Philadelphia Regional Port Authority

FINAL REPORT

Operational Analysis Report
Terminal Layout and Transition Plans
Cost Estimates

Deliverable 1.3 - DRAFT

TABLE OF CONTENTS

EXECUTIVE SUMMARY		**1**
1.	**INTRODUCTION**	**3**
2.	**DESCRIPTION OF OPERATIONS SYSTEM**	**4**
2.1	**Conventional Containers**	**4**
2.1.1	**Quay**	**4**
2.1.2	**Horizontal Transport**	**4**
2.1.3	**Yard**	**6**
2.1.4	**Gate**	**10**
2.2	**Automated Terminal in Terminal FastShip**	**12**
2.2.1	**Quay**	**12**
2.2.2	**Horizontal Transport**	**12**
2.2.3	**Yard and Staging Area**	**13**
2.2.4	**Gate**	**14**
2.3	**Manual Terminal in Terminal FastShip**	**15**
2.3.1	**Quay**	**15**
2.3.2	**Horizontal Transport**	**15**
2.3.3	**Yard and Staging Area**	**16**
2.3.4	**Gate**	**16**
2.4	**Manual Integrated FastShip**	**16**
2.4.1	**Quay**	**16**
2.4.2	**Horizontal Transport**	**16**
2.4.3	**Yard and Staging Area**	**17**
2.4.4	**Gate**	**18**
2.5	**Military**	**18**
3.	**TERMINAL CAPACITY PLANNING**	**20**
3.1	**Market Potential**	**20**
3.2	**Conventional Containers**	**21**
3.2.1	**Quay Capacity**	**21**
3.2.2	**Yard Capacity**	**24**
3.2.3	**Gate Capacity**	**28**
3.2.3.1	**Existing Gate Structure and Processes**	**28**
3.2.3.2	**Modifications to the Existing Gate Structure and Processes**	**29**
3.2.4	**Capacity Analysis**	**35**
3.3	**Automated Terminal in Terminal FastShip**	**36**

3.3.1	Quay Capacity	36
3.3.2	Yard Capacity	36
3.3.2.1	FastShip Yard Capacity Requirements to Automated Terminal in Terminal Layout	39
3.3.3	Gate Capacity	40
3.3.4	Capacity Analysis	41
3.4	Manual Terminal in Terminal FastShip	41
3.4.1	Quay Capacity	41
3.4.2	Yard Capacity	41
3.4.3	Gate Capacity	42
3.4.4	Capacity Analysis	42
3.5	Manual Integrated FastShip	42
3.5.1	Quay Capacity	42
3.5.2	Yard Capacity	42
3.5.2.1	Yard CapacityFastShip Yard Capacity Requirements to Manual Integrated Terminal Layout	44
3.5.3	Gate Capacity	45
3.5.4	Capacity Analysis	46
4.	RESOURCE DETERMINATION	47
4.1	Conventional Containers	47
4.1.1	Quay	47
4.1.2	Horizontal Transport	49
4.1.3	Yard	50
4.1.4	Gate	59
4.2	Automated Terminal in Terminal FastShip	59
4.2.1	Quay	59
4.2.2	Horizontal Transport	61
4.2.3	Yard and Staging Area	63
4.2.4	Gate	68
4.3	Manual Terminal in Terminal FastShip	69
4.3.1	Quay	69
4.3.2	Horizontal Transport	69
4.3.3	Yard and Staging Area	70
4.3.4	Gate	70
4.4	Manual Integrated FastShip	70
4.4.1	Quay	70
4.4.2	Horizontal Transport	71
4.4.3	Yard and Staging Area	73

4.4.4	**Gate**	**79**
5.	**TERMINAL LAYOUT**	**81**
5.1	**Conventional Containers Conventional Containers**	**81**
5.1.1	**Quay**	**82**
5.1.2	**Yard**	**82**
5.1.3	**Gate**	**83**
5.1.4	**Traffic Flow**	**83**
5.1.5	**Buildings**	**85**
5.2	**Automated Terminal in Terminal FastShip**	**85**
5.2.1	**Quay**	**85**
5.2.2	**Yard**	**86**
5.2.3	**Gate**	**86**
5.2.4	**Traffic Flow**	**87**
5.2.5	**Buildings**	**87**
5.3	**Manual Terminal in Terminal FastShip**	**88**
5.3.1	**Quay**	**88**
5.3.2	**Yard**	**89**
5.3.3	**Gate**	**89**
5.3.4	**Traffic Flow**	**89**
5.3.5	**Buildings**	**89**
5.4	**Manual Integrated FastShip**	**89**
5.4.1	**Quay**	**90**
5.4.2	**Yard**	**90**
5.4.3	**Gate**	**91**
5.4.4	**Traffic Flow**	**91**
5.4.5	**Buildings**	**92**
5.5	**Shared Areas**	**92**
5.5.1	**Customs Inspection Area**	**92**
5.5.2	**Buildings**	**92**
6.	**TRANSITION PLAN**	**93**
6.1	**Conventional Transition Plan**	**93**
6.1.1	**Existing Gate Operations**	**94**
6.1.2	**Phase 1 – Module B**	**94**
6.1.3	**Phase 2 – Module B + A**	**97**
6.1.4	**Phase 3 – Module B + A + C**	**100**
6.1.5	**Phase 4 – Module B + A + C + D**	**102**
6.1.6	**Subsequent Phases to Full Build-Out**	**103**

6.2 FastShip Integration Phase 104
6.2.1 FastShip – Terminal-In Terminal Options 104
6.2.2 FastShip – Integrated 104

7. INVESTMENT COST ASSESSMENT 105
7.1 Equipment 105
7.1.1 Investment Costs for Conventional Layout According to Reconstruction Phases 108
7.2 Gate 109

8. SUMMARY 111

APPENDIX

APPENDIX A

APPENDIX B

APPENDIX C

LIST OF FIGURES

		Page
Figure 1:	**Handover Area RTG to/from Trucks or PMs**	**5**
Figure 2:	**RTG Reefer Racks**	**7**
Figure 3:	**Genset Handling**	**8**
Figure 4:	**Comparison FastShip vs. Conventional Chassis**	**15**
Figure 5:	**Cassette storage location in RTG block**	**17**
Figure 6:	**Example of Military Operations at PAMT**	**19**
Figure 7:	**Conventional Container Yard**	**21**
Figure 8:	**Truck Call Distributions by the Month**	**34**
Figure 9:	**Truck Call Distributions by the Day**	**34**
Figure 10:	**Truck Call Distributions by the Hour**	**35**
Figure 11	**Comparison Yard Capacities**	**39**
Figure 12	**Comparison Yard Capacities**	**45**
Figure 13	**Schematic Bayview of an RTG Container Block**	**51**
Figure 14:	**Conventional Container Terminal – Full Build-Out**	**81**
Figure 15:	**Conventional Container Terminal – General Quay Layout**	**82**
Figure 16:	**Conventional Container Terminal – Gate Flow**	**83**
Figure 17:	**Conventional Container Terminal – Internal Traffic Flow**	**84**
Figure 18:	**Conventional Container Terminal – External Traffic Flow**	**84**
Figure 19:	**Automated Terminal in Terminal FastShip**	**85**
Figure 20:	**Automated Terminal in Terminal FastShip – Gate Flow**	**87**
Figure 21:	**Manual Terminal in Terminal FastShip**	**88**
Figure 22:	**Manual Integrated FastShip**	**90**
Figure 23:	**Manually Integrated Terminal FastShip – Gate Flow**	**91**
Figure 24:	**Demand versus Annual Phased Yard Capacity**	**93**
Figure 25:	**Phase 1 – Module B**	**95**
Figure 26:	**Phase 1 - Upgraded Gate**	**97**
Figure 27:	**Phase 2 – Module B + A**	**97**

Figure 28: Phase 2 Gate 99

Figure 29: Phase 3 – Module B + A + C 100

Figure 30: Phase 3 Gate 101

Figure 31: Phase 4 – Module B + A + C + D 102

Figure 32: Phase 4 Gate 103

Figure 33: Equipment Investment Overview 108

LIST OF TABLES

		Page
Table 1:	Market Potential as Volume Slices for Conventional Containers	20
Table 2:	Quay Crane Capacity	22
Table 3:	Total Handling Volumes by Vessel	22
Table 4:	Average Productivities of Quay Cranes	23
Table 5:	Berth Occupancy	23
Table 6:	Determination of Block Width	24
Table 7:	Determination of Block Length	25
Table 8:	Container Slots Full Container Build-out	26
Table 9:	Yard Capacity for Dry and Reefer Containers	27
Table 10:	Yard Capacity for Empty Containers	27
Table 11:	Yard Capacity, Dry and MT	27
Table 12:	Capacity of Existing Gate Elements	28
Table 13:	Existing Gate Capacity Assumptions	29
Table 14:	Conventional Full Build-out Gate Assumptions	32
Table 15:	Automated Gate Transaction Times	32
Table 16:	Capacity Overview	35
Table 17:	Determination of Block Length	36
Table 18:	Key Data Yard Automated Terminal in Terminal	37
Table 19:	Yard Capacity, Calculation Dry Containers	38
Table 20:	Yard Capacity, Calculation MT Containers	38
Table 21:	Yard Capacity Overview Automated Terminal in Terminal	38
Table 22:	aTnT Gate Assumptions	40
Table 23:	Capacity Analysis	41
Table 24:	Capacity Analysis	42
Table 25:	Key Data Final Build-Out of Manual Integrated Alternative	43
Table 26:	Yard Capacity, Calculation Dry Containers	43
Table 27:	Yard Capacity, Calculation MT Containers	43

Table 28: Yard Capacity, Dry and MT 44
Table 29: mInT Gate Assumptions 45
Table 30: Capacity Analysis 46
Table 31: Quay Crane Requirements 47
Table 32: Final Adjustments for Quay Crane Calculations 48
Table 33: Requirements Terminal Truck 49
Table 34: Requirements Terminal Chassis 50
Table 35: Slot requirements for dry container yard 51
Table 36: Slot capacities dry container final build-out 52
Table 37: Slot requirements for reefer racks 53
Table 38: Slot capacities reefer container final build-out 53
Table 39: Slot requirements for MT container blocks 54
Table 40: Slot capacities for MT containers final build-out 54
Table 41: Calculations of RTG Total Moves 55
Table 42: RTG requirements by Handling Volumes 57
Table 43: RTG Requirements by Peak Performance 58
Table 44: Full Build-out Gate Results Summary 59
Table 45: Quay Crane Requirements 60
Table 46: Final Adjustments for Quay Crane Calculations 60
Table 47: Requirements Terminal Truck 61
Table 48: Requirements Truck Chassis 62
Table 49: Slot requirements for dry container yard 63
Table 50: Slot capacities dry container final build-out 63
Table 51: Slot requirements for reefer racks 64
Table 52: Slot capacities reefer container final build-out 64
Table 53: Slot requirements for MT container blocks 65
Table 54: Slot capacities MT container final build-out 65
Table 55: Calculations of RTG Total Moves 66
Table 56: RTG requirements by Handling Volumes 67
Table 57: RTG Requirements Peak Performance 68

Table 58: FastShip aTnT Gate Results Summary 69
Table 59: Quay Crane Requirements 70
Table 60: Final Adjustments for Quay Crane Calculations 71
Table 61: Requirements Terminal Hostlers 72
Table 62: Requirements Truck Chassis 72
Table 63: Calculations of RTG Total Moves 74
Table 64: RTG requirements by Handling Volumes 75
Table 65: RTG Requirements by Peak Performance 76
Table 66: Slot requirements for dry container yard 77
Table 67: Slot capacities dry container final build-out 77
Table 68: Slot requirements for reefer racks 78
Table 69: Slot capacities reefer container final build-out 78
Table 70: Slot requirements for MT container blocks 79
Table 71: Slot capacities MT container final build-out 79
Table 72: FastShip mInt Gate Results Summary 80
Table 73: Annual Yard and Reefer Capacities By Phase 94
Table 74: Overview Summarized Devices 105
Table 75: Single Prices of Devices 106
Table 76: Equipment Investment Overview 107
Table 77: Investment Costs for new Devices 109
Table 78: Investment Costs for new Gate 110

EXECUTIVE SUMMARY

This report provides the results of the study performed to analyze the conversion of Packer Avenue Marine Terminal (PAMT) into a 100% containerized terminal. The study considered conventional container operation as well as the incorporation of FastShip to the Terminal. A discussion of the conventional and FastShip operations is included.

The existing terminal throughput volume is approximately 225,000 TEU. The terminal capacity, using conventional containers, can increase to a maximum of 1,192,000 TEU through a series of terminal improvements and additional resources. The size of the yard is the limiting factor for this scenario. With incorporation of FastShip, the capacity of the terminal can be increased to 843,000 TEU for the Automated or Manual Terminal-in-Terminal options and 897,000 TEU for the Manual Integrated Terminal FastShip option. FastShip requires designated areas that cannot be used by the conventional operations, therefore reducing the capacity of the terminal. It is noted that with increased FastShip vessel calls the capacity of the terminal can be increased dramatically to over 1,600,000 TEU.

In order for the terminal to be able to handle the anticipated volumes, the terminal will need to undergo some improvements. These improvements must be implemented in stages to provide minimal disturbances to the existing operations. A transition plan is discussed in the report and has been set up to provide the maximum capacity to the terminal during the construction of the improvements. A transition to a fully built out container terminal can be completed in 4 phases with minimal disruption to normal terminal operations. The incorporation of FastShip is assumed to be implemented after the full build-out of the conventional terminal.

The additional resources needed at the terminal as the terminal expands are discussed in the report. The number of quay cranes required for each option is discussed. The number of container handlers required was determined, including hostlers, chassis and Rubber Tired Gantry Cranes (RTGs) is also discussed. The additional resources in the yard consist of the slot capacities for the different comities whether they be standard dry containers, reefers or empty containers. The gate will also need to be updated as the terminal expands and the assumptions and requirements for an updated gate structure are discussed.

Investment costs are based on the summary of devices, which are required for each terminal layout in the last volume slice. The costs do not include estimations for reconstruction activities like pavement, creation or demolishing of buildings. The purpose of the presented

amounts is to give an impression about the level of the expected investments and the ability to rank the different layout alternatives according to their price.

1. INTRODUCTION

In 2004 the Philadelphia Regional Port Authority (PRPA) received a $40 million Maritime Administration (MARAD) grant for the design and construction of a fast in/out direct service line, known as FastShip, capable terminal at the Packer Avenue Marine Terminal (PAMT). In February 2011, PRPA contracted Urban Engineers Inc. (Urban) along with Halcrow, Inc., HPC Hamburg Port Consulting GmbH, and TEC, Inc. to perform a terminal development study at PAMT.

Urban and its' sub-consultants were tasked with providing a terminal development plan for the conversion of PAMT to exclusively 100% containerized cargo. Since PAMT has been designated as a strategic military port, a discussion of the impact of military operation to the capacity and equipment requirements is also included. Also included in the report is a discussion of the incorporation of FastShip into the terminal operations.

The report looks at an incremental increase in volume to analyze the requirements of the terminal at each volume slice. These requirements include terminal layout, gate layout and operations, equipment and resource needs as well as transitioning plans. The incorporation of FastShip is assumed to occur after the full build-out of the terminal is completed.

2. DESCRIPTION OF OPERATIONS SYSTEM

The section depicts the operational procedures for conventional container handling in the proposed RTG environment as well as procedures related to the three different FastShip alternatives.

2.1 Conventional Containers

2.1.1 Quay

Quayside operation is executed by means of conventional quay cranes.

Loading/discharging of on-deck containers requires the operator to put/remove twistlocks to/from the containers' corner castings. These lashing activities are being executed on the ground beside the truck lanes in the cranes' portal. This task is executed manually in the common mode using lashers who handle the twistlocks once the container is loaded onto the chassis, or shortly after arrival of the truck in the handover position. A lashing platform is not foreseen, but may be required in case of future automation of the horizontal transport.

Aiming at the standardization of handling at the quay all container types, standard and specials, are handled in a consistent mode, i.e. no differences whatsoever apply in the modus operandi for different container types. Accordingly, it is expected that any special requirements towards documentation etc. are fully executed upon discharge of the container or delivery to the waterside by hostler, respectively. Staff at the quay is to check the discharge and loading of containers, thus ensuring adequate container data in the terminal operating system (TOS). It is expected that clerks will be equipped with handhelds for this purpose.

