NORTH CAROLINA
MARITIME Strategy

NC Maritime Strategy
Green Ports Strategies

Prepared for the
North Carolina Department of Transportation

by

AECOM
in association with URS

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DISCLAIMER

ACKNOWLEDGEMENTS

Initiated by the Governor's Logistics Task Force (GLTF), the *North Carolina Maritime Strategy* takes a fresh look at North Carolina's maritime assets and the needs for improvement to ensure that our State remains competitive in the future. A *Maritime Strategy* Executive Team has been formed to oversee this process, evaluate the results and provide an objective technical and economic analysis. The *Maritime Strategy* Executive Team includes: Lieutenant Governor Walter Dalton; the Governor's Senior Policy Advisor, Al Delia; Secretary of Transportation, Gene Conti; Secretary of Commerce, J. Keith Crisco; and Secretary of Environment and Natural Resources, Dee Freeman. The following North Carolina Department of Transportation (NCDOT) and North Carolina Department of Commerce (NCDOC) staff have provided day-to-day direction, guidance and support for study execution: NCDOT Director of Strategic Initiatives, Roberto Canales PE; NCDOT Project Manager, Virginia Mabry; NCDOT Liaison to the Lieutenant Governor, W. Seth Palmer; NCDOT/Commerce Liaison Joseph (Jed) McMillan; and Transportation Consultant to NCDOT and Global TransPark, Charles Diehl.

A Maritime Advisory Council, comprising State officials and staff, along with industry representatives from ocean shipping, trucking, rail and manufacturing interests, as well as community-at-large representatives, has provided further guidance and support to the study team. A roster of Advisory Council membership is included in the appendix of this report.

Finally, broad-based stakeholder outreach is key to successful development of the statewide *Maritime Strategy*. A comprehensive and ongoing public involvement program has provided additional input to the study by engaging the public, agencies and others through a series of informational meetings, public workshops and focused discussions with industry, as well as environmental and community groups.

EXECUTIVE SUMMARY

The *North Carolina Maritime Strategy* is being developed to connect maritime goods and economic development in North Carolina. This is accomplished through the following primary tasks:

- Facilitated collaboration of freight transportation, economic development and community interests as input to the statewide strategy,
- Definition of North Carolina's economic context and maritime market positioning strategies that would offer the greatest economic benefit to the State, and
- Identification of infrastructure investments and policies that would most significantly enhance North Carolina's economy through improved performance of the State's maritime gateways and related trade corridors.

The *North Carolina Maritime Strategy* will define maritime market scenarios in which the State could realize economic and public benefit. Opportunities to be explored will include those associated with import and export of containerized cargo, as well as the potential for expanded bulk, breakbulk, petrochemical and military cargos. Special emphasis will be made to link potential market positions with industry in the State. The range of market position alternatives to be investigated may include regional transshipment of goods, container-on-barge service and major international container terminal operations.

For each viable market scenario, the Strategy will define its infrastructure needs. Transportation investments to be examined may include reconfiguration or modernization of existing port facilities, new terminal developments, wharf and channel improvements, road and rail connections, and inland intermodal facilities. A comparative analysis of development alternatives will be conducted to measure the relative benefits, effectiveness and costs associated with various alternatives for market positions and associated infrastructure.

As a supporting document to the final report, *Green Ports Strategies* technical report provides a brief history of the green ports sector, as well as highlights of the major technologies and policies being pursued by ports worldwide as they strive to make operations more sustainable and achieve better harmony with their neighbors.

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1 TRADITIONAL US PORT OPERATIONS

Over the last century, US ports developed primarily as manual operations using all diesel powered equipment. Land availability was generally not the most significant concern to terminal developers, so storage densities were kept low in order to minimize operating costs. And ports were often surrounded by industrial uses or low-density development, so there were few concerns about impacts on surrounding neighborhoods.

Typically the trucks used for drayage moves to and from marine terminals were the oldest and cheapest trucks in operation. Use of old trucks for short haul drayage moves kept costs low, but resulted in large amounts of air emissions, which were not yet a subject of significant concern to terminal operators and port authorities. The same philosophy was also applied to all on-terminal cargo handling equipment, which typically used the cheapest engines possible even if they were less energy efficient and resulted in more pollution.

Gate operations were kept as simple as possible – with limited daytime-only hours and first-come, first-served queues to minimize operating costs. Ports were typically not obligated to consider the effects of trucks visiting their facilities on communities. With plentiful and relatively inexpensive energy, port operations did not typically consider means to reduce or replace the use of carbon-based fuels. Water quality requirements adhered to local standards but rarely took extraordinary steps to capture or treat stormwater runoff.

