Depleting
Energy	♦ EE1.1–Lighting
	♦ EE1.2–HVAC
	♦ EE1.3–Pump Systems
	♦ EE1.4–Mechanical Equipment
	♦ EE1.5–Hull/Propeller
	♦ EE1.6–Route Optimization
	♦ EE1.7–Vessel Speed
	♦ EE1.8–Energy Recovery
	♦ EE1.9–Hull Optimization
	♦ EE2.1–Other Fuels
	♦ EE2.2–Renewable Energies
	♦ EE3–Carbon Footprint

Water	♦ WE1–Oily Water
	♦ WE2–Non–Indigenous Species
	♦ WE2.1–Ballast Water/Sediment
	♦ WE2.2–Hull Fouling
	♦ WE3–Sanitary Systems
	♦ WE4–Solid Waste
	♦ WE5–Incidental Discharges
	♦ WE6–Protection of Oil
	♦ GM 2–Hotel Water Use
Materials	♦ GM 1–Materials
	♦ GM 4–Inventory Program
	♦ GM 5–Ship Recycling
Air Quality	♦ AE1–NOx Reductions
	♦ AE2–Sox Reductions
	♦ AE3–PM Reductions
	♦ AE4–VOC
	♦ AE5–GHGs
	♦ AE7–Port Air Emissions
Construction Phase	

Specific actions would then follow by using the previous figures as bases for detailed analyses and further refinement of the GRIP process, both on the higher level and also within the organizational workings of the agency or enterprise.

One possible scenario in which the GRIP could be useful is when deciding which rating system to pursue. If certain sustainability practices have already been established for a given project, the GRIP can be used to compare the sustainability practices across multiple rating systems to see how many credits the project is eligible for, allowing for a more effective pursuit of green rating systems achievements. Another situation in which the GRIP may prove useful is when a project is required to follow multiple rating systems covered in the GRIP. By being able to compare credits side by side, it could be easier to determine how a single sustainable practice may fulfill multiple credits across multiple systems.

FUTURE RESEARCH

The GRIP presented in the research currently integrates five rating systems relevant to intermodal facilities as well as a set of guidelines for ferry terminals previously developed by WSU. Ideally, future work could be done to expand this integration beyond simply green rating systems and guidelines to include regulations and standards as well. With this integration setup one can quickly see how the credits relate across rating systems. It is a simple spreadsheet approach for managing communication across complex organizational and project related sustainability goals and criteria. This spreadsheet only shows the title of each credit; more detailed management practices of each credit for the rating systems may be obtained from the rating systems themselves and are intended to be applied within each category.

FIGURE 6. Green Rating Integration Platform for WSF.