In case of out of gauge (OOG) cargo, it is expected that overheight frames will be used for the quayside handling for discharging/loading of flat racks. Only where OOG cargo exceeds the lifting capacity of the cranes, or the dimensions of the cargo do not allow the use of conventional cranes, special floating cranes are to be used which are not to be provided by the terminal operator.

2.1.2 Horizontal Transport

The horizontal transport is executed by hostlers. In case of export, hostlers are advised by the TOS on the container to be transported and the respective handover position. The operator moves the device to the handover position and waits for the container handover. For the loading activity trucks drive with the container to a dedicated handover position

adjacent to the yard crane. At the RTG handover of the container takes place alongside the block within the crane portal in a dedicated handover lane. Hostlers as well as external trucks are handled in the same lane.

Once the hostler stops in the correct handover position, the transport order for the yard crane is initiated. The dispatch onto/off the chassis is a fully manual process. Automated detection systems can improve work safety as they assist in avoiding incidents between the hostlers, external trucks and the RTGs. Figure 1 below illustrates the handover position as described above.

Figure 1: Handover Area RTG to/from Trucks or PMs

Source: HPC, 2009

Upon loading of the container onto the chassis, the operator moves the hostler to the predetermined quay crane along the terminal road network.

Import container handling follows the same principle in reverse direction.

Organization of horizontal transport can principally follow two different approaches, the dedication of hostlers to a specific quay crane, or the pooling concept, where transport orders from all cranes are allocated to the full hostler fleet. The strict dedication of trucks to

quay cranes may be considered the more common option in operation, as responsibilities and team structures are better addressed. The precise number of hostlers required depends on the assumed average driving distance between quay crane and block and the quay crane productivity.

2.1.3 Yard

2.1.3.1 Standard Dry

Standard containers account for the majority of units on the terminal. The yard layout is proposed to consider 20’ slots to maximize operational flexibility. Usually standard containers are subdivided into import and export areas. It shall be highlighted that the determined areas are flexible and may move according to terminal requirements. Export containers are mostly stacked near the quay as stacking density can be maximized for this container type. Dedicated export areas are used according to vessel, destination, weight, and other criteria. Additionally export containers for the same vessel should be distributed in different RTG working areas across the terminal. The loading plan considers the sequence of containers according to the containers’ position in the yard to avoid shuffle moves.

Import containers are moved into the full container yard. Given the unavailability of data related to the pick-up time of the individual container, import containers are not sorted, but blocks are built in the sequence in which the containers arrive at the yard block. For the stacking, it is expected that RTGs are used for all standard containers.

The TOS instructs the RTG to handle a specific container as well as indicate the target slot in which the container is or shall be positioned. Where shuffle or housekeeping moves occur, the operator is advised on the position into which the respective containers are to be relocated. In modern RTG systems, GPS verifies the position of the RTG upon dropping the container to ensure that the operator moved the container into the correct position. In case the RTG does not stand in the proper position, the RTG spreader will not release the container from the spreader, ensuring adequacy of the yard inventory.

The TOS ensures that the sequencing of the transport orders is optimized, i.e. harmonizes productivity requirements, especially ensuring container supply to the quay cranes, but also reducing empty travels consequently increasing RTG efficiency.

2.1.3.2 Reefer Operations

Reefer operations require additional process steps compared to standard dry processes. As part of the terminal yard layout, dedicated reefer blocks are implemented, which are the

distinct target locations for reefer containers, as only there electrical power connection for the continuous refrigeration of reefer cargo is available. It goes without saying that standard containers can easily be put into the reefer blocks if utilization allows.

Figure 2: RTG Reefer Racks

Source: HPC, 2009

Upon discharge of a reefer container from the vessel, the TOS advises the truck driver to proceed to a distinct handover position at the RTG where reefer racks are available. Once the container is stacked into the block, the TOS initiates a message to the reefer mechanics that the container is to be connected to power supply ensuring that the cold chain remains uninterrupted. After the reefer mechanic has connected the container to power, he notifies the TOS.

Reefer containers that are to be loaded to internal or external trucks, must be unplugged from power prior to the handover to avoid any possible damage. The request to unplug is initiated by the TOS. The reefer mechanic unplugs the container and notifies the TOS, which only then initiates the container handover request to the RTG.

In order to maintain high terminal productivity the reefer racks are only used from one end to avoid turning of containers by the RTG. Accordingly, spacing between reefer racks allows for the stacking of one 40’ container.

During the reefer containers’ stay on the terminal, containers are regularly checked, particularly related to the temperature to ensure that reefer cargo is kept at a constant temperature according to owner requirements. Related information is made available to the terminal as part of the regular document exchange at the gate.

Reefer cargo may require a Genset, which is manually connected to the respective container. Upon request, containers are moved to determined handling areas, where terminal employees attach the Genset to the container.

Figure 3: Genset Handling

Source: HPC, 2009

2.1.3.3 MT Operations

MT container operations are centered around dedicated high density blocks in the landside area of the terminal. In contrast to standard and reefer container storage, MT containers will be handled by special equipment, MT handlers, which allow the stacking of containers up

to seven high. MT containers are usually stacked according to owner and type, as numeric handling of containers is an exemption.

Alongside the MT block, dedicated handover positions to trucks, internal and external are established at which the container handover is executed. The TOS informs the MT handler driver on the container to be handed over thus ensuring adequacy of operations.

With stacking of the container to/from the block, the MT handler driver puts the related information into the TOS, thus the terminal has a proper MT container inventory documentation. Where desired, MT container handling can also be executed by means of Reach Stackers, which are however more expensive than MT handlers.

2.1.3.4 Hazmat and Out of Gage

Hazardous cargo must be stacked in dedicated areas according to the IMO segregation rules. Ideally, the dedicated positions are located at either end of the RTG blocks. Storage of hazardous cargo requires the coordination with local authorities to agree on precise stacking height and location. Particularly stacking height could be limited depending on equipment availability and capabilities of fire fighters and other emergency personnel. Also, regulations may require special, impermeable pavement for areas where IMDG and tank containers are stacked, preventing hazardous cargoes to drip into the ground.

For such special containers, additional documentation is to be made available to the terminal. Regular visual inspection of the IMDG storage areas are mandatory, optionally, detection systems may be installed to recognize fires as early as possible.

The handling of OOG cargo requires special equipment and storage areas. The nature of OOG (overheight or overweight) does not allow for the storage of units in the conventional container area for efficiency reasons. OOG cargo is predominantly flat rack cargo, which requires overheight frames for the handling, or special equipment, such as reach stackers. Trucks delivering OOG cargo are requested to proceed to a dedicated handling area where a reach stacker takes the unit and either puts it to the ground or on a terminal chassis. The latter eases operation, as upon loading, the reach stacker does not have to move the unit again.

In the dedicated storage zone, slots are marked allowing the terminal to allocate cargo units to slots in the TOS.

2.1.4 Gate

As this report will outline, a development and transition plan is in place for PAMT. Initially, existing gate operations will not change. The in-gate process begins as trucks approach from Delaware Avenue Service Road (DSR) and turn onto Packer Avenue. Trucks pass by a guardhouse at the east end of Packer Avenue in a single lane, and then enter PAMT and turn under the Walt Whitman Bridge. The single lane widens into four lanes plus a bobtail/bypass lane. These four lanes serve as TIR and checker booth queuing. Truckers exit their truck and enter TIR building, where their paperwork is processed. In the event of a problem, the problem truck is required to move to the Trouble Resolution Area (TRA). Upon completing TIR, trucks proceed under the canopy to a checker booth. Trucks advance to the first available booth on a first-come first-serve basis as there is currently no signaling system. The driver exits the vehicle and the checker inspects the trailer and/or container. Trucks then proceed into the Terminal.

Out-gate operations will initially be unchanged as well. Trucks leave the yard and enter a two-lane queue. All trucks are required to pass through Radiation Portal Monitors (RPMs), after which they proceed to the out-gate canopy. In the event that secondary screening is required, trucks must pass through the secondary RPM, and may require further checking by US Customs. Trucks queue, in 3 lanes minimum, at the out-gate canopy for inspection by a checker, and then, upon passing inspection, trucks proceed to the exit guardhouse. They then exit PAMT onto DSR.

In later stages of densification, PAMT will require a new state-of-the-art semi-automated gate. Section 6 describes when and why this is required. A description of the semi-automated gate process is described in the following paragraphs.

Trucks arriving at PAMT will have a pre-scheduled appointment time. This will help alleviate peaks in arrivals and allow the operator to better schedule labor. It is assumed that Packer Avenue will only be available for terminal traffic only and not open to public, non-terminal, traffic. Packer Avenue is currently 3 lanes wide, and is expected to remain so after the full build-out of the terminal. The south lane will be for in-bound trucks; the middle lane will be a bypass/ emergency vehicle lane; the north lane will be for out-bound trucks. The gate processes are described below, and a flow chart figure can be seen in Figure A-9 in Appendix A.

A truck arriving at PAMT will turn onto Packer Avenue from Delaware Service Road (DSR). It is assumed that most, if not all, trucks will arrive from the North, thus making a left-hand turn onto 1 lane of Packer Avenue. Trucks will pass through one of two security gate lanes at the end of Packer Avenue, where guards will visually inspect their TWIC

cards. Immediately after the security booth, an overhead Optical Character Recognition (OCR) camera bridge will scan the truck and container, if carrying one. Information such as container number and truck license plate will be automatically entered into a computer system that will verify the information and cross check against appointment time and cargo type.

After the OCR camera bridge, traffic will widen to three lanes and trucks will proceed under the Walt Whitman Bridge in a U-turn direction and wait in the queue, if present. At the end of the queue, trucks will turn left (South) to the pedestals and scales. Here, truckers will undergo identity verification such as a hand or TWIC scan. Computer systems will automatically match the trucker information against appointment and OCR information. Full loads will be weighed. Drivers with empty containers will exit the vehicle and open the doors of the container, where camera bridges behind the truck will look into the empty container. Workers at an off-site building will verify the container is empty, and the condition of the container. All trucks will undergo TIR processing and receive routing information and a ticket. The gate arm will rise and trucks proceed into the terminal to the destination information on the ticket, such as aisle, row and stack numbers. The Westernmost lane will be wider than other lanes for out-of-gauge cargo.

If any part of the in-gate process goes wrong, the truck will be required to enter the Trouble Resolution Area (TRA). Inbound trucks having trouble will proceed past the pedestals and immediately turn left before entering the terminal, and proceed around the traffic pattern shown in Figure A-9 in Appendix A, to designated parking spaces. There, telephones will be present where truckers will call a terminal worker to sort out the problem. If the problem is resolved, the trucker will walk to the Trouble Resolution Building, get a ticket, follow the traffic pattern, and enter the terminal. If the problem is not resolved, the trucker will exit the terminal via an entrance to the out-gate lanes past after the out-gate pedestals. TRA processes are illustrated in Figure A-9 in Appendix A.

Once truckers complete their business in the terminal, whether it is dropping off a container, picking up a container, or both, they will proceed to the out-gate lanes entrance, located at the top of the B-C aisle. Figure A-9 in Appendix A illustrates the out-gate process. Three lanes are available, and depending on where the truck is coming from, they will enter the appropriate lane (see Section 5.1.4 for detailed terminal traffic flow descriptions).

Similar to the in-gate procedure, trucks will pass under an OCR camera bridge, where the container and truck information will be scanned and compared to the terminal’s database. Shortly thereafter, trucks will pass through the primary Radiation Portal Monitors (RPMs),

which are required by US Customs and Immigration, and scan every import container for radiation. If any truck fails the primary RPM, it will be required to pull to the left and pass through a secondary RPM. Should a truck fail the secondary RPM, US Customs and Immigration officers in a building adjacent to the secondary RPM will direct the truck to the appropriate screening area.

After passing through the RPMs, trucks proceed to the out-gate pedestals. Like the in-gate pedestals, TWIC or hand scans are performed to verify the trucker's identity and match the OCR readings with the manifest and trucker. A ticket will be printed, the gate arm will rise, and the truck will exit the terminal by turning right, following three traffic lanes under the Walt Whitman Bridge, passing through a final security checkpoint (where the ticket will be visually inspected), proceeding onto Packer Avenue, and turning onto Delaware Service road. Should a problem occur at the out-gate pedestal, the trucker will proceed through the gate arm and turn left into the TRA. The trucker will follow the traffic flow, park in a designated parking space, and use a telephone to sort out the problem. If the problem is resolved, the trucker will pick up a ticket and exit the terminal where he entered the TRA; otherwise, he will return into the terminal. This process is illustrated in Figure A-9 in Appendix A.

2.2 Automated Terminal in Terminal FastShip

2.2.1 Quay

With arrival of the FastShip, the AGV trains enter the vessel to commence discharging. The AGVs drive under the cassettes, lift the same and then drive via the ramp onto the terminal. After the discharge of three rows, AGVs are expected to double cycle, i.e. bring a series of export containers and thereafter collect further import containers which are moved off the vessel by the AGVs.

Manual intervention shall only take place prior to discharging or after loading to ensure that manual and automated modes of operation are clearly distinguished. During automated operations, manual work may only take place in specifically secured areas.

2.2.2 Horizontal Transport

The cassette transport is executed by means of AGVs which form a logical train of nine units, but are not physically coupled. These AGVs circulate between the vessel and the staging area, i.e. storage location of the cassettes on which the containers are stacked.

On the quay apron a bi-directional AGV pathnet is established, which allows for the most flexible use according to terminal requirements. During AGV operation, the respective area

is inaccessible for manual operation. To avoid collisions AGVs claim a distinct area ahead when driving along the pathnet, and actively reserve this area, thus blocking it for any other AGV. Though the nine AGVs are operated in train mode, each of them individually claims the area ahead of the vehicle. Approaching the staging area, the AGVs are instructed by the TOS to proceed to a certain position in which the cassette shall be dropped. After dropping the cassette, the AGV takes an export cassette and returns to the vessel (once three rows of cassettes have been discharged from the vessel).

2.2.3 Yard and Staging Area

The staging area is designed to accommodate import and export FastShip containers. The staging area is only used for the FastShip operation and is the location where the storage of FastShip containers takes place.

The allocation of containers to cassettes must mirror the future cassette sequence on the vessel, as sorting of cassettes in the AGV train concept is not considered a standard process. Accordingly, planning of container to cassettes in the staging area must be done prior to the arrival of the container on the terminal. The cassettes are placed to provide sufficient spacing for a SCdle carrier to pass over a cassette. However, spacing between cassettes does not allow for the parallel service in neighboring lanes. Where safety systems are sufficiently sophisticated, it is expected that AGVs and SCs can both operate in the same lane simultaneously. In addition to systems, fencing could provide a clear separation of the working areas for both equipment types. In any case, manual intervention (staff access to the staging area) will be strictly prohibited. Only when neither SCs nor AGVs are operational in the staging area section, may staff may be granted access. Unauthorized access should immediately shut down operations in the affected area automatically. The container supply to the staging area will be executed by means of 4-high SCs, which will allow unimpeded access to all cassettes at all times. SCs drive over the cassettes to pick up the container in the predetermined position. Upon pick up, the SC drives backwards to the main driving lanes. SCs are expected to feature cabins allowing the operator to switch driving directions easily.

With an import container, the SC proceeds to the interchange area, where the external truck waits for the container handover. The SC drives over the truck and drops the container to the chassis. The truck has passed the gate before (see section 2.2.4) and accessed the interchange area where the truck driver exited the truck to initiate the container handover. During the handover process the truck driver stays outside the truck. With successful handover, the SC operator clears the transport order and continues with the next order. The truck driver has to fasten the container onto the chassis and then proceeds to the out-gate.

2.2.4 Gate

The aTnT option for a FastShip terminal will be functionally the same as the conventional full build-out described in Section 2.1.4, with a few minor differences. Packer Ave. will be widened from three to five lanes, and at each gate step, for example OCR, pedestals, etc, there will be lanes dedicated to FastShip trucks. By dedicating lanes to FastShip, expedited gate transaction times will enable the quick 12 hour delivery/ pick up window that FastShip requires. Gate processes will be identical to that described in Section 2.1.4, with the exception of dedicated lanes, and the gate layout will be the same as the conventional full build-out except the number of lanes will be different, as seen in Figure A-11 in Appendix A.