2 INCREASED IMPORTANCE OF ENVIRONMENTAL ISSUES

In the 2000's, environmental issues began to take more priority for terminal operators and port authorities. In 2001, the Natural Resources Defense Council (NRDC) sued the Port of Los Angeles regarding its plans for a large new container terminal after opposition from many residents in neighborhoods around the Port led them to voice concerns about the increased noise, traffic, and pollution the development would bring. This lawsuit resulted in several requirements for the port to be allowed to expand, including many of the green ports initiatives now popular in the US.

Overall, perhaps the most significant impact of the suit has been greater public awareness of, and opposition to, the negative impacts of port operations on communities, resulting in a shift in priorities for ports and terminal operators. Previously operations focused on using low cost but dirty diesel equipment running on the cheapest fuels available regardless of environmental impacts, with operations spread out to minimize cost.

By far the largest focus in the US for green ports strategies has been on air emissions due to the health impacts they have on neighboring communities. Other issues of importance include light and noise impacts on neighboring residents, as well as the effects of stormwater runoff and ocean dredging and landfill on marine habitats.

2.1 Environmental Regulations and Initiatives

On a global level, the International Maritime Agency (IMO) regulates emission standards for the shipping industry, primarily regarding Nitrogen Oxides (NO_x), Particulate Matter (PM), and Sulfur Oxides (SO_x) levels from vessels. The IMO also limits acceptable levels of sulphur content for fuels used in marine engines, and allows individual countries to designate their own emission control areas (ECA) around their coasts with more stringent standards.

Within the United States, there are numerous acts, regulations, and initiatives regarding reducing emissions from port activities. Some of the most significant regulations and initiatives within the US include:

- Clean Air Act: Requires the US EPA to regulate emissions of hazardous air pollutants such as SOx and PM; sets emission standards for new diesel engines and boilers on vessels, as well as other engine types generally used on ports (on-road, non-road, and locomotive).
- Clean Ports USA: Incentive-based program to encourage ports to reduce emissions from diesel equipment on ports; funds a variety of project types, such as gate automation systems, shore power for vessels, and alternative fuel vehicles.
- Diesel Emissions Reduction Act (DERA): provides funds to federal and state programs to retrofit or rebuild diesel engines with proven, cost-effective technologies.
- AAPA Strategic Initiative – Sustainability: Implemented a task force to examine port sustainability issues and encourages ports to implement the concept of sustainability as part of their standard business practices for both near and long-term planning.

2.2 Adoption of Sustainability Policies

Under regulatory, and community pressure, the nation's largest ports have adopted formal policies to enhance the environmental, social, and economic sustainability of their operations. These sustainability goals complement and supplement basic regulatory and legal requirements imposed on port operations. Regional ports and transportation providers may partner together to adopt sustainability objectives and strategies to achieve their common goals.

As an example, the Port of Long Beach adopted a Green Port Policy that incorporates the following five guiding principles:

1. Protect the community from harmful environmental impacts of Port operations.
2. Distinguish the Port as a leader in environmental stewardship and compliance.
3. Promote sustainability.
4. Employ best available technology to avoid or reduce environmental impacts.
5. Engage and educate the community.

3 BEST PRACTICES FOR GREEN PORTS

3.1 Air Quality

The Clean Air Act requiring the US EPA to set federal limits on level of emissions from hazardous pollutants was first signed into law in 1970. Since then, numerous other regulations and policies have been enacted regarding air emissions, both by the US EPA and by other state and local agencies. One of the best examples of the effectiveness of a focused program to improve air quality is the combined effort of the Ports of Los Angeles and Long Beach as set forth in their Clean Air Action Plan (CAAP).

The CAAP was first developed in 2006 by the Ports of Los Angeles and Long Beach in conjunction with the South Coast Air Quality Management District, California Air Resources Board, and the US EPA. The goal of the CAAP is to provide a comprehensive strategy to reduce emissions from port-related activities with the goal of reducing the negative impacts of ports while allowing major economic expansion efforts to continue. The plan is updated periodically to keep in line with new industry standards, technologies, and developments. The CAAP focuses on specific, measurable reductions in particulate matter, NOx, and SOx emissions, the pollutants known to have the most significant health impacts on communities. The complete CAAP can be found at: www.portoflosangeles.org/environment/caap.asp.

3.1.1 Vessel Speed Reduction

The CAAP includes a vessel speed reduction program that requires ships to operate at reduced speeds within 24 nautical miles of the California coast; slower speeds result in lower levels of emissions from marine engines, allowing reductions in air emissions for communities near the port.