	Upland GreenLITES	Land Side LEEDretail	Land Side Sustainable Sites Initiative	Intermodal Port Authority	Intermodal WSU Ferry Guidelines	Marine Side MVeP
Traffic/Parking	☐ E-1: Improve Traffic Flow	☐ SSc4-Alternative Transportation		☐ IS-17: Optimize Traffic Safety	☐ Promote HOV	
	☐ E-4: Bicycle/Pedestrian Facilities			☐ IS-19: Enhance Intermodal Connectivity	☐ Encourage walk-ons	
				☐ IS-20: Transportation System Management	☐ Encourage bicycle use	
				☐ IS-21: Transportation Technologies	☐ Facilitate drop-off	
					☐ Park-and-ride program	
					☐ Shared-car program	
					☐ Optimize traffic flow	
					☐ Reservation system	
					☐ Peak periods prices	
					☐ Allow future growth	
Community/Social	☐ S-2: Context Sensitive Solutions	☐ SSc2-Community Connectivity	☐ SSp1.2-Protect floodplain functions	☐ IS-5: Protect Ecological Health	☐ Architecturally blend	☐ GM 3.1-Aquatic Life Impact
	☐ S-3: Land Use Planning	☐ SSc5.1-Protect or Restore Habitat	☐ SSp1.3-Preserve wetlands	☐ IS-6: Maintain Absorbent Landscapes	☐ Visitor center	☐ GM 3.2-Shore Protection
	☐ S-4: Protect Wildlife Habitat	☐ SSc5.2-Maximize Open Space	☐ SSp1.4-Preserve endangered species	☐ IS-8: Utilize Appropriate Vegetation	☐ Include guided tours	☐ AE6-Ozone-Depleting
	☐ S-5: Protect Plant Communities	☐ SSc7-Heat Island Effect	☐ SSc1.6-Select sites in communities	☐ IS-14: Mitigate Heat Island Effect	☐ Prevent flood damage	
	☐ E-5: Noise Abatement	☐ SSc8-Light Pollution Reduction	☐ SSc1.7-Accessible to public transit	☐ IS-15: Minimize Light Pollution	☐ Allow change in activity	
	☐ E-6: Stray Light Reduction	☐ EAp3-Refrigerant Management	☐ SVp4.1-Control invasive plants	☐ IS-16: Optimize Public Environments	☐ No ozone depleting substances	
		☐ EAc4-Refrigerant Management	☐ SVp4.2-Use non-invasive plants		☐ Light Pollution Prevention	
		☐ IEQc6-Controllability of Systems	☐ SVp4.3-Soil management plan		☐ Noise Pollution Prevention	
		☐ IEQc7-Thermal Comfort	☐ SVc4.5-Preserve special status veg.		☐ Wildlife Considerations	
		☐ IEQc8-Daylighting and Views	☐ SVc4.6-Daylighting and Views			
			☐ SVc4.7-Use native plants			
			☐ SVc4.8-Preserve native plants			
			☐ SVc4.9-Restore native plants			
			☐ SVc4.12-Reduce heat island effect			
			☐ SVc4.13-Reduce wildfire risk			
			☐ HHc6.1-Equitable site development			
			☐ HHc6.2-Equitable site use			
			☐ HHc6.3-Sustainability education			
			☐ HHc6.4-Protect historical places			
			☐ HHc6.5-Optimum site accessibility			
			☐ HHc6.6-Outdoor physical activity			
			☐ HHc6.7-Views of vegetation			
			☐ HHc6.8-Outdoor spaces			
			☐ HHc6.9-Reduce light pollution			
Energy	☐ E-2: Reduce Electrical	☐ EAp2-Minimum Energy Performance	☐ SVc4.10-Minimize heating	☐ IE-1: Optimize Energy Performance	☐ Produce renewable energy	☐ EE1.1-Lighting
	☐ E-3: Reduce Petroleum	☐ EAc1-Optimize Energy	☐ SVc4.11-Minimize cooling	☐ IE-2: Electrical and Mechanical Systems	☐ Use waste heat from engine	☐ EE1.2-HVAC
		☐ EAc2-On-site Renewable Energy	☐ OMc8.4-Reduce energy consumption	☐ IE-3: Utilize End Use Metering	☐ Use local material	☐ EE1.3-Pump Systems
		☐ EAc5-Measurement and Verification	☐ OMc8.5-Use renewable energy	☐ IE-4: Use On-Site Renewable Energy	☐ Minimal embodied energy	☐ EE1.4-Mechanical Equipment
		☐ EAc6-Green Power		☐ IE-5: Protect Ozone Layer	☐ Daylight harvesting	☐ EE1.5-Hull/Propeller
				☐ IE-6: Provide Alternative Fueling Stations	☐ High-efficiency systems	☐ EE1.6-Route Optimization
					☐ Individual control in offices	☐ EE1.7-Vessel Speed
					☐ Automatic control in public	☐ EE1.8-Energy Recovery
					☐ Automatically turn off lights	☐ EE1.9-Hull Optimization
					☐ High reflectance	☐ EE2.1-Other Fuels
						☐ EE2.2-Renewable Energies
						☐ EE3-Carbon Footprint
Water	☐ W-1: Stormwater Management	☐ SSc6.1-Stormwater Quantity Control	☐ Wp3.1-Reduce landscape irrigation	☐ IS-7: Utilize Pervious Pavement	☐ Emergency plan for spills	☐ WE1-Oily Water
	☐ W-2: BMPs	☐ SSC6.2-Stormwater Quality Control	☐ Wc3.2-Reduce landscape irrigation	☐ IS-9: Use Turfgrass Appropriately	☐ Oil separation equipment	☐ WE2-Non-Indigenous Species
		☐ Wfp1-Water Use Reduction	☐ Wc3.3-Protect/Restore buffers	☐ IW-1: Implement Stormwater BMPs	☐ Non toxic paint	☐ WE2.1-Ballast Water/Sediment
		☐ Wfc1-Water Efficient landscaping	☐ Wc3.4-Rehabilitate streams	☐ IW-2: Implement Rainwater Neutrality	☐ High-efficiency fixtures	☐ WE2.2-Hull Fouling
		☐ Wfc2-Innovative Technologies	☐ Wc3.5-Manage stormwater on site	☐ IW-3: Reduce Use of Potable Water	☐ Prevent leaks	☐ WE3-Sanitary Systems
		☐ Wfc3-Water Use Reduction	☐ Wc3.6-On-site water resources	☐ IW-4: Utilize End Use Metering	☐ Reduce potable water	☐ WE4-Solid Waste
			☐ Wc3.7-Use stormwater for landscape	☐ IO-1: Sustainable Landscape Maintenance	☐ Reduce city water	☐ WE5-Incidental Discharges