For export cargo (in-gate process), FastShip trucks will turn off of Delaware Service Road (DSR) on to the Southernmost lane on Packer Ave., which will be dedicated for export FastShip trucks. Overhead signage on DSR and Packer Avenue will make it clear that only FastShip trucks can use the lane. There will be a dedicated security checkpoint, OCR camera bridge, and queue lane for FastShip cargo. Upon reaching the pedestals, the northern most 5 lanes will be dedicated FastShip pedestals and scales. FastShip trucks will then proceed along the top of the terminal directly to the FastShip Terminal-in-Terminal and unload their container at the transfer spaces.

For import cargo (out-gate process), upon receiving their load, FastShip trucks will head towards the out-gate via the top of the terminal, parallel to DSR. FastShip export trucks will pass under a dedicated OCR camera bridge, through a dedicated primary RPM (any secondary RPM screening will use the conventional cargo secondary RPM), to 4 dedicated FastShip out-gate pedestals, through one dedicated traffic lane, a dedicated security checkpoint, and then out through a dedicated lane on Packer Avenue (the Northernmost lane). Signage present throughout the process will ensure that only FastShip trucks use the dedicated lanes.

Conventional export and import cargo will follow the same process as described in Section 2.1.4, except that the number of lanes will be reduced due to a decreased conventional throughput and dedicated lanes for FastShip trucks. Because the terminal phasing plan has been developed to accommodate any of the FastShip options, room has been left for the maximum number of gate lanes required (the mInt option discussed in Section 2.4.4), which requires one additional FastShip lane. While aTnT and mTnT require fewer gate lanes, the area required for the mInt option has been allotted to the gate.

2.3 Manual Terminal in Terminal FastShip

2.3.1 Quay

Successive to berthing of the FastShip the manual hostlers access the FastShip and commence discharging the FastShip lane-wise similar to the operation conducted within the AGV operation, whereby all manual hostlers are clearly operated individually. After the discharge of three rows, hostlers are expected to double cycle, i.e. bring a series of export containers and thereafter collect further import containers which are moved off the vessel.

The use of manual equipment allows the execution of additional manual interventions, checks, etc. onboard the vessel during discharging and loading operations. In view of the envisioned vessel turn time, the potential parallelization of activities is considered favorable.

2.3.2 Horizontal Transport

Horizontal transport being executed by manual hostlers comprises the use of individual hostler units circulating between the FastShip and the staging area. The hostlers carry a specific chassis which allows for driving underneath the cassettes and subsequent lifting of the same. Accordingly, the chassis needed for the transport differ from standard chassis commonly used on container terminals as shown below.

Figure 4: Comparison FastShip vs. Conventional Chassis

Source: TTS , MAFI

For the import process hostlers turn in front of the cassettes onboard the vessel and drive with the chassis backwards under the cassette. The cassette is then lifted with the chassis and the hostler commences horizontal transport via the ramp and the lanes on the quay towards the staging area. Lanes on the quay may be used flexibly for either direction, it is expected however that dedication of directions is advantageous for safety reasons.

Approaching the staging area, the hostlers turn again to drive with cassette backwards into the predetermined storage location where the cargo is dropped off. The precise storage location is determined by the TOS and made available to the driver. The system shall not release the cassette in case the driver is not in the requested target position. Validity checks of the drop-off position are expected to be done using DGPS.

2.3.3 Yard and Staging Area

The yard and staging area layout and operation, including the truck service, are similar to the descriptions for the automated terminal in terminal as presented in section 2.2.3.

Given the manual horizontal transport however slight changes are to be considered as highlighted hereinafter. The hostlers ideally require a setup where they can drive as close as possible to the actual drop-off position to minimize driving distance in reverse mode. Accordingly, planning of the staging area setup is to consider that sufficient space for circulation is kept, i.e. unoccupied slots are available adjacent to the actual drop-off position throughout the operation which requires thoughtful container allocation to the cassettes. Additionally a result from the manual operation is the inability to clearly separate hostler and SC operation areas unless long reverse driving is accepted. As a result, it may neither be possible to operate with an SC in the same row as the hostler, nor in any of the two neighboring rows.

2.3.4 Gate

Since the FastShip and conventional throughputs are the same as Section 2.2.4, the gate processes for the mTnT (FastShip and Conventional) are identical to those described in that section.

2.4 Manual Integrated FastShip

2.4.1 Quay

Quay operation is equal to the procedure presented in section 2.3.1.

2.4.2 Horizontal Transport

Horizontal cassette transports between staging area and FastShip are identical to the procedures presented in section 2.3.2, horizontal transports between RTG and staging area are presented below.

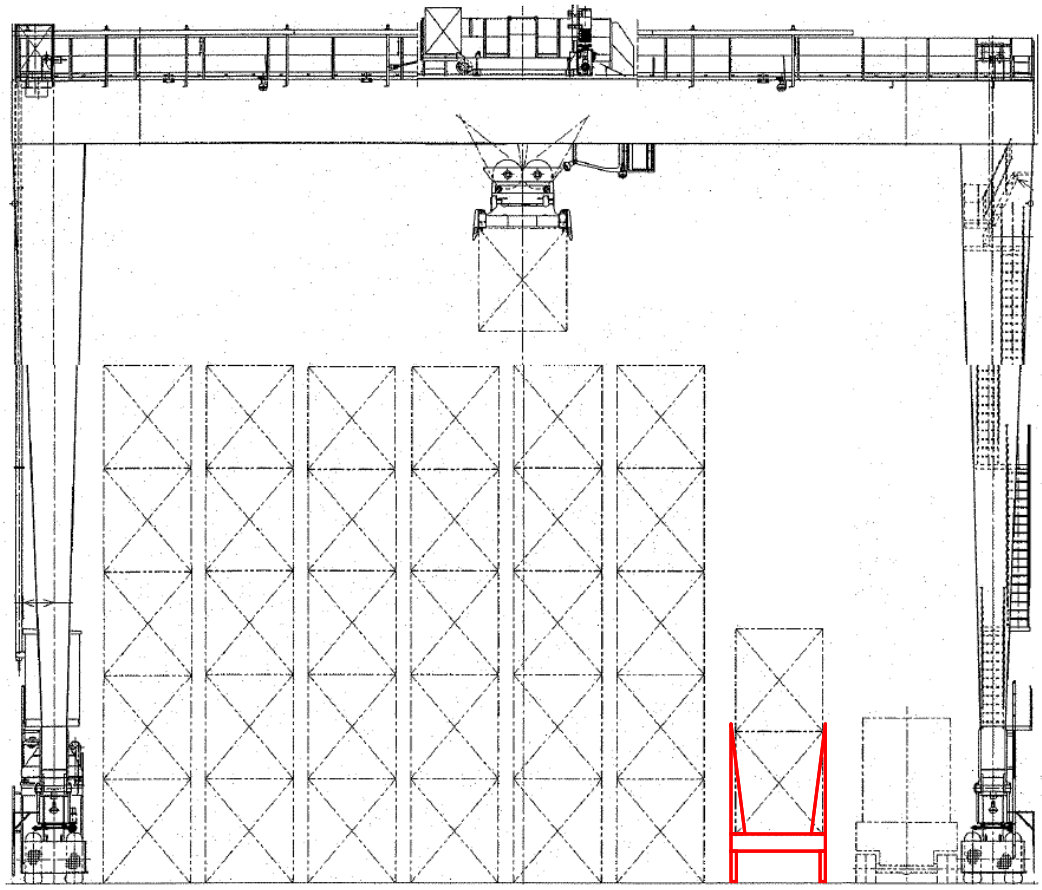
Hostlers for FastShip supply use the same road network on the conventional terminal area as all other hostlers and trucks, i.e. travel along the road network. At the RTG block

hostlers pick up a cassette from the dedicated areas as highlighted in the successive section and transport it to the staging area, where cassettes are arranged according to the loading sequence. For the positioning hostlers will have to back into the final drop-off position. It is expected that throughout FastShip operation hostlers will continuously transport cassettes between staging area and yard.

2.4.3 Yard and Staging Area

The manual integrated option considers the availability of dedicated storage and handover lanes as part of the RTG. Accordingly, one row of containers within the RTG portal is reserved for the storage of cassettes onto which containers are being loaded as the below depiction highlights.

Figure 5: Cassette storage location in RTG block



Source: HPC, 2011

Cassettes are parked alongside the RTG distributed across all RTG blocks on the terminal. With arrival of an export container, the truck is advised to proceed to a distinct handover

position where the RTG lifts the container from the truck onto the cassette. The process equals the conventional container handling in the RTG environment, only the storage location is a cassette. For the trucker the process does not differ. It is expected that FastShip export containers will be placed on the cassette without interim storage in the yard given the assumed low dwell time of FastShip cargo. Only in cases where the upper container is delivered first, the container will have to be stacked into the standard container area and later moved onto the cassette. Once the cassette is loaded, the TOS will ensure that cassette transport is initiated in the most advantageous situation. Similarly, the TOS initiated the transport of import cassettes to the RTG in due time. After dropping off the cassette, the related containers are ready for import pick-up. Container handover to trucks will take place similar to the export handover. Where the bottom-most container is requested first, the top-tier container is to be stacked into the conventional container RTG yard.

The staging area operation is consistent with the operation presented in section 2.3.3, apart from the fact that no SC operation occurs.

2.4.4 Gate

The mInT option for a FastShip terminal will be virtually identical to both the Terminal-in-Terminal options, with one difference: since the conventional throughput is higher due to a smaller FastShip footprint, one additional conventional gate lane is required each direction (one more in and one more out), as shown in Figure A-10 in Appendix A. Since the FastShip throughput is the same, the number of dedicated FastShip lanes does not change. Because the terminal phasing plan has been developed to accommodate any of the FastShip options, room has been left for the maximum number of gate lanes required- the mInt option. While the area required is more than the other options and has been blocked out for FastShip gate lanes in other scenarios, it is only required in this option.

2.5 Military

The PRPA has contracted with the US Government, specifically the Department of Defense (DOD), to classify PAMT as a Strategic Military Facility. This classification permits the DOD, primarily the Army, the ability to utilize PAMT for receipt and shipment of DOD related material and equipment. Basic requirements of a Strategic Military Facility include having a 20-acre terminal area reserved for military cargo (does not need to be contiguous) as well as being available with a minimum of 48 hour notice.

With U.S. military operations winding down in Afghanistan and Iraq, more frequent shipments of returning personnel and equipment should be expected at PAMT. A recent

military deployment at PAMT consisted of 33 helicopters, 225 containers and various vehicles and was unloaded over a 9 hour period.

The container storage yard, as shown in the full build-out configuration of the conventional container terminal, is approximately 60 acres in size and can be more than adequate to fulfill the requirements of a Strategic Facility within 48 hours. At full build-out for the container terminal, as well as all FastShip alternatives, berth one could be utilized for military operations and the containers (non-reefers) in Modules D 1-4, C 7-8 and B10 temporarily relocated to provide the required 20 acre terminal area. As non-military vessels may berth concurrently with military vessels, typical container loading and unloading operations could still be undertaken at PAMT in the other two berths unless secure gate operations are required.

During any of the four construction phases, military operations can be facilitated at PAMT with 48 hours prior notice. In order to fulfill the requirements of a Strategic Facility, all non-reefer containers located in Modules A & B can be temporarily relocated to provide the required 20 acre terminal area. Typical container port operations are not expected to be feasible in concurrence with military operations that take place during Phases 1 through 3 as there will be little to no room at the terminal for import/export and empty containers.

Figure 6: Example of Military Operations at PAMT

3. TERMINAL CAPACITY PLANNING

The future terminal capacity planning is based on volume slices, which represent the expected throughput of the container terminal. The details of volume slices have been explained in the document 'Deliverable 1.1 – Operation Criteria and Assumptions Report'. In order to be compatible with the previous study done by TBA b.v., Netherlands, all capacity calculations include a peak factor of 1.2.

3.1 Market Potential

Further calculations are based on the following assumptions on market potential. The depicted numbers were previously agreed upon, as presented in Deliverable 1.1.

Table 1: Market Potential as Volume Slices for Conventional Containers

Volume Slice	0	5	10	15	20
Volumes					
Market Potential (TEU)	223,522	473,522	723,522	973,522	1,223,522
Market Potential (#Containers)	144,208	291,267	438,325	585,384	732,443
TEU Factor					
TEU factor	1.55	1.63	1.65	1.66	1.67
Traffic Split (domestics)					
Import	53.4%	53.4%	53.4%	53.4%	53.4%
Export	46.6%	46.6%	46.6%	46.6%	46.6%
Modal Split					
Truck	93%	93%	93%	93%	93%
Stripping in CFS	7%	7%	7%	7%	7%

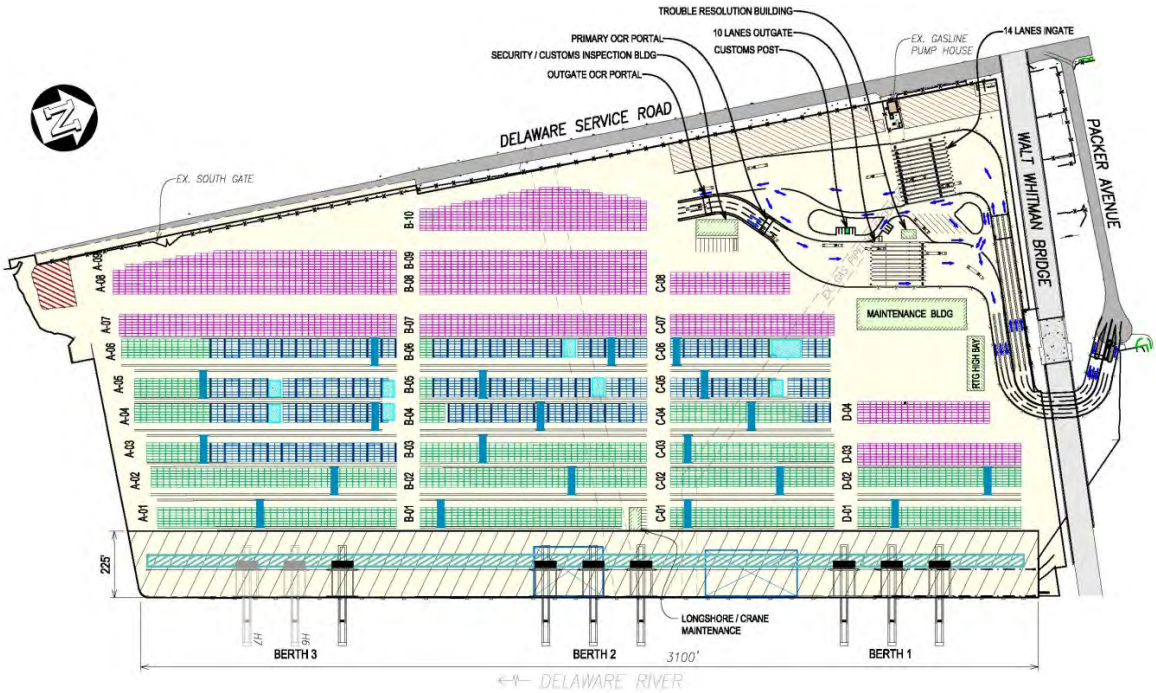
Source: HPC, 2011

The market potential to be taken into account is chosen in order to cover the maximum possible capacity of the terminal to be planned. Since no time-based forecast is available, the planning scenario consists of 20 volume slices beginning at today's volume of approximately 225,000 TEU per year, and ending at approximately 1,225,000 TEU per year. The TEU-factor is supposed to grow over the years with a maximum of 1.67 in the last volume slice. The split between import and export containers (including empties) is assumed to be constant. For the modal split drayage by truck is distinguished from loads being transloaded at the on-site Container Freight Station (CFS). Within scenarios without the CFS the truck share is of course set to 100 %.

For the FastShip volumes two weekly calls are assumed. Each vessel will be utilized 86.5% on average. Imports and exports will be balanced and consist of 40% Reefers. The annual FastShip throughput is planned for 250,000 TEU per year.

3.2 Conventional Containers

Figure 7: Conventional Container Yard



Source: TEC, 2011

3.2.1 Quay Capacity

The berth capacity is usually derived from two independent approaches, firstly, based on a vessel call pattern and secondly based on the quay crane capacity. The assessment based on a likely vessel call pattern considers the length of the vessels calling the port and their respective number of container exchanges. Based on this approach and including the berth meter requirements for mooring, the berth capacity can be calculated. However, with only a fractional vessel call pattern available, such assessment has not been made for Packer Avenue Marine Terminal at this time.