3.1.2 Shore Power

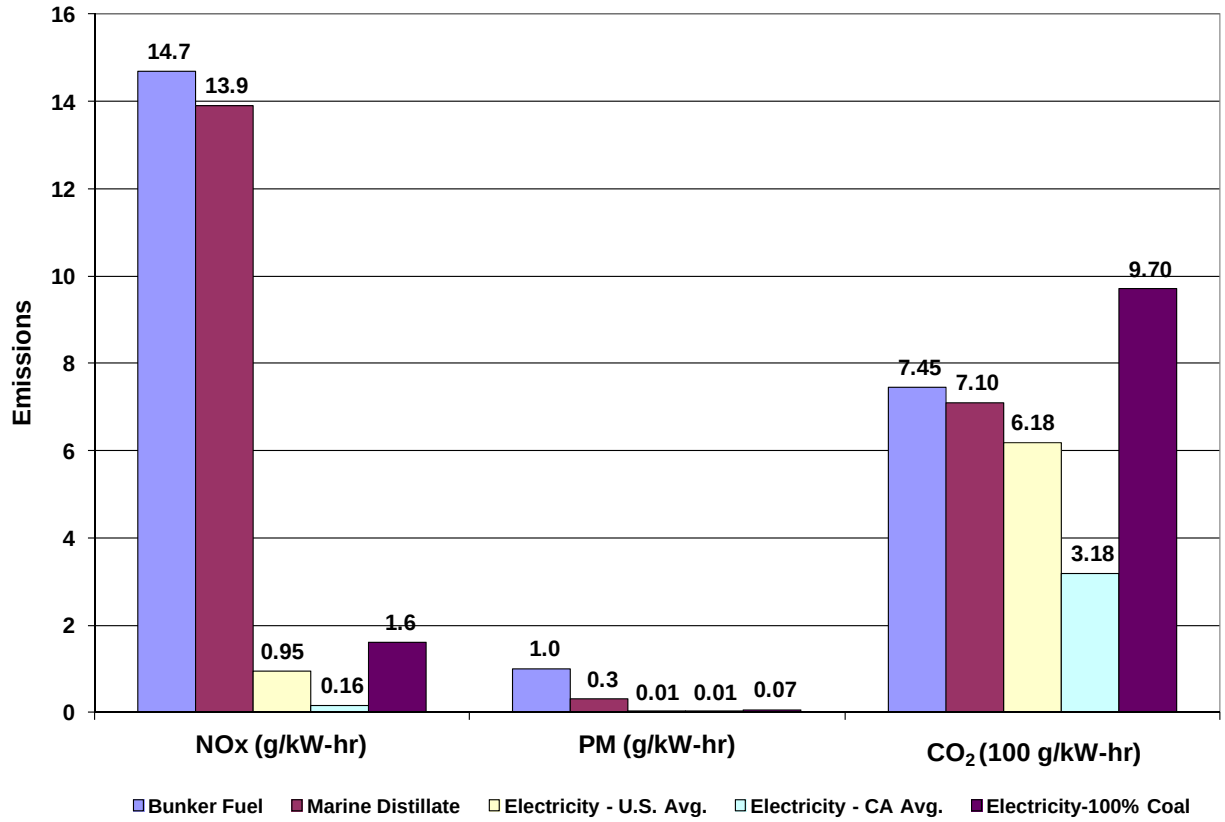
CAAP includes a comprehensive shore-power initiative to meet and exceed the requirements set by the California Air Resources Board (CARB). Installing shore-to-ship power infrastructure allows vessels to turn off engines completely while at berth (see Figure 1).

Figure 1: Alternative Marine Power (AMP) at the Port of Los Angeles Allows Ships to Use Electric Power at Berth

Ship fuel in particular is the dirtiest, so there has been great emphasis on shore-to-ship power.

Figure 2 is a chart developed by AECOM comparing the emission factors of marine fuels and electricity sources. This demonstrates the relative emissions that will result from a vessel call depending on the type of energy used at berth and shows the advantages of electricity over traditional fuels.

Figure 2: Vessel Hotelling Emission Rates by Energy Source



Note: (g/kW-hr) Gram per Kilowatt/hour

As Figure 2 demonstrates, switching ships to electric power at berth will always result in massive reductions in local pollutants such as NO_x and particulate matter (PM), regardless of the fuel source used to generate electricity. Even coal fired power plants are equipped with fairly robust equipment to remove pollutants from the exhaust gas whereas cargo ships feature little or no exhaust filtering technology.