			☐ Wc3.8-Maintain water features	☐ IO-2: Maintain Soil Quality	☐ Treat waste water on-site	☐ WE6-Protection of Oil
			☐ OMp8.1-Sustainable maintenance		☐ Implement LIDs	☐ GM 2-Hotel Water Use
					☐ Collect runoff/rainwater	
					☐ Treat water on boat	
					☐ Maintain ballast tanks	
					☐ Exchange s off-shore	
Materials	☐ M-1: Reuse of Materials	☐ MRp1-Recyclables	☐ MSp5.1-Eliminate threatened wood	☐ IS-10: Amend and Reuse Existing Soils	☐ Reduce waste due to activity	☐ GM 1-Materials
	☐ M-2: Recycle content	☐ MRc1.1-Building Reuse-Exterior	☐ MSc5.2-Maintain often	☐ IS-11: Balance Earthwork	☐ Recycling dumpsters	☐ GM 4-Inventory Program
	☐ M-3: Locally Provided Material	☐ MRc1.2-Building Reuse-Interior	☐ MSc5.3-Design for deconstruction	☐ IM-1: Use Recycled Materials	☐ Sort waste for recycling	☐ GM 5-Ship Recycling
	☐ M-4: Bioengineering Techniques	☐ MRc2-Waste Management	☐ MSc5.4-Reuse salvaged materials	☐ IM-2: Use Local/Regional Materials	☐ Recycle bins	
	☐ M-5: Hazardous Minimization	☐ MRc3-Materials Reuse	☐ MSc5.5-Recycled content materials	☐ IM-3: Reuse Materials	☐ High-recyclable materials	
		☐ MRc4-Recycled Content	☐ MSc5.6-Use certified wood	☐ IM-4: Use Durable Materials	☐ Hazardous waste plan	
		☐ MRc5-Regional Materials	☐ MSc5.7-Use regional materials	☐ IM-5: Sustainably Harvested Wood	☐ Sustainable materials	
		☐ MRc6-Rapidly Renewable Materials	☐ MSc5.8-Reduce VOC emissions	☐ IM-6: Minimize Toxic Materials	☐ Low-emitting materials	
		☐ MRc7-Certified Wood	☐ MSc5.9-Sustainable plant production	☐ IM-7: Enhance Pavement Lifecycle		
		☐ IEQc4-Low-Emitting Materials	☐ MSc5.10-Sustainable manufacturing	☐ IM-8: Utilize Thin Surface Paving		
			☐ OMp8.2-Collect recyclables	☐ IM-9: Utilize WMA Technology		
			☐ OMc8.3-Recycle organic matter			
Air Quality		☐ IEQp1-Minimum IAQ	☐ OMc8.6-Minimize tobacco smoke		☐ Outside air intake	☐ AE1-NOx Reductions
		☐ IEQp2-ETS control	☐ OMc8.7-Minimize greenhouse gases		☐ Natural ventilation	☐ AE2-Sox Reductions
		☐ IEQc1-Outdoor Air Monitoring	☐ OMc8.8-Reduce emissions		☐ Minimize chemical use	☐ AE3-PM Reductions
		☐ IEQc2-Increased Ventilation			☐ Reduce flying dirt	☐ AE4-VOC
		☐ IEQc5-Indoor Pollutant Control			☐ Limit engines running	☐ AE5-GHGs
					☐ Avoid fossil fuel engines	☐ AE7-Port Air Emissions
Construction Phase	☐ S-1: Alignment Selection	☐ SSp1-Pollution Prevention	☐ SSp1.1-Limit farmland development	☐ IS-1: Integrated Team Approach	☐ Brownfield site	
		☐ SSc1-Site Selection	☐ SSc1.5-Select brownfields	☐ IS-2: Prepare a Site Assessment	☐ Clean polluted water	
		☐ SSc3-Brownfield Redevelopment	☐ PDp2.1-Pre-design assessment	☐ IS-3: Previously Developed Sites	☐ Reduce construction waste	
		☐ EAp1-Fundamental Commissioning	☐ PDp2.2-Integrated site development	☐ IS-4: Known Contaminated Sites	☐ Dredging	
		☐ EAc3-Enhanced Commissioning	☐ PDc2.3-Engage users in site design	☐ IS-12: Coordinate Utility Work		
		☐ IEQc3-Construction IAQ	☐ SVp4.4-Minimize soil disturbance	☐ IS-13: Utilize Trenchless Technology		
			☐ Cp7.1-Control construction pollutants	☐ IS-18: Roadway Alignment Section		
			☐ Cp7.2-Restore disturbed soils	☐ IC-1: Minimize Pollution		
			☐ Cc7.3-Restore disturbed soils	☐ IC-2: Protect Existing Natural Systems		
			☐ Cp7.4-Divert materials from disposal	☐ IC-3: Transportation Management		
			☐ Cp7.5-Reuse soil	☐ IC-4: Green Construction Equipment		
			☐ Cp7.6-Minimize emissions	☐ IC-5: Reduce Noise and Vibration		
				☐ IC-6: Waste Management		
				☐ IC-7: Integrated Pest Management		

More integration on the detail level is part of ongoing research. This ongoing research envisions the development of a database where specific practices, actions and impacts can be data-mined in order to provide decision makers and designers with a more comprehensive view of the impacts of various decisions. In addition, integration is being analyzed to correlate the rating systems and sustainability guidelines with the WSF safety management system (SMS).

CONCLUSION

There is uncertainty in which regulations or green rating system guidelines WSF may be subject to in the future. The provided *green rating integration platform* (GRIP) will allow WSF to easily relate design and construction decisions across multiple green rating systems and within their sustainability guidelines as the situation or area of construction dictates. This will help facilitate green building, pollutant reduction, and other environmental goals of WSF. The GRIP format might similarly be applied to other projects which contain diverse components, and to more effectively and economically address sustainability across all aspects of projects and facility operations.

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