As first step, the number of moves and containers per quay crane and annum is calculated. Therefore, the operating hours are multiplied by the number of containers per operating hour and the crane's availability during operation. The operating hours are derived from the assumption of a 24/7 operation and the average crane utilization of 50%. During these

hours the quay crane on average handles 33 moves at a reliability rate of 95%. Thus, the quay crane executes 135,000 moves per annum during which it handles almost 146,820 containers. The calculation is shown below.

Table 2: Quay Crane Capacity

Conventional Quay Crane	
Work Days per Week	7
Work Hours per Day	24
Max operating days/year	361
Average Quay Crane Utilization	50.0%
Availability	95.0%
Moves/h	33.00
Cont./mvs	1.08
Cont./h	**35.68**
Cont./Year	146,820
Mvs/Year appr.	**135,000**

Source: HPC, 2011

The Consultants recommend using not more than nine quay cranes at Packer Avenue Marine Terminal due to the overall quay length. Nine quay cranes will provide a capacity of more than 2,000,000 TEU per year of quay crane capacity. Thus, this being far above the market potential, the quay cranes will not limit the terminal capacity.

According to growth of the container throughput the number of the vessels as well as their capacity is rising. With increasing volume the number of vessels within each size type is increasing as well. Based on the depicted assumption on the vessel size the total handling volume in the final volume slice has been modeled to accommodate 1.22M TEU.

Table 3: Total Handling Volumes by Vessel

Volume Slice	0	5	10	15	20
Number of Vessels per Vessel Size					
Small/Medium Feeder (<600 TEU)	52	52	52	52	52
Small Mainliner (600 - 2,399 TEU)	28	28	28	28	28
Medium Mainliner (2.400 - 4,999 TEU)	218	252	273	288	299
Mainliner (5,000 - 8,499 TEU)	53	81	103	122	137
Average Handling Quantities per Vessel Size					
Small/Medium Feeder (<600 TEU)	83	128	164	194	220
Small Mainliner (600 - 2,399 TEU)	133	206	265	316	361
Medium Mainliner (2.400 - 4,999 TEU)	566	887	1,153	1,383	1,590
Mainliner (5,000 - 8,499 TEU)	1,882	2,953	3,840	4,610	5,304
Total Handling Volumes (TEU)	*231,174*	*475,141*	*726,237*	*979,660*	*1,223,606*

Source: HPC, 2011

The next table shows the different, assumed productivities of the quay cranes at the different vessel types. These productivities are being used within all calculations regarding the capacity analysis.

Table 4: Average Productivities of Quay Cranes

QC Productivity per Vessel Size (container/h)	
Small/Medium Feeder (<600 TEU)	20
Small Mainliner (600 - 2,399 TEU)	33
Medium Mainliner (2.400 - 4,999 TEU)	33
Mainliner (5,000 - 8,499 TEU)	34
Average Productivity (net)	**33**

Source: HPC, 2011

According to the above listed table the overall productivity is determined to be 33 containers per hour while working with quay cranes.

On basis of assumed vessel arrivals and size-specific productivities the berth occupancy is being calculated. Berth occupancy increases from 12.95% to 55.62%. Industry standards advise not to exceed berth occupancy of 65% where three or more berths are available.

Table 5: Berth Occupancy

Volume Slice	0	5	10	15	20
Available Berth Meter Hours					
Length of Quay Wall (m)	945	945	945	945	945
Days per year	360	360	360	360	360
Hours per day	22.5	22.5	22.5	22.5	22.5
available annual berthing hours	8,100	8,100	8,100	8,100	8,100
Total	*7,653,528*	*7,653,528*	*7,653,528*	*7,653,528*	*7,653,528*
Percentage of Berth Occupancy	*12.95%*	*23.79%*	*34.61%*	*45.37%*	*55.62%*
Max. Percentage of Berth Occupancy	65%	65%	65%	65%	65%
Volumes in TEU at actual berth occupancy	*223,334*	*473,522*	*723,522*	*973,522*	*1,223,522*
Volumes in TEU at max. berth occupancy	1,121,001	1,293,924	1,358,632	1,394,732	1,429,932

Source: HPC, 2011

Assuming maximum berth occupancy of 65% and given the vessel schedule and vessel types for the last volume slice the maximum berth capacity is determined to be 1.43M TEU.

3.2.2 Yard Capacity

The next two tables show considerations about block dimensioning on the terminal. The depth of the terminal from east to west is about 1,184 ft. From this value an estimated number of 429ft for traffic and administrative usage has been subtracted. The remaining width of 755ft is net space which can be used as block storage area. The table below shows different configurations of container rows between five and seven per block. The last line shows that the configuration with seven rows results the most slots for the present yard layout.

Table 6: Determination of Block Width

Block Width			
TERMINAL DEPTH (W-E)	RTG/TTU 5+1	RTG/TTU 6+1	RTG/TTU 7+1
Total terminal depth [ft]	**1183.6**	**1183.6**	**1183.6**
Quay wall - waterside rail [ft]	3	3	3
Rail gauge [ft]	90	90	90
Quay crane clearance [ft]	3	3	3
Hatch cover area [ft]	60	60	60
Horizontal transport lanes [ft]	*4*	*4*	*4*
Width per hor. transport lane in ft	*11*	*11*	*11*
Hor. transport lanes total width [ft]	44	44	44
Lighting mast [ft]	3	3	3
Yard crane clearance [ft]	3	3	3
Yard Clearance to hyster yard [ft]	8	8	8
Hyster stack (14*2.5m) [ft]	114.83	114.83	114.83
Hyster circulation area [ft]	53	53	53
Horizontal transport lanes [ft]	4	4	4
Width per hor. transport lane [ft]	11	11	11
Traffic circulation lanes [ft]	44	44	44
Clearance to terminal boundaries [ft]	6	6	6
Total w/o yard [ft]:	**428.83**	**428.83**	**428.83**
Remaining for yard [ft]:	**754.77**	**754.77**	**754.77**
Yard block width [ft]	76.51	85.83	95.14
Number of Possible blocks:	9.87	8.79	7.93
Full Blocks	***9***	***8***	***7***
Width of block in rows	5	6	7
Slots vertical	**45**	**48**	**49**

Source: HPC, 2011

The following table shows five different configurations with the aim to determine the best fitting length of a container storage block for RTG. Beginning with the measured length of the facility of about 2,872ft two distances for clearances at the north and the south side have been subtracted. Additionally for every estimated block a distance of 80ft has been determined for circulation of trucks. This circulation area is assembled from lane spaces, safety clearances and a buffer space. Each occurrence in the shown table is parameterized

with a different number of blocks, varying between two and six. According to this the summarized distance for all crossings varies between 80ft and 400ft. Using the values *Number Of Blocks*, *Residual Container Storage* and *Total Requirements Per Block* the number of total possible blocks can be determined. According to the different configurations these values vary from 18 to 62 bays per block.

From experience it can be said that a length between 20 and 50 bays is the best fitting size for RTGs blocks. For the present situation this means that a configuration between three and five blocks in the length of the terminal is best for PAMT.

Table 7: Determination of Block Length

TERMINAL WIDTH (N-S)	Conf.1	Conf.2	Conf.3	Conf.4	Conf.5
Total terminal width	***2,872***	***2,872***	***2,872***	***2,872***	***2,872***
Clearance south	***80***	***80***	***80***	***80***	***80***
Quayside operation area	*65*	*65*	*65*	*65*	*65*
Clearance	*10*	*10*	*10*	*10*	*10*
safety buffer	*5*	*5*	*5*	*5*	*5*
Clearance north	***68***	***68***	***68***	***68***	***68***
Clearance to fence	10	10	10	10	10
Driving lanes per direction	*2*	*2*	*2*	*2*	*2*
Directions	*2*	*2*	*2*	*2*	*2*
Width per driving lane	*11*	*11*	*11*	*11*	*11*
Driving lanes space requirements	44	44	44	44	44
Clearance to block	10	10	10	10	10
Safety distance	4	4	4	4	4
Residual terminal width	***2,724***	***2,724***	***2,724***	***2,724***	***2,724***
Circulation area between blocks	80	80	80	80	80
Driving lanes per direction	*2*	*2*	*2*	*2*	*2*
Space required per lane	*13*	*13*	*13*	*13*	*13*
Directions	*2*	*2*	*2*	*2*	*2*
Total lane space	**52**	**52**	**52**	**52**	**52**
Safety clearances	*2*	*2*	*2*	*2*	*2*
Space required per safety clearance	*10*	*10*	*10*	*10*	*10*
Total safety clearance space	**20**	**20**	**20**	**20**	**20**
Buffers to block	*2*	*2*	*2*	*2*	*2*
Space required per buffer	*4*	*4*	*4*	*4*	*4*
Total buffer space	**8**	**8**	**8**	**8**	**8**
Number of Blocks	2	3	4	5	6
Total longitudinal circulation areas	1	2	3	4	5
Space all crossings	80	160	240	320	400
Remaining for container storage	***2,644***	***2,564***	***2,484***	***2,404***	***2,324***

TERMINAL WIDTH (N-S)	Conf.1	Conf.2	Conf.3	Conf.4	Conf.5
Less one container per block	40.00	60.00	80.00	100.00	120.00
Residual container storage	***2,604***	***2,504***	***2,404***	***2,304***	***2,204***
Length per slot	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*
Clearance between containers	*1.31*	*1.31*	*1.31*	*1.31*	*1.31*
Total requirements per slot	21.31	21.31	21.31	21.31	21.31
Total slots possible (numeric)	61.09	39.16	28.20	21.62	17.23
Rounded	61.00	39.00	28.00	21.00	17.00
adjustments per block	1.00	1.00	0.00	1.00	1.00
Total block length (TEU)	**62.00**	**40.00**	**28.00**	**22.00**	**18.00**

Source: HPC, 2011

With regard to the present situation and the estimated intermediate layouts during transition the number of four blocks in north/south direction is a good choice. Thus, the recommendation for the RTG blocks is to configure four blocks in the north/south direction with about 28 bays (rough estimation) in the length and seven rows in the width.

The final full container build-out consists of 4 sections A – D. Sections A – C accommodate containers of all categories whereas section D only holds dry and empty containers. Table 8 gives a summary of all sections with the groundslot numbers and the according technical total slot numbers as well as reefer plugs.

Table 8: Container Slots Full Container Build-out

Sections	Reefer	Ground Slots (TEU)			Max Capacity (TEU)		
	Plugs	Dry	Reef	MT	Dry	Reef	MT
A	1,304	847	652	1,016	4,235	2,608	4,592
B	1,092	784	546	1,322	3,920	2,184	6,677
C	548	693	274	384	3,465	1,096	1,728
D	0	364	0	376	1,820	0	1,692
Sum	**2,944**	**2,688**	**1,472**	**3,098**	**13,440**	**5,888**	**14,689**

Source: HPC, 2011

Dry containers have a maximum stacking height of five, reefer containers four, and empties may be stacked seven tiers high. Note that MT stacking areas are shaped in a pyramid pattern starting with three tiers in the first rows and depending on the depth of the stack having a maximum stacking height of seven tiers. Given the technically available number of slots the throughput capacity of the yard can be calculated.

The following table shows the throughput capacity for dry and reefer (13,440 + 5,888) containers given a combined dwell time, maximum utilization and peak factor. Of course, storage capacity needs to be provided for a full annual 365 days. The full yard yields an

annual capacity of about 858,000 TEU for dry and reefer containers as well as 10% of empties out of 19,300 20' slots.

Table 9: Yard Capacity for Dry and Reefer Containers

Dry Container Yard	
Total Static Slots	**19,328**
Dwell time	5.46
Utilization	80%
Peak factor yard	1.2
Days per Year	365
Yard Capacity	**858,092**

Source: HPC, 2011

With more than twice the dwell time for empty containers and approximately 14,700 slots available, space for 334,000 TEU per year of empties is available.

Table 10: Yard Capacity for Empty Containers

Total MT Yard	
Total Static Slots	**14,689**
Dwell time	10.71
Max Yard Utilization	80%
Peak factor yard	1.2
Days per Year	365
Yard Capacity	**333,702**

Source: HPC, 2011

The following table summarizes the overall terminal yard capacity.

Table 11: Yard Capacity, Dry and MT

Total Yard Capacity Final	
Full Container Yard	858,092
MT Yard	333,702
Grand total	**1,191,794**
Static Slots Reefer (TEU)	5,888
Static Reefer Plugs	2,944
Static Slots Dry (TEU)	13,440
Static Slots MT (TEU)	14,689

Source: HPC, 2011

The yard of the full container build-out will provide an annual throughput capacity of 1.192M TEU.

3.2.3 Gate Capacity

3.2.3.1 Existing Gate Structure and Processes

The existing gate structure and process was described extensively in Section 2.1.4 and Deliverable 1.1 – Operational Criteria and Assumptions Report. Table 12 lists the capacity of the existing gate structure, as exists today, based on the assumptions provided in Table 13.

Currently, PAMT handles several thousand automobiles each month. They are offloaded from a vessel at Berth 1 and driven down a dedicated trestle and gate out onto Packer Avenue, where they are driven to an offsite storage area. They therefore require minimal terminal resources, and are expected to continue operations until there is not enough berth capacity or terminal space to handle the automobiles. It is assumed that at the final build-out, there will be no automobiles offloaded at PAMT, only containerized goods. This allows the gate to expand at the east end of Packer Avenue to accommodate the larger throughput.

Table 12: Capacity of Existing Gate Elements

Existing Gate Capacity	
TIR Building Capacity (In)	350,000 TEU
Canopy Capacity (In & Out)	450,000 TEU
RPM Capacity (Out)	830,000 TEU
Security Gate Capacity (In & Out)	455,000 TEU
Limiting Gate Capacity	**350,000 TEU**

Source: Halcrow, 2011

Table 13: Existing Gate Capacity Assumptions

Existing Gate Assumptions		
Gate Operating Hours	0700 - 1700	Hours
Gate Operating Days	Monday - Friday	Days
TIR		
MT Process Time	4	Minutes
Chassis/Bobtail Process Time	4	Minutes
Export Process Time	5	Minutes
Time to Walk to/from Building	35	Seconds
Time Between Trucks	30	Seconds
Canopy		
Time Between Trucks	30	Seconds
MT Process Time - In	4	Minutes
Chassis/Bobtail Process Time – In	4	Minutes
Export Process Time - In	5	Minutes
MT Process Time – Out	4	Minutes
Chassis/Bobtail Process Time – Out	2	Minutes
Export Process Time – Out	5	Minutes
Lanes Available – Total	13	each
% Lanes for In or Outbound Trucks	Based on Breakdown of In/Out Trucks	
RPM		
MT/Export Process Time	20	Seconds
Chassis/Bobtail Process Time	20	Seconds
Primary Lanes Available	2	Each
Security Gate In & Out		
Process Time	15	Seconds
Lanes Available	1	each

Source: Halcrow, 2011

3.2.3.2 Modifications to the Existing Gate Structure and Processes

Despite the limiting capacity of 350,000 TEU per annum through the existing gate structure with the existing processes, there are several improvements and modifications that can be implemented in the short-term to increase the gate capacity before an entirely new gate structure is required.

Below is a list of several ways to achieve additional capacity out of the existing gate structure. Further discussions with the operator (Holt) and the owner (PRPA) are required to determine the feasibility, fixed and variable costs, and effectiveness of the various options. Depending on the implementation, some options may be too costly for a short term solution and installing a new gate structure sooner may make more sense. Additionally, further analysis into contracts with labor unions may be required.

- Addition of labor to fully man booths
- Extending gate operating hours and days

- Addition of an appointment or pre-booking system
- Moving the TIR paperwork process outside via tablets or pedestals
- Widening the lanes at the TIR process

During several visits to PAMT, a lack of labor at the booths under the canopy was observed several times. With 13 lanes available, often less than half were staffed, and once it was observed that only 1 lane was manned. This could be due to a variety of reasons, most likely due to the fact that half of the labor takes lunch from 1100 to 1200, with the other half from 1200 to 1300. By providing additional labor so that all 13 lanes are fully staffed for the entire operating day, additional capacity could be achieved. However, this would lead to higher labor costs as more than 13 clerks would have to be working each day, resulting in paid downtime for some clerks at certain times of day.