In many cases, there will also be reductions in greenhouse gas (GHG) emissions as well. The 100 percent coal case on the far right is essentially a 'worst-case' scenario of emission levels from electricity; as long as the electricity generation grid includes some cleaner than coal sources (as the electric grid from a vast majority of US port states do), CO_2 emissions will be reduced as well.

3.1.3 Low-Sulphur Fuels

CAAP requires that low sulphur fuels be used in all vessel engines and boilers near the coast (within 40 nautical miles).

3.1.4 Clean Trucks

CAAP includes a comprehensives Clean Trucks Program, which bans drayage trucks not

meeting 2007 US EPA on-road engine standards from visiting the port starting in 2012. To help offset the cost to trucking companies to upgrade their fleets, the Ports spent $44 million on incentives for new diesel truck purchases, with another $12.5 million going towards LNG-fueled truck purchases (Source: www.portoflosangeles.org/ctp/CTP_Fact_ Sheet.pdf).

3.1.5 Cargo Handling Equipment

Several efforts have been made by ports to meet the highest US EPA emissions standards for existing and replacement cargo handling equipment (CHE):

- Minimum Tier 4 engine performance standards for all new cargo handling equipment; Tier 4 standards are set by the US EPA and have the strictest requirements for acceptable levels of particulate matter and NO_x emissions.
- Replacement or retrofitting of engines in existing cargo handling equipment with Best Available Control Technology (BACT).

Modernization of container yards to incorporate the latest cargo handling strategies and technologies yields even more air quality benefits. The automated container operation at APMT Virginia results in drastically reduced diesel emissions through the use of electric automated stack cranes (ASCs) in the container yard, rather than diesel-fueled rubber-tired gantry (RTG) cranes typical in traditional operations. In addition, the use of end-loaded yard cranes allows street trucks to back into an ASC row and turn off their engines while waiting for service (see Figure 3), resulting in significantly reduced emissions from drayage trucks while on terminal.

Figure 3: Truck Buffers at APMT Virginia

Environmental issues are not the only factor driving the switch from diesel to electric power on terminal. In the past, diesel costs were low enough that the cheapest equipment available was typically implemented, even if it was not the most energy efficient. As diesel prices have increased significantly in recent years however, the trend is moving towards replacing diesel with electricity whenever possible.

Perhaps the best example of this trend is APM terminals' 2011 announcement of plans to retrofit every RTG in their world fleet from diesel to hybrid diesel-electric power. This is over 400 machines in total to be retrofit to accept electric power via a busbar system, an example of which is shown in Figure 4. Previously, such a significant financial investment in alternative energy technologies would not have been considered a viable option; however, with increasing diesel fuel costs, this upgrade makes both fiscal and environmental sense. These retrofits are expected to reduce CO_2 emissions from RTGs by 60 to 80 percent, while also leading to cost savings due to increased energy efficiency and reduced maintenance costs.

Figure 4: Conductix Wampfler E-RTG with Conductor Bar at Ningbo International Container Terminal

The trend toward increased electricity use over diesel-powered equipment is also spurring development of electric terminal vehicles, such as a prototype electric yard tractor designed by Balqon Corp, currently being tested at the Port of Los Angeles. An image of the electric tractor model undergoing testing is shown in Figure 5.

Figure 5: Prototype Balqon Electric Truck at the Port of Los Angeles

Twenty-five of these electric yard tractors were delivered to the Port in February 2009 and are currently undergoing testing. Even in a world-class system such as APMT Virginia in Figure 3, diesel-powered vehicles are used to transport containers from the dock crane to the stacks and are the largest source of emissions remaining for on-terminal CHE in a modern terminal. Electrifying terminal transport equipment will result in significant reductions in on-terminal emissions.