An extension of this option would be to extend the gate operating hours and/ or operate the gate on the weekends. By extending the gate by 1 hour a day, 5 days per week, all year long, an additional almost 10,000 TEU per annum could be achieved through the gate. This number considers that the majority of transactions would still occur during today's operating hours due to trucker schedules. Similarly, by opening the gate for 8 hours on a weekend day, with the lowest existing hourly truck calls all day, gate capacity could be increased by almost 13,000 TEU per annum. This option would not give a completely even truck distribution but could help to alleviate some of the peaking that occurs at various hours, and provide additional capacity.

Many US terminals are beginning to implement a pre-booking or appointment system, in which truckers have a pre-assigned time to arrive at the terminal. This option would help to redistribute some of the trucks at peak times to other times when there is availability at the gate, thus taking advantage of empty lanes and idle gate clerks. While it is hard to quantify the capacity gained by this option, an appointment system would add capacity to the gate by taking advantage of underutilized clerks at certain hours. This option requires further discussions with the trucker community and also upgrades to the existing TOS.

The bottleneck at the existing terminal is the TIR stage, where truckers exit their trucks in the queue (and leave them idling) and enter the building adjacent to the gate canopy. Trucks queue up behind those waiting. By eliminating the time it takes for the trucker to walk inside and walk back outside (keeping the transaction process time the same), approximately 30-45 seconds can be cut from each transaction. Two possible ways of keeping the trucker inside his vehicle are installing pedestals in the existing lanes, or bringing the TIR workers out to the truckers and conducting the process via tablet

computer. By eliminating 30 seconds from the transaction, an additional 40,000 TEU could be through the gate. A more in depth analysis of labor and cost issues is required. It should also be noted that idling trucks are contributing to unnecessary air pollution. Improvements to this process would therefore improve air quality.

One other solution could include increasing the number of lanes available for trucks to wait. Since the truckers have to exit their vehicles, truckers behind them must wait to pull forward until everyone in front of them completes their paperwork. By increasing the amount of lanes available for truckers to park, it may be possible to gain additional capacity through the existing gate. However, this would yield more truckers in the TIR building, which would not resolve bottleneck. Therefore, additional TIR clerks would be required as well. Also, there is limited room for expansion between the Walt Whitman Bridge and the terminal buildings. This option is not recommended.

With the implementation of a various combination of the above improvements, a gate capacity of approximately 450,000 to 500,000 TEU could be achieved. However, because the existing canopy structure can handle 450,000 TEU per annum, improvements would have to be made to the canopy structure and processes to increase the existing capacity. This money and effort would be better spent on installing a new gate system and structure.

New Gate Structure

The new automated gate system is designed so that it is never the limiting factor at the terminal. By designing the gate complex to have a greater capacity than the small of either the yard or the berth, it is ensured that the gate will never become the bottleneck on the terminal, and that there is always enough gate capacity to handle the yard and quay throughput.

Several assumptions have been used in designing the new gate complex. Table 14 below presents the most important assumptions used to calculate the number of gates required for the full build-out, based on existing data and discussions with Holt and PRPA.

Table 15 summarizes typical automated gate transaction times, in line with industry standards for typical gate systems. It should be noted that when a specific gate equipment manufacturer is selected, the transaction times and processes should be verified against the numbers used in this report to generate the number of gates.

Equally important is the distribution of truck arrivals and departures from the terminal. Figure 8, Figure 9 and Figure 10 show the distribution of truck calls at the existing terminal, which has been used for analyzing the future terminal, as a worst-case scenario.

An appointment system should be set up to level off the truck call distribution. For the new automated gate system, it is assumed that there is a constant amount of staff working the gate processes from the offsite building. It should also be noted that the new gate design has been determined assuming the same hours of operation as exist today (0700 to 1700, Monday through Friday). Fewer gate lanes would be required should the operator decide to extend the gate hours per day or work on the weekend. The impact of such modifications on the truck arrival patterns requires further study. Spreading the truck arrivals over more hours and/ or days means that a smaller gate footprint and less infrastructure is required, resulting in additional ground slots and a minimal increase in terminal throughput. However, additional labor, likely at a premium due to the time of day, will be required thus resulting in higher variable costs. Results of the gate calculations can be found in Section 4 – Resource Determination.

As discussed in later sections, the FastShip gates will be in the same complex as the conventional gates. Because of a higher peak factor, and despite the total lower throughput, the FastShip layouts require more gate lanes than the conventional full build-out. Therefore the gate layout for the full build-out leaves additional space for the addition of FastShip gate lanes, when required and as discussed in later sections.

Table 14: Conventional Full Build-out Gate Assumptions

Assumption	Value	Unit	Source
Total Throughput	1,230,318	TEU	HPC
% Exports Full	38	%	Deliverable 1.1
% Exports MT	62	%	Deliverable 1.1
% Imports Full	92	%	Deliverable 1.1
% Imports MT	8	%	Deliverable 1.1
Import Throughput	655,919	TEU	Calculated on %
Export Throughput	674,399	TEU	Calculated on %
TEU Box Ratio	1.67	-	HPC
Throughput	736,717	Containers	Calculated
% of Trucks that Dual Cycle	60	%	3/4/11meeting at PAMT
Trucks per year	515,702	Each	Calculated

Source: Halcrow, 2011

Table 15: Automated Gate Transaction Times

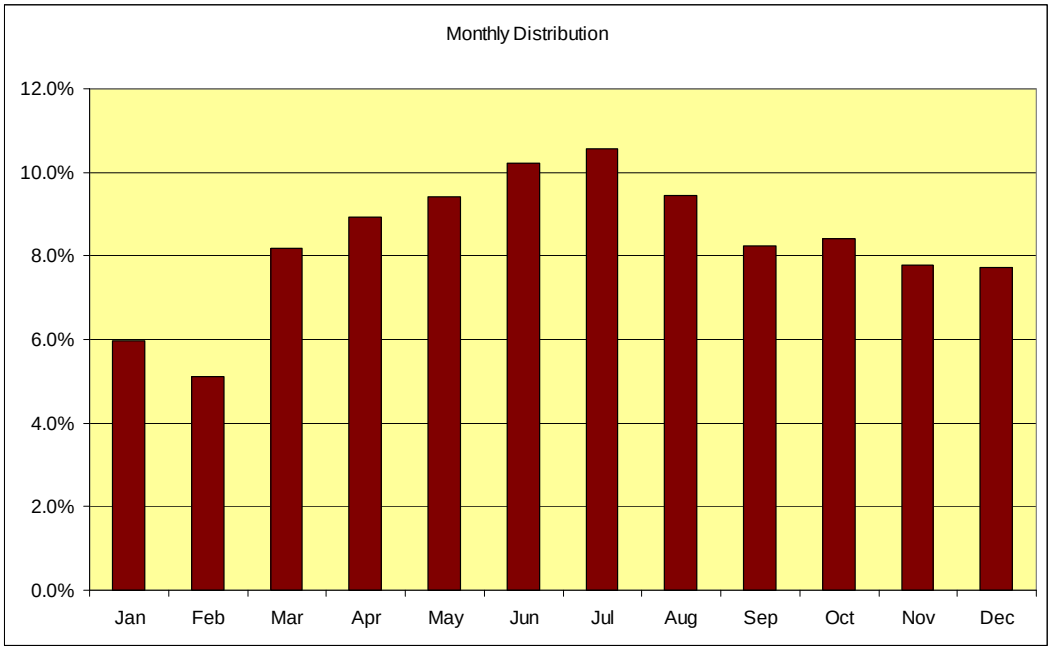
Assumption	Value	Unit	Source
In and out Gate Common Processes			
Security Gate Process Time in and out (Chassis or Bobtail)	10	Seconds	Assumption
Security Gate Process Time in and out (Loaded Truck- MT or Full)	20	Seconds	Assumption

OCR Scan Time (Chassis or Bobtail; due to truck slow down)	10	Seconds	Assumption
OCR Scan Time (Loaded Truck- MT or Full; due to truck slow down)	20	Seconds	Assumption
In-Gate - Import Truck (Chassis or Bobtail)			
Hand Scan Time	20	Seconds	Assumption
Damage Inspect., & TIR	60	Seconds	Assumption
Time Between Trucks	10	Seconds	Assumption
In-Gate - Export Box (Full or MT)			
Hand Scan Time	20	Seconds	Assumption
Full - Weighing, Damage Inspect., & TIR	90	Seconds	Assumption
MT - Check & TIR	180	Seconds	Assumption
Time Between Trucks	10	Seconds	Assumption
Out-Gate - Import Box (Full or MT)			
Hand Scan Time	20	Seconds	Assumption
Full - Damage Inspection & TIR	60	Seconds	Assumption
MT - Check & TIR	60	Seconds	Assumption
Time Between Trucks	10	Seconds	Assumption
Out- Gate -Export Truck (Chassis or Bobtail)			
Hand Scan Time	20	Seconds	Assumption
Processing & TIR	50	Seconds	Assumption
Time Between Trucks	10	Seconds	Assumption

Note: Transaction times were determined in association with various automated gate equipment manufacturers.

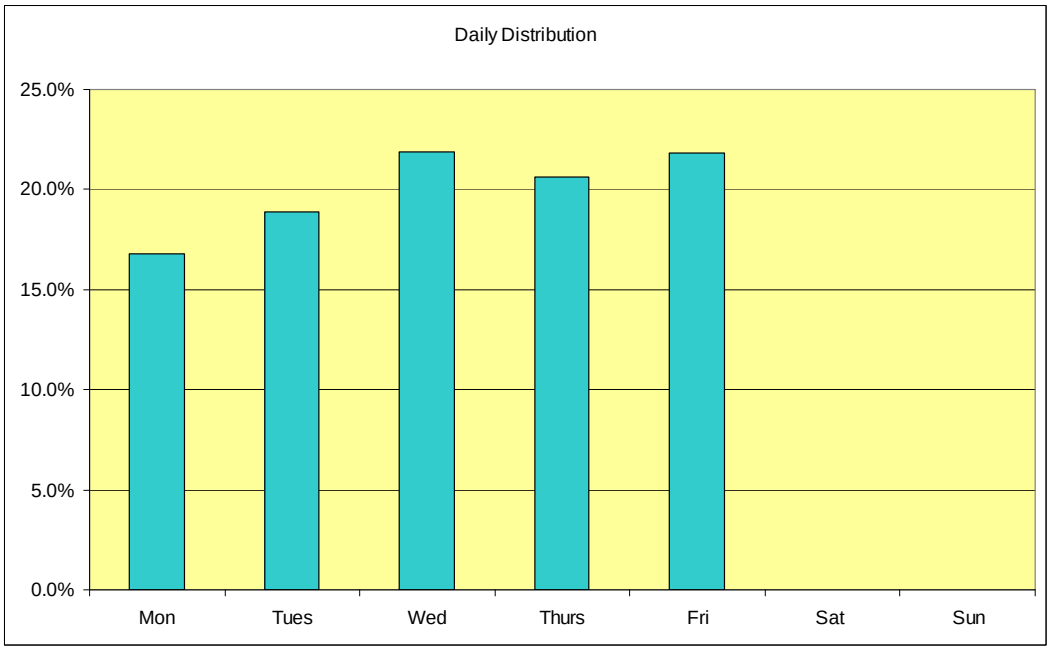
Source: Halcrow, 2011

Figure 8: Truck Call Distributions by the Month



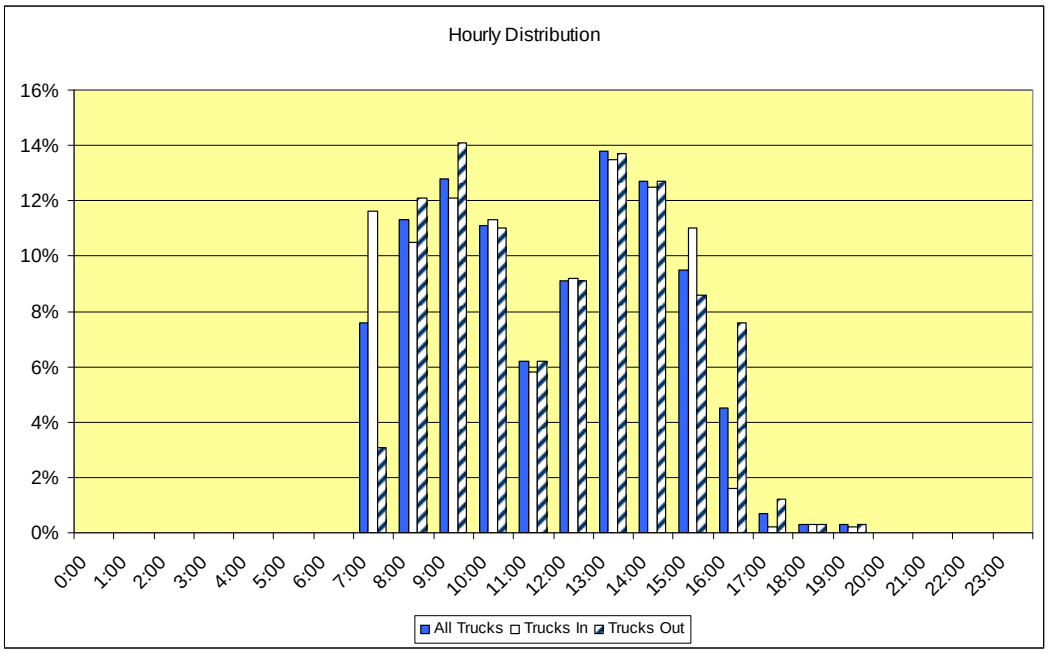
Source: March 2010 PAMT Gate Statistics Provided by Holt

Figure 9: Truck Call Distributions by the Day



Source: March 2010 PAMT Gate Statistics Provided by Holt

Figure 10: Truck Call Distributions by the Hour



Source: March 2010 PAMT Gate Statistics Provided by Holt, compiled by Halcrow

3.2.4 Capacity Analysis

In the following table the capacities of the resources quayside, yard, gate and the market potential are being compared. Due to an assumed increasing TEU factor the capacity in all areas slightly increases as well.

Table 16: Capacity Overview

Volume Slice		0	5	10	15	19	20
Market potential	M TEU	0.223	0.474	0.724	0.974	1.174	1.224
Quayside Capacity	M TEU	1.121	1.294	1.359	1.395	1.425	1.430
Yard Capacity	M TEU	0.496	1.189	1.191	1.191	1.192	1.192
Gate Capacity	M TEU	Designed to match capacity constraint at each slice					
Actual annual quayside	M TEU	*0.223*	*0.474*	*0.724*	*0.974*	*1.174*	*1.192*
Capacity constraint		Market	Market	Market	Market	Market	Yard

Source: HPC, 2011

The table shows that the terminal is able to handle the modeled market potential until volume slice 19. The total capacity of the terminal in volume slice 20 is 1.192M TEU. This limit is defined by the yard. Only the last slice is influenced by this limitation.

3.3 Automated Terminal in Terminal FastShip

3.3.1 Quay Capacity

The quayside capacities of this alternative are the same as already shown for the Conventional Containers alternative. For details refer to section '3.2.1 Quay Capacity' on page 21.

3.3.2 Yard Capacity

The consideration to determine the best fitting length and width of the storage blocks are equal as described in chapter 3.2.2. Especially the determination of the number of container rows is identical. The available space in the length from the north to south differs from the former description layout alternative. Due to the dedicated handling area for FastShip at the south the terminal length is reduced. Hence, the number of blocks must be determined with adjusted parameter values.

The calculation of block length is done in the same way as in chapter 3.2 but with a reduced terminal width. The width of the FastShip handling area will be about 800ft. The calculation shows that a number of two or three blocks in north/south direction fit best to the given terminal layout. With regard to the terminal grid with sections A to D the value with three blocks can be recommended for this terminal layout.

Table 17: Determination of Block Length

TERMINAL WIDTH (N-S)	Conf.1	Conf.2	Conf.3	Conf.4
Total terminal width	2,056	2,056	2,056	2,056
Clearance south	***80***	***80***	***80***	***80***
Quayside operation area	*65*	*65*	*65*	*65*
Clearance	*10*	*10*	*10*	*10*
safety buffer	*5*	*5*	*5*	*5*
Clearance north	***68***	***68***	***68***	***68***
Clearance to fence	10	10	10	10
Driving lanes per direction	*2*	*2*	*2*	*2*
Directions	*2*	*2*	*2*	*2*
Width per driving lane	*11*	*11*	*11*	*11*
Driving lanes space requirements	44	44	44	44
Clearance to block	10	10	10	10
Safety distance	4	4	4	4
Residual terminal width	***1,908***	***1,908***	***1,908***	***1,908***

TERMINAL WIDTH (N-S)	Conf.1	Conf.2	Conf.3	Conf.4
Circulation area between blocks	80	80	80	80
Driving lanes per direction	*2*	*2*	*2*	*2*
Space required per lane	*13*	*13*	*13*	*13*
Directions	*2*	*2*	*2*	*2*
Total lane space	***52***	***52***	***52***	***52***
Safety clearances	*2*	*2*	*2*	*2*
Space required per safety clearance	*10*	*10*	*10*	*10*
Total safety clearance space	***20***	***20***	***20***	***20***
Buffers to block	*2*	*2*	*2*	*2*
Space required per buffer	*4*	*4*	*4*	*4*
Total buffer space	***8***	***8***	***8***	***8***
Number of Blocks	1	2	3	4
Total longitudinal circulation areas	0	1	2	3
Space all crossings	0	80	160	240
Remaining for container storage	***1,908***	***1,828***	***1,748***	***1,668***
Less one container per block	20.00	40.00	60.00	80.00
Residual container storage	***1,888***	***1,788***	***1,688***	***1,588***
Length per slot	*20.00*	*20.00*	*20.00*	*20.00*
Clearance between containers	*1.31*	*1.31*	*1.31*	*1.31*
Total requirements per slot	21.31	21.31	21.31	21.31
Total slots possible (numeric)	88.58	41.95	26.40	18.63
Rounded	88.00	41.00	26.00	18.00
adjustments per block	1.00	1.00	1.00	1.00
Total block length (TEU)	**89.00**	**42.00**	**27.00**	**19.00**

Source: HPC, 2011

The Terminal-in-Terminal FastShip alternatives are foreseen in Section A of Packer Avenue Marine Terminal. Other than the easternmost RTG block all blocks in section A will be occupied by FastShip operations. Hence, this RTG block is left for certain uses in conventional operations, such as to pre-stow exports for the southernmost berths.

Table 18: Key Data Yard Automated Terminal in Terminal

Sections	Reefer	Ground Slots (TEU)			Max Capacity (TEU)		
	Plugs	Dry	Reef	MT	Dry	Reef	MT
A	0	266	0	0	1,330	0	0
B	1,092	784	546	1,322	3,920	2,184	6,677
C	548	693	274	384	3,465	1,096	1,728
D	0	364	0	376	1,820	0	1,692
Sum	**1,640**	**2,107**	**820**	**2,082**	**10,535**	**3,280**	**10,097**

Source: HPC, 2011

Approximately 13,800 slots for full dry and reefers (10,535 + 3,280) as well as 10% of empties yield an annual capacity of approximately 613,000 TEU. Parameters for this calculation have been retained.

Table 19: Yard Capacity, Calculation Dry Containers

Dry Container Yard	
Total Static Slots	**13,815**
Dwell time	5.46
Utilization	80%
Peak factor yard	1.2
Days per Year	365
Yard Capacity	**613,335**

Source: HPC, 2011

For empty containers 10,000 TEU slots gain an annual throughput capacity of approximately 229,000 TEU.

Table 20: Yard Capacity, Calculation MT Containers

Total MT Yard, Final	
Total Static Slots	**10,097**
Dwell time	10.71
Max Yard Utilization	80%
Peak factor yard	1.2
Days per Year	365
Yard Capacity	**229,382**

Source: HPC, 2011

Thus, the overall yard capacity for conventional containers adds up to approxmately 843,000 TEU.

Table 21: Yard Capacity Overview Automated Terminal in Terminal

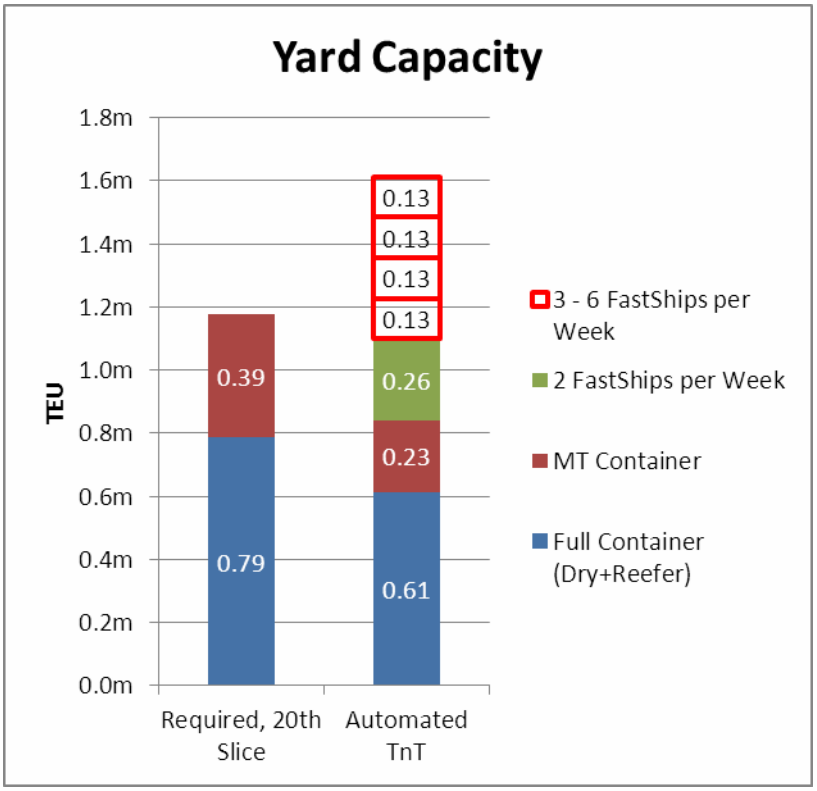
Full Container Yard	613,335
MT Yard	229,382
Grand total	**842,717**
Static Slots Reefer (TEU)	3,280
Static Reefer Plugs	1,640
Static Slots Dry (TEU)	10,535
Static Slots MT (TEU)	10,097

Source: HPC, 2011

3.3.2.1 FastShip Yard Capacity Requirements to Automated Terminal in Terminal Layout

One FastShip cycle per week yields an additional container volume of about 128,500 TEU per year. In the first phase, two FastShip calls per week will be established, which corresponds to a yearly estimated handling volume of about 257,000 TEU. In conjunction with the estimated yard capacities for the conventional vessel handling with 230,000 TEU for MT container and 613,000 TEU for dry and reefer container the sum is 1.1m TEU. In comparison to the required volume in the 20th volume slice with about 1.18m TEU this capacity is a little lower. Due to the high operational speed and short dwell times at the FastShip area the assigned yard is able to handle more than two FastShip calls per week. For reference, six FastShips causes an additional handling volume of about 771,000 TEU which leads to a total handling volume of about 1.61m TEU per year. This size is significantly higher than the requirements from the last volume slice.

Figure 11 Comparison Yard Capacities



Source: HPC, 2011

3.3.3 Gate Capacity

For the FastShip terminals, the gates required for FastShip were designed independently from those required for the conventional throughput. This enables easy determination of: dedicated lanes, construction and labor costs associated solely with FastShip, and differences in terminal layouts where FastShip is present. When the number of lanes at each stage was calculated for each type of cargo, the total was combined to yield a total number of lanes required for each step. For the purposes of this report it is assumed that FastShip would be implemented after the Full Build-out phase. Therefore, it is assumed that the gate process is semi-automated by the time FastShip is incorporated into PAMT; the only changes required will be the addition of gate lanes.

Gate transaction times are the same as those presented Table 15 in Section 3.2.3. It should be noted that for all FastShip terminal calculations, it is assumed that FastShip trucks are independent from conventional trucks and terminal operations are completely separate; a truck delivering or receiving a FastShip container will not be receiving or delivering a conventional container.

Table 22 below presents the most important assumptions used to calculate the number of gates required for the aTnT. It was assumed that the distribution of conventional truck calls is the same as in Section 3.1.3, while the FastShip truck distribution is even over a 12 hour period each way, with a 35% peak factor. This means that FastShip exports arrive spread out evenly over the 12 hour period prior to FastShip's arrival, and a 35% increase was applied to account for peaking.

Table 22: aTnT Gate Assumptions

Assumption	Value	Unit	Source
Conventional Throughput	861,565	TEU	HPC
% Conventional Exports Full	38	%	Deliverable 1.1
% Conventional Exports MT	62	%	Deliverable 1.1
% Conventional Imports Full	92	%	Deliverable 1.1
% Conventional Imports MT	8	%	Deliverable 1.1
Conventional Import Throughput	459,326	TEU	Calculated on %
Conventional Export Throughput	402,239	TEU	Calculated on %
Conventional TEU Box Ratio	1.67	-	HPC
Conventional Throughput	515,907	Containers	Calculated
% of Conventional Trucks that Dual Cycle	60	%	3/4/11meeting at PAMT
Conventional Trucks per Year	361,135	Each	Calculated
FastShip Throughput	297,856	TEU	FastShip
% FastShip Exports Full	100	%	FastShip
% FastShip Exports MT	0	%	FastShip
% FastShip Imports Full	100	%	FastShip
% FastShip Imports MT	0	%	FastShip

FastShip TEU Box Ratio	1.8	-	FastShip
FastShip Callings per Year	104	-	FastShip
FastShip Utilization (Load Factor)	80	%	FastShip
Window for FastShip Containers – Import	12	Hours	FastShip
Window for FastShip Containers – Export	12	Hours	FastShip
Truck Arrival Pear Factor	1.35	-	Assumption

Source: Halcrow, 2011

3.3.4 Capacity Analysis

The new yard layout offers sufficient capacities until end of slice twelve. Afterwards the capability of the terminal is limited by the yard.

Table 23: Capacity Analysis

Volume Slice		0	5	10	12	13	15	20
Market potential	M TEU	0.223	0.474	0.724	0.824	0.874	0.974	1.224
Quayside Capacity	M TEU	1.121	1.294	1.359	1.376	1.382	1.395	1.430
Yard Capacity	M TEU	0.496	0.841	0.842	0.842	0.842	0.842	0.843
Gate Capacity	M TEU	Designed to match capacity constraint at each slice						
Actual annual quayside	M TEU	*0.223*	*0.474*	*0.724*	*0.824*	*0.842*	*0.842*	*0.843*
Capacity constraint		Market	Market	Market	Market	Yard	Yard	Yard

Source: HPC, 2011

The total annual throughput capacity for conventional containers is 843,000 TEU, with two weekly FastShip calls the throughput increases to 1.093M TEU.

3.4 Manual Terminal in Terminal FastShip

The key data of the Manual Terminal in Terminal FastShip design regarding the capacities are the same as for the Automated Terminal in Terminal FastShip alternative. The corresponding tables are shown in the previous chapter.

3.4.1 Quay Capacity

The details of the quay capacity are shown in chapter ‘3.3.1 Quay Capacity’ on page 36

3.4.2 Yard Capacity

The details of the yard capacity are shown in chapter 3.2.2 Yard Capacity on page 24.

3.4.3 Gate Capacity

The gate design for the mTnT is exactly the same as the aTnT presented in Section 3.3.3. above, since both the conventional and FastShip throughputs are the same. Therefore, all assumptions and procedures are the same.

3.4.4 Capacity Analysis

There is no difference between the capacities of the manual and automated terminal-in-terminal alternative.

Table 24: Capacity Analysis

Volume Slice		0	5	10	12	13	15	20
Market potential	M TEU	0.223	0.474	0.724	0.824	0.874	0.974	1.224
Quayside Capacity	M TEU	1.121	1.294	1.359	1.376	1.382	1.395	1.430
Yard Capacity	M TEU	0.496	0.841	0.842	0.842	0.842	0.842	0.843
Gate Capacity	M TEU	Designed to match capacity constraint at each slice						
Actual annual quayside	M TEU	*0.223*	*0.474*	*0.724*	*0.824*	*0.842*	*0.842*	*0.843*
Capacity constraint		Market	Market	Market	Market	Yard	Yard	Yard

Source: HPC, 2011

The total annual throughput capacity for conventional containers is 843,000 TEU, increasing to 1.093M TEU with two weekly FastShip calls.

3.5 Manual Integrated FastShip

3.5.1 Quay Capacity

The details of the quay capacity are equal to the calculations for the conventional part which is shown in chapter ‘3.3.1 Quay Capacity’ on page 36.

3.5.2 Yard Capacity

Assumptions of the best fitting storage block size are the same as the ones of the conventional layout alternative. For details refer to chapter ‘3.2.2 Yard Capacity' on page 24.

The integrated FastShip alternative will occupy less of Section A when compared to the two terminal-in-terminal alternatives. However, in each RTG run, one container row is lost, since it is strictly used for cassette handling. The following table gives an overview of available slots for the different conventional container types.

Table 25: Key Data Final Build-Out of Manual Integrated Alternative

Sections	Reefer Plugs	Ground Slots (TEU) Dry	Reef	MT	Max Capacity (TEU) Dry	Reef	MT
A	772	270	386	646	1,350	1,544	2,902
B	924	672	462	1,322	3,360	1,848	6,677
C	464	594	232	384	2,970	928	1,728
D	0	312	0	376	1,560	0	1,692
Sum	**2,160**	**1,848**	**1,080**	**2,728**	**9,240**	**4,320**	**12,999**

Source: HPC, 2011

The integration of FastShip reduces available container slots to approximately 78% of the conventional layout. All parameters are the same as in previous calculations. The annual throughput capacity for the full container yard is 602,000 TEU.

Table 26: Yard Capacity, Calculation Dry Containers

Total Static Slots	**13,560**
Dwell time	5.46
Utilization	80%
Peak factor yard	1.2
Days per Year	365
Yard Capacity	**602,014**

Source: HPC, 2011

The capacity for empty containers is also affected. Approximately 295,000 TEU can be handled per year.

Table 27: Yard Capacity, Calculation MT Containers

Total MT Yard, Final	
Total Static Slots	**12,999**
Dwell time	10.71
Max Yard Utilization	80%
Peak factor yard	1.2
Days per Year	365
Yard Capacity	**295,309**

Source: HPC, 2011

This adds up to an annual throughput capacity of approximately 897,000 TEU.

Table 28: Yard Capacity, Dry and MT

Full Container Yard	602,014
MT Yard	295,309
Grand total	**897,323**
Static Slots Reefer (TEU)	4,320
Static Reefer Plugs	2,160
Static Slots Dry (TEU)	9,240
Static Slots MT (TEU)	12,999

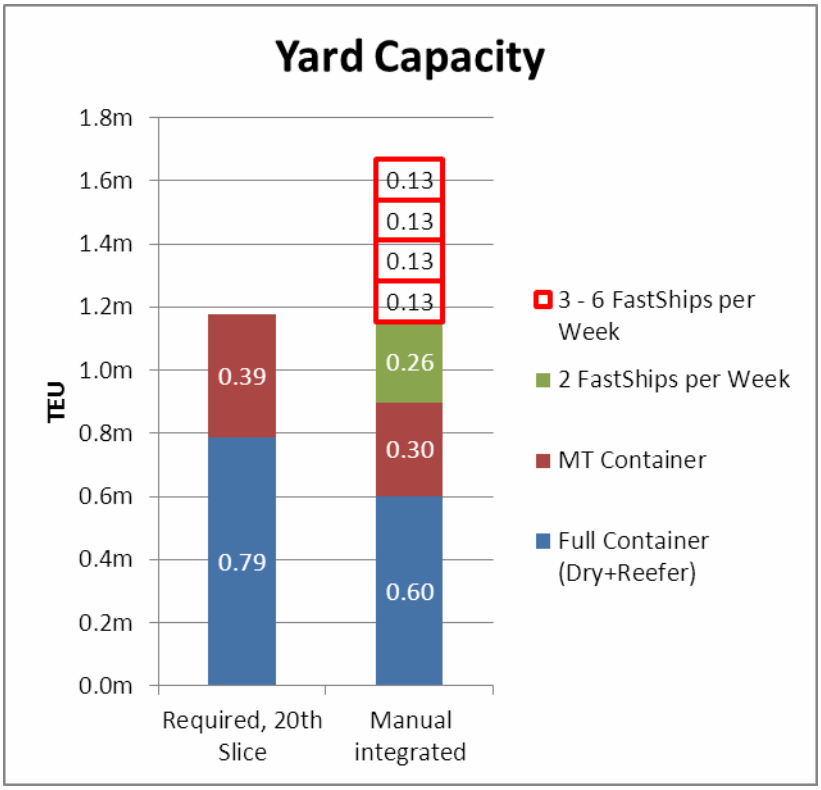
Source: HPC, 2011

3.5.2.1 Yard CapacityFastShip Yard Capacity Requirements to Manual Integrated Terminal Layout

Two FastShip calls per week like planned in the first phase will cause a handling volume of about 257,000 TEU per year. In conjunction with the estimated yard capacities for the conventional vessel handling with 295,300 TEU for MT containers and 897,000 TEU for dry and reefer container the sum is 1.15m TEU. In comparison to the required volume in the 20th volume slice with about 1.18m TEU this capacity is a little lower.