3.1.6 Trains and Harbor Craft

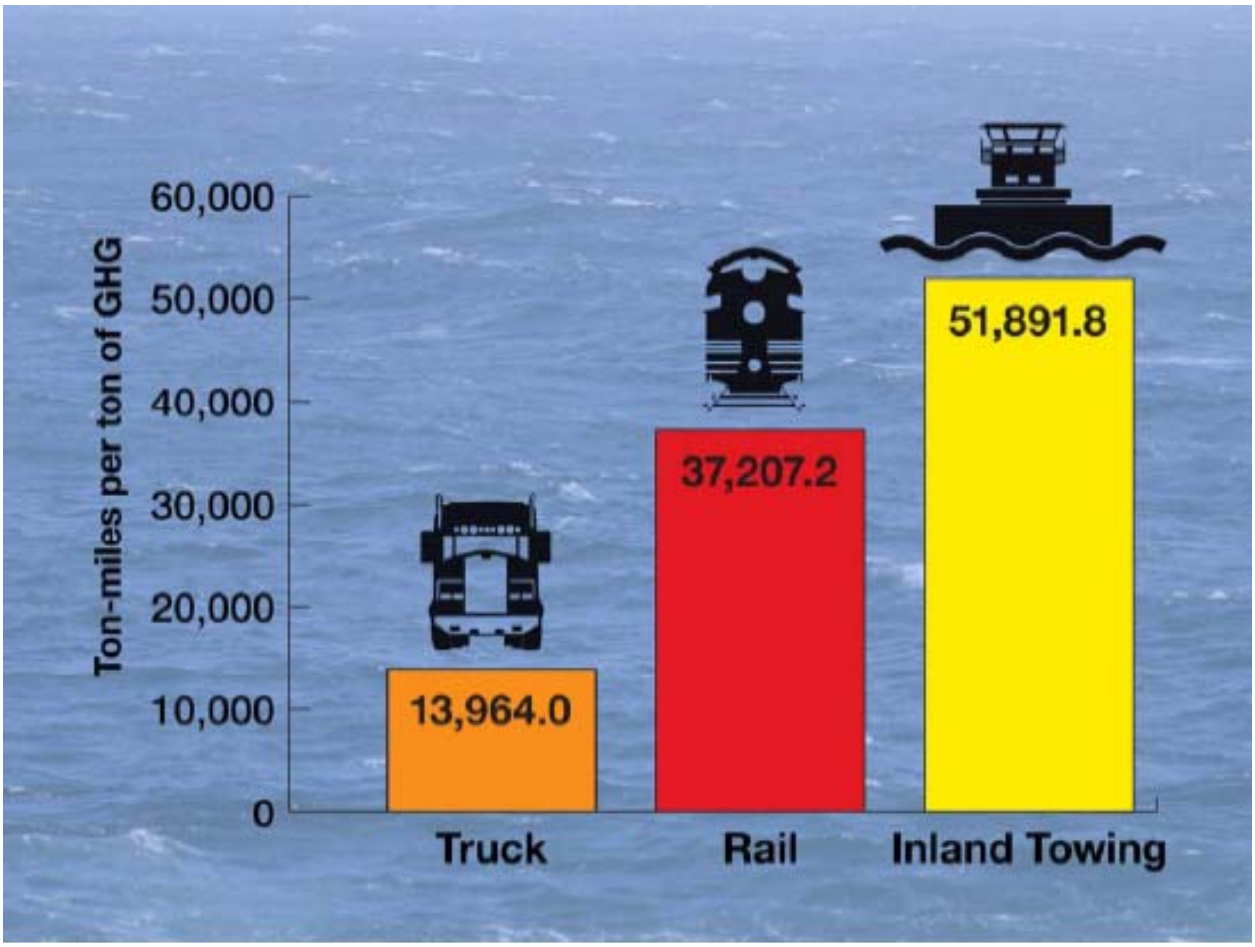
Several standards have also been developed to address and reduce air emissions from trains and harbor craft; however, initial surveys of traditional operations find that ocean going vessels, trucks, and in-terminal cargo handling equipment are the largest sources of air pollution.

3.1.7 Landside Mode Shifts

Significant reduction to air emissions can be achieved by shifting landside transport of waterborne cargo from trucks to either rail or barge.

Figure 6 demonstrates the different emission levels of the three primary modes of cargo transportation: truck, rail, and barge. GHG refers to 'greenhouse gases', a vast majority of which are composed of CO_2.

Figure 6: Ton-miles per Ton of GHG by Mode of Transport



Source: *A Modal Comparison of Domestic Freight Transportation Effects on the General Public*, Texas Transportation Institute, March 2009

As Figure 6 indicates, rail is far more efficient from an energy consumption and air emissions perspective than trucking. To take advantage of this, ports have been trending toward implementing large on-terminal rail yards to encourage consumers to use rail over trucking whenever possible.

Figure 6 also shows that inland towing (barging) is even more efficient than rail. Several American ports are considering implementing barge shipping programs in order to eliminate truck or rail trips. For instance, the Port of Oakland is starting a barge service to Stockton along the inland corridor designated M580 (the marine highway parallel to I-580 in California). This service involves transferring containers from the terminal in Oakland onto a barge, which would then be towed via M580 to the Port of Stockton. At Stockton, containers are offloaded from the barges onto a terminal where they can be picked up by trucks for transportation to their final

local or regional destination. This reduces the distance cargo must be transported via less energy-efficient trucks, and has the added benefit of allowing more cost-effective shipment of containers too heavy for highways.