The containers for the FastShip operation are collected and delivered directly from the chassis, except of shifting containers, which are intermediately stored in the block storage. Due to the high operational speed and short dwell times the throughput of the FastShip operation can be scaled up by additionally vessel calls. This will make possible to reach a yearly throughput of about 1.67m TEU, if six FastShip vessels are operated per week.

Figure 12 Comparison Yard Capacities



Source: HPC, 2011

3.5.3 Gate Capacity

All FastShip gate assumptions and results are identical to Sections 3.2.3 and 3.3.3, the aTnT and mTnT. With the mInt option, the conventional throughput is slightly higher. Therefore, more gate lanes are required to achieve an adequate gate capacity. The gate transaction times are the same as in Section 3.1.3.

It was assumed that the distribution of conventional truck calls is the same as in Figure 8, Figure 9, and Figure 10 in Section 3.2.3, while the FastShip truck distribution is the same as in Table 22 in Section 3.3.3. The assumptions that vary from the Terminal-in-Terminals, presented in Section 3.3.3, are presented below in Table 29.

Table 29: mInT Gate Assumptions

Assumption	Value	Unit	Source
Conventional Throughput	937,845	TEU	HPC
% Conventional Exports Full	38	%	Deliverable 1.1
% Conventional Exports MT	62	%	Deliverable 1.1
% Conventional Imports Full	92	%	Deliverable 1.1

% Conventional Imports MT	8	%	Deliverable 1.1
Conventional Import Throughput	499,933	TEU	Calculated on %
Conventional Export Throughput	437,852	TEU	Calculated on %
Conventional TEU Box Ratio	1.67	-	HPC
Conventional Throughput	561,584	Containers	Calculated
% of Conventional Trucks that Dual Cycle	60	%	3/4/11meeting at PAMT
Conventional Trucks per Year	393,109	Each	Calculated
FastShip Throughput	297,856	TEU	FastShip
% FastShip Exports Full	100	%	FastShip
% FastShip Exports MT	0	%	FastShip
% FastShip Imports Full	100	%	FastShip
% FastShip Imports MT	0	%	FastShip
FastShip TEU Box Ratio	1.8	-	FastShip
FastShip Callings per Year	104	-	FastShip
FastShip Utilization (Load Factor)	80	%	FastShip
Window for FastShip Containers – Import	12	Hours	FastShip
Window for FastShip Containers – Export	12	Hours	FastShip
Truck Arrival Pear Factor	1.35	-	Assumption

3.5.4 Capacity Analysis

In volume slice 14 conventional container storage becomes the capacity bottleneck. It is possible to handle 897,000 TEU per year.

Table 30: Capacity Analysis

Volume Slice		0	5	10	13	14	15	20
Market potential	M TEU	0.223	0.474	0.724	0.874	0.924	0.974	1.224
Quayside Capacity	M TEU	1.050	1.209	1.269	1.291	1.295	1.304	1.337
Yard Capacity	M TEU	0.496	0.895	0.896	0.897	0.897	0.897	0.897
Gate Capacity	M TEU	Designed to match capacity constraint at each slice						
Actual annual quayside	M TEU	*0.223*	*0.474*	*0.724*	*0.874*	*0.897*	*0.897*	*0.897*
Capacity constraint		Market	Market	Market	Market	Yard	Yard	Yard

Source: HPC, 2011

The total annual throughput including two weekly FastShip calls is approximately 1.147M TEU.

4. RESOURCE DETERMINATION

4.1 Conventional Containers

4.1.1 Quay

To determine the required number of quay cranes for the conventional layout two different considerations have been made. On one hand, the calculation is based on the annual quayside moves and on the other it is based on limitations of the berth length and the single capacity of a crane.

As a first step the number of required crane moves has to be determined. Assuming a share of 55% for single 40' container moves, 15% for twin 20' container moves and 30% for single 20' container moves the factor 1.08 has been calculated which is mentioned as *Container per conventional QC move*. Using this factor the expected count of moves for all cranes can be determined according to its volume slice.

The number of assumed total moves is divided by the average conventional crane capacity of 135,000 moves per year and results in the number of required cranes. In some cases the number of cranes is adjusted manually, since the calculated floating point number of cranes is marginally above a full crane count, e. g. in slices 10 and 15.

Table 31: Quay Crane Requirements

Volume Slice	0	5	10	15	20
Annual quayside container	148,847	291,267	438,325	585,384	713,450
Conventional Quay Cranes					
Quayside cont. conventional	148,847	291,267	438,325	585,384	713,450
Container per conventional QC move	1.08	1.08	1.08	1.08	1.08
Total moves	137,683	269,422	405,451	541,480	659,941
Cont. p.a./conventional crane	135,000	135,000	135,000	135,000	135,000
Numeric result of conventional quay cranes	1.02	2.00	3.00	4.01	4.89
Calculated No. of conventional quay cranes by utilization	2	2	4	5	5
Manual adjustment	0	0	-1	-1	0
No. of conventional quay cranes by utilization	2	2	3	4	5

Source: HPC, 2011

According to the requirements of the handling volume the number of conventional cranes varies from two to five devices.

Another approach to determine the required number of quay cranes leads to the assumed average of cranes moves. The average will be calculated with a recommended number of crane devices. With regard to the present configuration of equipment and the expected development of handling volumes the terminal is well prepared for the future to have six cranes permanently available. This number makes it possible to handle more than one mainliner vessel at the same time.

With six assigned quay cranes the expected number of annual moves per crane increases from about 25,000 to 119,000 in the final volume slice.

Table 32: Final Adjustments for Quay Crane Calculations

Volume Slice	0	5	10	15	20
Final Adjustments					
Min. Number by operational reasons conventional QC	6	6	6	6	6
Length of quay (m)	945	945	945	945	945
Min. space per crane (m)	100	100	100	100	100
Max. number of quay cranes	9	9	9	9	9
No of conventional cranes	6	6	6	6	6
Decision on quay crane allocation					
Number of conventional cranes	6	6	6	6	6
Moves per conventional crane/year	135,000	135,000	135,000	135,000	135,000
Percentage of quayside containers conventional crane	100.0%	100.0%	100.0%	100.0%	100.0%
Moves conventional crane	148,847	291,267	438,325	585,384	713,450
per crane	24,808	48,544	73,054	97,564	118,908
Number of required quay cranes	6	6	6	6	6
Total number of quay cranes	6	6	6	6	6
No. of Conventional Quay Cranes	6	6	6	6	6

Source: HPC, 2011

The required lifting capacity of the cranes as shown above can only be produced with modern state-of-art cranes. The previously shown calculation is based on the assumption that an average productivity of 33 moves per hours is achieved. The details of this calculation are described in chapter ‘3.2.1 Quay Capacity ’ on page 21. Comparing this requirement to the present situation on the terminal, it becomes clear that not all of the available cranes are able to achieve the needed productivity. Replacement of each quay crane must be decided on an individual crane level.

4.1.2 Horizontal Transport

The resource determination for horizontal transports regards the requirements for hostlers and terminal chassis (bombcarts).

4.1.2.1 Terminal Hostlers

To determine a sufficient number of required hostlers the demand for quayside trips as well as for trips needed for container inspections need to be taken into account.

The number of trucks for quayside operations is deduced from the number of used quay cranes. The average productivity of a quay crane is assumed to be almost 36 containers per hour. Six quay cranes are recommended with a utilization of 75 %. The number of round trips per hour for terminal trucks has been assumed to be six on average.

The number of inspection operations increases from 8 to 40 per day in proportion to the volume slices. Assuming a performance of four round trips per hour the inspection operations require less than half of a truck at any time. For Hostlers an availability of 85 % is used, mainly reflecting unavailability for maintenance and repair (M&R) purposes.

Table 33: Requirements Terminal Truck

Volume Slice	0	5	10	15	20
Tractors					
Quayside Operations					
Number of conventional QC	6	6	6	6	6
Productivity conventional QC (cont./h)	35.68	35.68	35.68	35.68	35.68
Peak QC utilization	75%	75%	75%	75%	75%
Total quayside containers	161	161	161	161	161
Truck round trips per hour	6	6	6	6	6
Number of Trucks Quayside	**26.76**	**26.76**	**26.76**	**26.76**	**26.76**
Inspection Operations					
Moves Inspection Area/day	8	16	24	32	40
Inspection moves/hour	0.34	0.67	1.01	1.35	1.64
Truck round trips/hour	4	4	4	4	4
Tractors inspection (numeric)	**0.09**	**0.17**	**0.25**	**0.34**	**0.41**
Truck for operation (numeric)	**26.84**	**26.92**	**27.01**	**27.09**	**27.17**
Availability	85%	85%	85%	85%	85%
Total Trucks	**32**	**32**	**32**	**32**	**32**

Source: HPC, 2011

Consequently, the terminal should be equipped with 32 terminal trucks.

4.1.2.2 Terminal Chassis

Firstly, chassis requirements result from the continuous transport of containers to/from the quayside and the inspection area respectively. Secondly, chassis are required for the on chassis storage of OOG units.

In general, one chassis per hostler is required for transport operations. However, for OOG units, chassis are also used for storage. Hence, the calculation of required number of OOG chassis is based on the parameters: percentage of chassis storage, dwell time and peak factor for this type of cargo units.

Table 34: Requirements Terminal Chassis

Volume Slice	0	5	10	15	20
Chassis					
Quayside Operations					
Chassis per truck quayside operation	1	1	1	1	1
Chassis quayside	**26.76**	**26.76**	**26.76**	**26.76**	**26.76**
Inspection Operations					
Chassis per truck inspection operation	1	1	1	1	1
Chassis for inspection ops	**0.09**	**0.17**	**0.25**	**0.34**	**0.41**
OOG Operations					
Annual OOG units (bx)	96	187	282	376	458
Percentage of chassis storage	10%	10%	10%	10%	10%
Dwell time	5.73	5.73	5.73	5.73	5.73
Days per year	365	365	365	365	365
Peak Factor	1.2	1.2	1.2	1.2	1.2
Chassis OOG Storage	**0.18**	**0.35**	**0.53**	**0.71**	**0.86**
Subtotal Chassis	**27**	**27**	**28**	**28**	**28**
Equipment Availability Chassis	90%	90%	90%	90%	90%
Calculated Total Chassis	31	31	31	31	32
Manual adjustment	0	0	0	0	-1
Total Chassis	**31**	**31**	**31**	**31**	**31**

Source: HPC, 2011

Due to lower maintenance technical complexity compared to hostlers the chassis have a significantly higher availability of 90%. Thus, the recommended number of chassis for the terminal is 31.

4.1.3 Yard

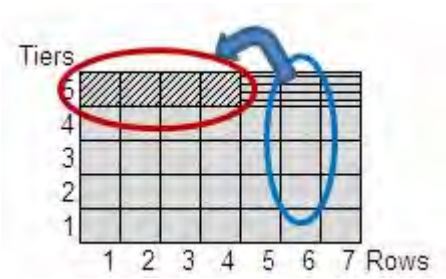
The resource determination for the container yard covers the resources of slot capacities for all different commodities as well as yard cranes.

4.1.3.1 Standard Dry

The calculation is based on the volumes for import-, export- and empty containers and their corresponding dwell times. With regard to a maximum utilization of 90%, an operational to static slot conversion factor of 89% and a peak factor the required number of slots for importers, exporters and empty containers is determined.

The next figure illustrates the facts of operational utilization and conversion factor on the base of a typical RTG block with five tiers and seven rows. Mathematically the number of slots is computed by the numbers of rows multiplied by the numbers of tiers, means 5 * 7 = 35 slots. From an operational prospective this capacity never should be reached, because only containers at the outer locations are accessible for the lifting device but no restow activities in the same bay are possible. Thus the number of maximum available slots must be reduced by the number of *tiers – 1*, or 4. The reduction of 4 slots equates to a rate of about 11%. Additionally the bay capacity must be reduced by an utilization factor, because the more containers are stored in tiers the higher the rate for shuffling will be. For this yard layout the utilization is determined to 90%. Taking both factors together a maximum occupation of about 28 slots per bay can be reached. The calculation: 35 slots * 89% (conversation) * 90% (utilization) = 28 slots.

Figure 13 Schematic Bayview of an RTG Container Block



Source: HPC, 2011

The factor for the operational to static slot conversion reserves a certain amount of empty slots. The slots are needed for shuffling activities. In general the RTG needs to be able to access any container at any time without moving the portal.

Table 35: Slot requirements for dry container yard

Volume Slice	0	5	10	15	20
Full Container Yard (incl. Reefer)					
Total TEUs	*155,558*	*319,272*	*487,834*	*656,397*	*803,567*
Full Import (TEU)	108,638	222,972	340,692	458,412	561,191

Volume Slice	0	5	10	15	20
Dwell Time (days)	*5.40*	*5.40*	*5.40*	*5.40*	*5.40*
Full Export (TEU)	39,544	81,160	124,010	166,859	204,271
Dwell Time (days)	*5.68*	*5.68*	*5.68*	*5.68*	*5.68*
Full Transhipment (TEU)	0	0	0	0	0
Dwell Time (days)	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Percentage of MTs in full container yard	*10%*	*10%*	*10%*	*10%*	*10%*
MTs Full Cont. Yard	7,376	15,140	23,133	31,126	38,105
Dwell Time (days)	*10.84*	*10.84*	*10.84*	*10.84*	*10.84*
Avg. Dwell Time Full Cont. Yard	***5.73***	***5.73***	***5.73***	***5.73***	***5.73***
Peak Factor	1.2	1.2	1.2	1.2	1.2
Operational to static slot conversion	89%	89%	89%	89%	89%
Max. Yard Utilization	90%	90%	90%	90%	90%
Days per Year	365	365	365	365	365
Slots Import	*2,408*	*4,942*	*7,551*	*10,161*	*12,439*
Slots Export	*921*	*1,891*	*2,890*	*3,888*	*4,760*
Slots Transhipment	*0*	*0*	*0*	*0*	*0*
Slots MT Domestic	*328*	*674*	*1,029*	*1,385*	*1,695*
No. of Slots by Volume Slices	**3,658**	**7,507**	**11,470**	**15,434**	**18,894**

Source: HPC, 2011

The total number of required slots for dry containers grows from about 3,650 to nearly 17,850 slots. The numbers of dry containers in the table above includes the requirements for reefer containers.

In comparison to the requirements the next table shows the yard capacities for the final build-out. The depicted numbers correspond to the drawings in the appendix. For each of the sections A, B, C and D the information of available reefer plugs, ground slots for dry- and reefer container and its maximum yard capacity is shown.

Table 36: Slot capacities dry container final build-out

Sections	Reefer Plugs	Ground Slots (TEU)			Max Capacity (TEU)		
		Dry	Reef		Dry	Reef	
A	1,304	847	652		4,235	2,608	
B	1,092	784	546		3,920	2,184	
C	548	693	274		3,465	1,096	
D	0	364	0		1,820	0	
Sum	**2,944**	**2,688**	**+ 1,472**	**= 4,160**	**13,440**	**+ 5,888**	**= 19,328**

Source: HPC, 2011

Obviously the maximum slot capacity on the yard with more than 19,300 slots is significantly higher than the requirement with about 18,900 slots. This rough check ensures sufficient yard capacity for all volume slices for dry containers. More details with different commodities are checked in the following subchapters.