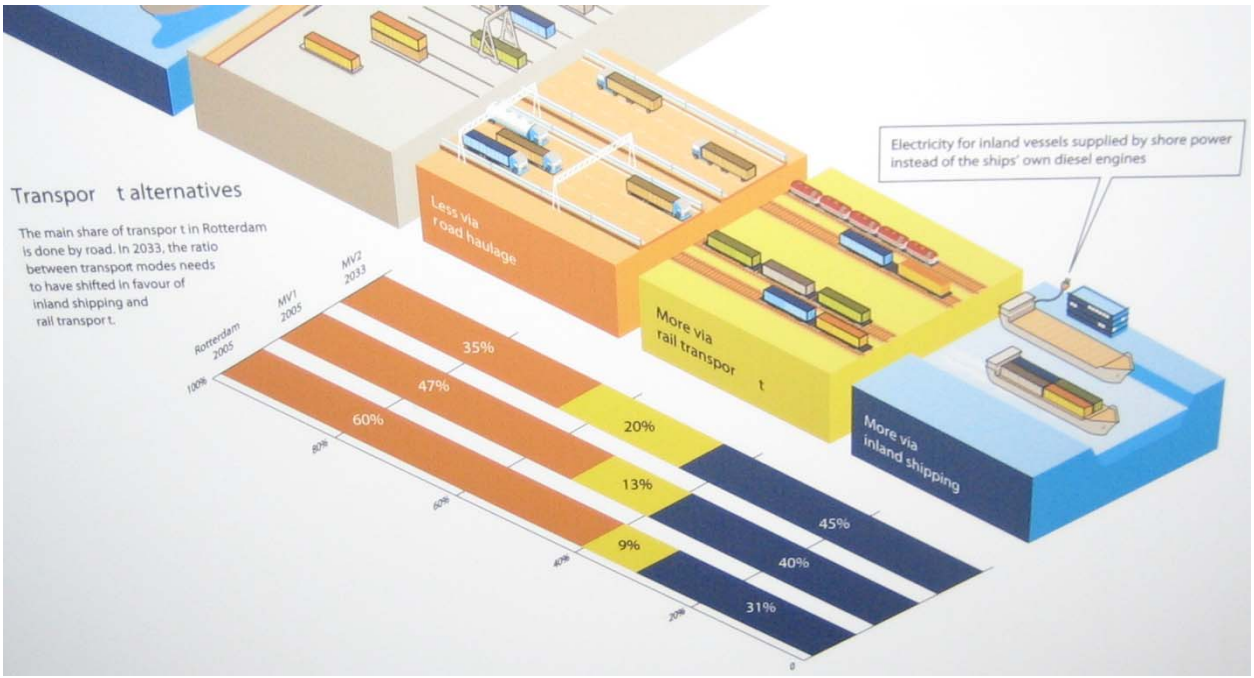
3.2 Mobility

3.2.1 Rail and Barge Transport

In addition to the air quality benefits described above, increased usage of rail and inland waterways have the added benefit of easing road congestion through elimination of truck trips.

Some ports have begun to mandate reductions in truck moves as part of all new terminal leases, particularly the Port of Rotterdam. Figure 7 shows the modal shift being implemented by the Port via lease requirements.

Figure 7: Port of Rotterdam Mandated Modal Shifts



In Figure 7, the orange bar represents containers moved via truck, which occurred in 60 percent of all container moves at the port in 2005. As the chart shows, Rotterdam is attempting to reduce this to 35 percent by 2033 via lease mandates.

3.2.2 Gate Hours of Service and Appointment Systems

Reduction of daytime truck queuing and peak hour traffic impacts of truck movements can be achieved through longer gate hours and the use of gate appointment systems. This has been one of the primary motivating factors behind the implementation of the PierPass system, another measure first implemented at the ports of Los Angeles and Long Beach. PierPass is a system developed by terminal operators to address truck congestion issues at the Ports. In the PierPass system, there are two 8-hour gate shifts operated per weekday at container terminals.

During the dayshift (the 'busy' shift), there is an additional fee to access the terminal. Customers who are willing to use the off-peak shift are not required to pay this fee, thereby creating a financial incentive to shift traffic to lighter hours. This has the added benefit of reducing peaking in truck arrivals (i.e. resulting in more uniform truck arrivals), which yields higher terminal gate capacity.

Shortly after the implementation of PierPass, 40 percent of the gate transactions shifted from the busy shift to the off-peak shift. This smoother flow of truck arrivals through the course of each day significantly reduced congestion and truck idle time both on the terminals, and on major freeways serving the port.

3.3 Efficient Land Use

The increased resistance to physical expansion of ports onto undeveloped land combined with better automation technology has made high density terminals more feasible in the US. A good example of the type of terminal that will become more typical due to the increasing importance of environmental issues is APMT Virginia, shown in Figure 8 below.

Figure 8: APM Terminal in Virginia

Note that the terminal in Figure 8 is surrounded by undeveloped lands. This contrasts significantly with older styles of port operations where the facility was purposely kept low-density for cost-effectiveness, like those shown in Figure 1. The system in Figure 8 allows drastic

improvements in storage density, resulting in lower acreage requirements for the same level of annual throughput. This allows the environment around the terminal to stay undeveloped, and reduces the amount of damaging ocean fill required.

3.4 Water Resources and Marine Habitats

3.4.1 Habitat Preservation and Restoration

Ports that require ongoing maintenance dredging, like the Port of Houston Authority (PHA), have opportunities to reuse clean dredge material in ways that benefit the environment and community users. PHA has developed an off-shore island called Redfish Island from dredge materials. This island is now a well-established bird habitat and rookery as well as a productive oyster reef.

The website betterbay.org has this to say about PHA's habitat preservation and enhancement efforts:

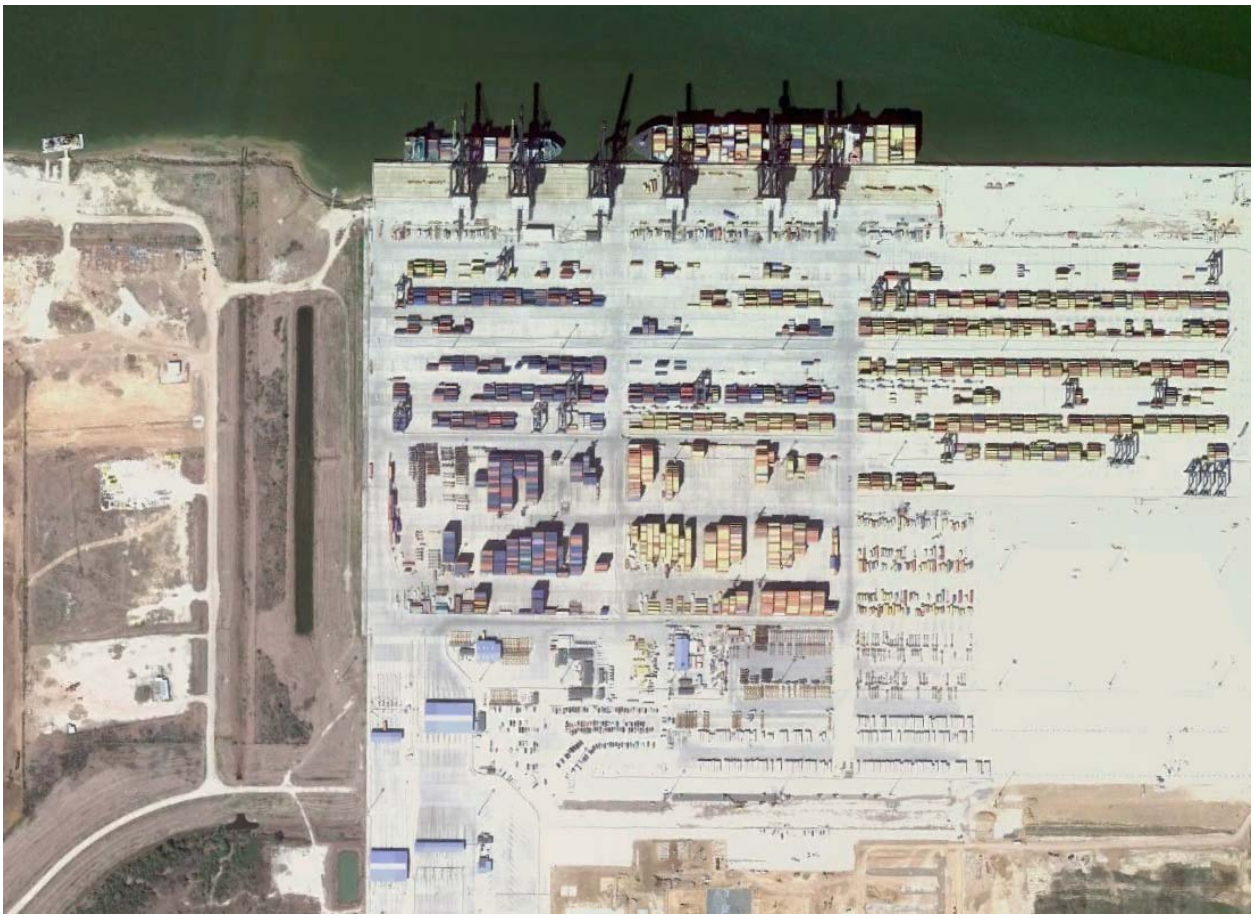
> *As the deepening and widening of the Houston-Galveston Navigation Channels (HGNC) continues, the silt, sand, shell and clay dredged during the expansion and subsequent channel maintenance are being creatively utilized as an environmental resource to enhance Galveston Bay. This project is the largest wetland creation effort of its kind in the nation and, possibly, one of the largest environmental initiatives to date.*

3.4.2 Stormwater Pollution Prevention

Ports are governed by local regulations with regard to stormwater discharge. These vary from place to place but typically do not allow direct discharge of untreated storm water into the ocean or river on which a port is located. Interceptor devices are used to retain some amount of storm water so that some of the pollution that may be carried by storm water settles out in the system as opposed to being swept directly into the sea.

Terminals in areas that receive heavy rain may install retention ponds adjacent to the terminal in order to achieve a higher level of preliminary treatment of stormwater. Figure 9 of the Port of Houston's Bayport terminal shows a linear stormwater retention pond to the left of the terminal; this is the secondary facility. Water from the terminal drains into a primary pond (instead of into the ocean) adjacent and to the left of the linear pond (not shown).

Figure 9: Storm Water Retention Ponds at Bayport Houston



Container terminals can store a great deal of water through the use of gravel pavement for container stacks. These stacks are only compatible with overhead cranes for container handling. Figure 10 shows the pavement at the Pusan Newport Terminal in Korea. Containers are stored directly on the gravel surface. The storm water is drained from the terminal via pipes that are placed at low points in the gravel beds.

Figure 10: Gravel Bed for Container Stacking at Pusan Newport Terminal, Korea

Areas around maintenance shops and reefer wash facilities do not drain to the storm water system but will drain to a sanitary sewer. Some ports that handle a great deal of dangerous and hazardous cargo may have designated areas for this cargo that do not drain into the storm sewer but instead are treated on the facility or drain to a sanitary sewer for off-site treatment.

3.5 Public Uses and Community Interfaces

3.5.1 Buffer areas and Land Use Compatibility

Ports strive to block light and noise from operations from impacting nearby residences, while allowing public access to the waterfront as much as possible. The ports of Los Angeles and Houston have built soil berms at the perimeter of some terminals to minimize light and noise.

As part of their Vision 2000 expansion, the Port of Oakland created a Middle Harbor Shoreline Park, a new park that provides shallow water habitat for marine life as well as open space for the public to enjoy the waterfront adjacent to operating marine terminals. The following description of the park is taken from the Port of Oakland website:

> *Since World War II, military use has restricted public access to the shoreline of the Middle Harbor. As part of the Port's Vision 2000 seaport program, the public will regain access to the former naval ship basin. Agencies, community*

representatives and scientists worked together to design the habitat restoration for the more than 150-acre water area of the harbor and the integration of the park with the habitat. Middle Harbor will become an ecological reserve of shallow bay and shoreline habitats for many species, such as Dungeness crab, flatfish, anchovy, herring and perch.

Figure 11: Middle Harbor Shoreline Park in Oakland

3.6 Energy Use

3.6.1 Sustainable Buildings

Most of port areas are open spaces or special materials handling structures. However, ports still feature a number of traditional buildings for administration and maintenance functions. The Leadership in Energy and Environmental Design (LEED) rankings can be used to help improve the sustainability of terminal buildings.

The LEED evaluation process scores buildings on the following categories:

- Site sustainability

- Water efficiency
- Energy use
- Materials and resources
- Indoor environmental quality

Many Ports are now specifying LEED building certification as part of new building projects.

3.6.2 Clean and Renewable Energy

Ports provide great opportunities for the generation of clean power on port property. Solar and wind are the primary energy sources for green power on ports, and their applicability depends considerably on the local climate. The Dutch have been building windmills for hundreds of years, and the trend continues today at the Port of Rotterdam which has over 100 large wind turbines on port property. Each of these turbines can generate over a megawatt of power under peak conditions.

Figure 12: Wind Turbines at the Port of Rotterdam

Many ports are installing solar photovoltaic (PV) panels on terminal buildings. In March 2011, Progress Energy signed a contract to install an 800 kilowatt PV system on a warehouse at the Port of Morehead City.

Renewable energy not only reduces the carbon emissions from port operations but provides a reliably-priced long-term source of energy and often generates considerable positive public relations for ports in the process.