4.1.3.2 Reefer Operation

This subsection takes a closer look at the details of required reefer slots. The share of reefer containers is 21%, which have dwell time for empty reefers is 5.73 days. The line *Total reefer TEU annually* shows the expected number of reefer containers in TEU per year. Taking this number in conjunction with the peak factor of 1.2 and an assumed utilization of 80% the number of required reefer slots in TEU can be determined. This value multiplied with the given *TEU factor* defines the number of required reefer plugs. The number of required plugs starts in the first volume slice with 488 and increases to 2,519 in the final slice.

Table 37: Slot requirements for reefer racks

Volume Slice	0	5	10	15	20
Reefer Slots					
Reefer percentage	21%	21%	21%	21%	21%
Total reefer TEU annually	32,140	65,964	100,791	135,617	166,023
avg. dwell time (see full cont. yard)	5.73	5.73	5.73	5.73	5.73
Peak Factor	1.2	1.2	1.2	1.2	1.2
Avg. Yard Utilization	80%	80%	80%	80%	80%
Days per Year	365	365	365	365	365
No. of Reefer Slots	**756**	**1,551**	**2,370**	**3,189**	**3,904**
TEU Factor	1.6	1.6	1.6	1.6	1.6
No. of Reefer Plugs	**488**	**1,001**	**1,530**	**2,058**	**2,519**
Height of Reefer Rack	4	4	4	4	4
Width of Reefer Rack	6.5	6.5	6.5	6.5	6.5
No. of Reefer Racks	**19**	**39**	**59**	**80**	**97**

Source: HPC, 2011

In the final build-out a total amount of 5,888 reefer slots in TEU can be provided on the terminal. The number of reefer plugs on the terminal will be 2,944. Both values are significantly higher than the requirements.

Table 38: Slot capacities reefer container final build-out

Sections	Reefer Plugs	Ground Slots (TEU) Reef	Max Capacity (TEU) Reef
A	1,304	652	2,608
B	1,092	546	2,184
C	548	274	1,096
D	0	0	0
Sum	**2,944**	**1,472**	**5,888**

Source: HPC, 2011

4.1.3.3 MT Operations

Subsequently to reefer containers, the empty containers need a separate assessment as well. In the first row of the following table the expected numbers for empty container throughput are listed, based on the agreed volume slices. With regard to the specific dwell time, peak factor, utilization and stacking height the required number of slots is calculated.

The next table shows slightly increased yard utilization for the last two volume slices. For empty container storage the used utilization of 80% is relatively low. In comparison to full containers these containers must not be fetched out from the yard in random access. Empty containers are stored according to their construction types and stacked-in and stacked-out from the front. Thus, the use of a slightly increased utilization is acceptable to meet the requirements on the terminal.

Table 39: Slot requirements for MT container blocks

Volume Slice	0	5	10	15	20
MT Cont. Yard					
MT Domestic	66,388	136,257	208,195	280,133	342,941
Dwell Time (days)	*10.84*	*10.84*	*10.84*	*10.84*	*10.84*
Peak Factor	1.2	1.2	1.2	1.2	1.2
Max. Yard Utilization	80%	80%	80%	80%	83%
Stacking height	6	6	6	6	6
Days per Year	365	365	365	365	365
No. of Slots	**2,957**	**6,070**	**9,275**	**12,479**	**14,688**
No. of Ground Slot	**493**	**1,012**	**1,546**	**2,080**	**2,448**

Source: HPC, 2011

The following table shows the calculated block stow resources for empty containers according the planned terminal layout. In comparison to the results of the previous table the number of ground slots is more than sufficient and the maximum capacity differs only in the last two volume slices.

Table 40: Slot capacities for MT containers final build-out

Sections	Ground Slots (TEU) MT	Max Capacity (TEU) MT
A	1,016	4,592
B	1,322	6,677
C	384	1,728
D	376	1,692
Sum	**3,098**	**14,689**

Source: HPC, 2011

4.1.3.4 Stacking Devices

The calculation of number of required RTGs is based on a multi-dimensional approach. Firstly, the total number of required moves per volume slice is determined. Secondly, the number of RTG devices based on average handling volumes is calculated. Finally, terminal equipment must be able to respond to peak situations.

The calculation of RTG total moves is subdivided into quayside and landside requirements.

For the former the number of productive full import and export containers and a certain amount of shuffle moves for boxes is taken into account. The share of shuffle moves for export moves is assumed with 5%. Shuffle operations have been assumed for import operations at the landside only. From experience it cannot be predicted in which order the incoming trucks pick up the import containers. Thus it is assumed to have one shuffle move for every import box in average. At the export side the number of shuffles can be reduced to nearly zero. A contemporary stowage planning process is able to build up loading sequences in coordination with the stacking situation in the yard. The line *unproductive moves landside* shows the sum of expected landside moves.

In addition to the landside moves, it is assumed that 2 % of the moves will be for inspection purposes. Due to the fact that import containers are stored in a random sequence in the RTG block one shuffle move has been assumed on average for stacking out. The line *Inspection Moves Landside* shows the sum of required RTG moves for inspection activities.

Table 41: Calculations of RTG Total Moves

Volume Slice	0	5	10	15	20
Yard Moves Quayside (container)					
Import full [box]	70,089	137,151	206,398	275,645	335,949
Export full [box]	25,512	49,922	75,128	100,333	122,283
Productive Moves to Quayside [box]	95,601	187,074	281,526	375,979	458,232
Shuffle Import	0%	0%	0%	0%	0%
	0	0	0	0	0
Shuffle Export	5%	5%	5%	5%	5%
	1,276	2,496	3,756	5,017	6,114
Unproductive Moves Quayside	1,276	2,496	3,756	5,017	6,114
Total Yard Moves Quayside	96,877	189,570	285,283	380,995	464,346

Volume Slice	0	5	10	15	20
Yard Moves Landside					
Import Full [box]	70,089	137,151	206,398	275,645	335,949
Export Full [box]	25,512	49,922	75,128	100,333	122,283
Productive Moves Landside [box]	95,601	187,074	281,526	375,979	458,232
Shuffle Import	1	1	1	1	1
	70,089	137,151	206,398	275,645	335,949
Shuffle Export	0%	0%	0%	0%	0%
	0	0	0	0	0
Unproductive Moves Landside	70,089	137,151	206,398	275,645	335,949
Yard Moves Inspection					
Import Full	70,089	137,151	206,398	275,645	335,949
Inspection	2%	2%	2%	2%	2%
	2,804	5,486	8,256	11,026	13,438
Shuffle Import	1	1	1	1	1
	1,402	2,743	4,128	5,513	6,719
Inspection Moves Landside	4,205	8,229	12,384	16,539	20,157
Total Yard Moves Landside	169,895	332,454	500,309	668,163	814,338
Housekeeping Moves	20%	20%	20%	20%	20%
	53,354	104,405	157,118	209,832	255,737
Total RTG-Moves	320,126	626,429	942,710	1,258,990	1,534,421

Source: HPC, 2011

The amount of additional housekeeping moves is based on the sum of landside moves and quayside moves. A share of 20% has been assumed to determine the expected housekeeping operations. Thus, the total RTG moves consist of housekeeping, total landside and total quayside moves.

The following table determines the number of RTG devices based on the average handling volume. For calculation of required working hours the average performance of the RTG for different operations like quayside, landside and housekeeping has been defined by HPC experience. The assumptions are 20 moves per hour for quayside operation, and 13 moves per hour for landside operation and housekeeping. Quayside operations average a higher productivity due to less shuffling activities. The average performance has been calculated with regard to the number of expected moves.

In the next step of calculation the required working hours must be determined. The quayside hours are computed by *Total Yard Moves Quayside* subtracted by *Unproductive Moves Quayside* divided by *Assumed Average RTG Performance for Quayside Operation*. The landside working hours are calculated similarly. The required RTG working hours for landside operations are derived by *Total Yard Moves Landside* subtracted by *Unproductive Moves Landside* divided by *Assumed Average RTG Performance for Landside Operation*. The working hours for housekeeping have been calculated by number of *Housekeeping*

Moves divided by assumed average RTG performance for housekeeping. The number of *Net Annual Average RTG Working Hours* is determined with an assumed availability of 85% and utilization of 65%. Thus, the calculated number of RTGs results from *Total Working Hours* divided by *Net Annual Average Working Hours*.

Table 42: RTG requirements by Handling Volumes

Volume Slice	0	5	10	15	20
Assumed average RTG Performance					
Quayside Operations [mvs/h]	20	20	20	20	20
Landside Operations [mvs/h]	13	13	13	13	13
Housekeeping [mvs/h]	13	13	13	13	13
Average Performance [mvs/h]	15.02	15.02	15.02	15.02	15.02
Required RTG Working h p.a.					
Quayside	4,780	9,354	14,076	18,799	22,912
Landside	7,677	15,023	22,608	30,194	36,799
Housekeeping	4,104	8,031	12,086	16,141	19,672
Total RTG Working hours p.a.	16,562	32,408	48,771	65,133	79,383
Assumed avg. RTG utilization (24/7)	65%	65%	65%	65%	65%
Days per year	361	361	361	361	361
Hours per day	24	24	24	24	24
Gross Annual average RTG working h	5,632	5,632	5,632	5,632	5,632
Equipment Availability	85%	85%	85%	85%	85%
Net Annual average RTG working h	4,787	4,787	4,787	4,787	4,787
Total Productive Moves per RTG p.a.	71,900	71,900	71,900	71,900	71,900
Calculated Number of RTGs by handling volumes	*3.46*	*6.77*	*10.19*	*13.61*	*16.58*
Calculated Number of RTGs by handling volumes	4	7	11	14	17
Manual adjustment	0	0	-1	0	0
Number of RTGs by handling volumes	4	7	10	14	17

Source: HPC, 2011

Based on average handling volumes the number of required RTG devices varies between 4 and 17 for the selected period of time.

The next table shows the required numbers of RTG devices for peak situations. This calculation makes a separate investigation for landside as well as for quayside. According to the quay crane performance at the berth the lift equipment must provide a similar throughput capacity. Otherwise a waiting queue of hostlers or idling quay cranes may occur. In peak situations all quay cranes create a performance of about 161 containers per hour. According to the analyzed traffic structure a share of 33% empty containers has to be expected whereof 10% are stored in the RTG blocks. Thus, a throughput of 113 containers

per hour must be handled. With the given productivity of the cranes this results in a requirement of nearly six RTGs only for the quayside operation.

Table 43: RTG Requirements by Peak Performance

Volume Slice	0	5	10	15	20
Peak Performance Requirements Container Terminal					
Quayside					
Conventional quay cranes	6	6	6	6	6
Containers/h/conventional QC	35.68	35.68	35.68	35.68	35.68
Peak QC utilization	75%	75%	75%	75%	75%
Quayside containers/h	161	161	161	161	161
MT share	33%	33%	33%	33%	31%
MT percentage to full container yard	10%	10%	10%	10%	10%
Quayside container to full container yard in peak hour	113	113	113	113	113
Productivity quayside	20	20	20	20	20
RTGs quayside	5.63	5.63	5.63	5.63	5.63
Landside					
Hourly landside moves	26	51	77	103	126
Import share on domestic container	73%	73%	73%	73%	73%
Import containers	19	38	57	76	92
Shuffling on import	1	1	1	1	1
Total landside container/peak hour	46	89	134	179	218
MT share	33%	33%	33%	33%	33%
MT percentage to full container yard	10%	10%	10%	10%	10%
Landside container to full container yard in peak hour	32	62	94	125	153
Productivity landside	13	13	13	13	13
RTGs landside	2.45	4.80	7.23	9.65	11.76
Total numeric RTGs	8.08	10.43	12.85	15.28	17.39
Availability	85%	85%	85%	85%	85%
Total RTG requirements	10	13	16	18	21
RTGs to be employed	10	13	16	18	21

Source: HPC, 2011

The requirements for the landside operation are primarily based on the expected throughput at the gates (*Hourly landside moves*). Additionally it is expected to perform one shuffling move for every import container on average. The *Total Landside Container Peak Hour* results from the addition of *Hourly Landside Moves* and *Import Containers*. This value corrected by the amount of expected empty containers and divided by the average productivity of the RTG at the landside results in landside RTG requirements.

Considering landside and quayside requirements as well as the RTG specific availability of 85% total RTG requirements throughout the volume slices are calculated.

Thus, the number of RTGs will start with at least ten devices and grow to 21 devices in the final build-out.

4.1.4 Gate

The assumptions and results presented in Section 3. were used to generate the results shown in Table 44 below, for the fully built out conventional terminal.

Table 44: Full Build-out Gate Results Summary

Infrastructure	Number	Unit
In-Gate		
Security Lanes	2	Lanes
OCR Lanes	2	Lanes
Pedestals and Weigh Scales	14	Lanes
Queue Space	48	Truck Lengths
Out-Gate		
RPM Lanes	2	Lanes
OCR Lanes	2	Lanes
Pedestals	10	Lanes
Security Lanes	2	Lanes
Queue Space	15	Trucks Lengths
General Gate Structure		
Acreage	12.7	Acres
PAMT Lanes	3	Lanes

4.2 Automated Terminal in Terminal FastShip

4.2.1 Quay

According to the volume restrictions from the capacity analysis the maximum possible volumes for the quay side operations must be adjusted as well. The depicted volumes in the first row of the following table include this consideration. With regard to the handling volumes the number of required quay cranes starts with 2 in the first slice and ends with 4 in the last slice.

Table 45: Quay Crane Requirements

Volume Slice	0	5	10	15	20
Annual quayside container	148,847	291,267	438,325	506,549	504,480
Conventional Quay Cranes					
Quayside cont. conventional	148,847	291,267	438,325	506,549	504,480
Container per conventional QC move	1.08	1.08	1.08	1.08	1.08
Total moves	137,683	269,422	405,451	468,557	466,644
Cont. p.a./conventional crane	135,000	135,000	135,000	135,000	135,000
Numeric result of conventional quay cranes	1.02	2.00	3.00	3.47	3.46
Calculated No. of conventional quay cranes by utilization	2	2	4	4	4
Manual adjustment	0	0	-1	0	0
No. of conventional quay cranes by utilization	2	2	3	4	4

Source: HPC, 2011

The simple calculation based on handling volumes neglects considerations about assured service timeframes for shippers, availability of equipment and contemporary and competitive equipment configurations of a modern container terminal. Thus, the number of gantry cranes should be increased as shown in the following table.

Table 46: Final Adjustments for Quay Crane Calculations

Volume Slice	0	5	10	15	20
Final Adjustments					
Min. Number by operational reasons QC	5	5	5	5	5
Length of quay (m)	945	945	945	945	945
Min. space per crane (m)	100	100	100	100	100
Max. number of quay cranes	9	9	9	9	9
No of conventional cranes	5	5	5	5	5
Decision on quay crane allocation					
Number of conventional cranes	5	5	5	5	5
Moves per conventional crane/year	135,000	135,000	135,000	135,000	135,000
Percentage of quayside containers conventional crane	100.0%	100.0%	100.0%	100.0%	100.0%
Moves conventional crane	148,847	291,267	438,325	506,549	504,480
per crane	29,769	58,253	87,665	101,310	100,896
Number of required quay cranes	5	5	5	5	5
Total number of quay cranes	5	5	5	5	5
No. of Conventional Quay Cranes	5	5	5	5	5

Source: HPC, 2011

Based on consultants experience and the depicted handling volumes a number of five cranes is considered a meaningful configuration. This amount enables the terminal to offer contemporary service time frames to shippers.

4.2.2 Horizontal Transport

4.2.2.1 Terminal Hostlers

The determination of terminal hostlers is based on the number of gantry cranes. In this alternative an average throughput of 134 containers per hour can be expected. With assumed six round trips per truck and per hour for quayside an amount of 23 trucks is calculated. Additionally a certain amount of inspection operations must be taken into account. The volume of inspections depends from the total terminal throughput.

In this terminal layout alternative the number of expected inspection operations varies between eight and 28 moves per day. That number of round trips requires less than one hostler.

Table 47: Requirements Terminal Truck

Volume Slice	0	5	10	15	20
Tractors					
Quayside Operations					
Number of conventional QC	5	5	5	5	5
Performance conventional QC (cont./h)	35.68	35.68	35.68	35.68	35.68
Peak QC utilization	75%	75%	75%	75%	75%
Total quayside containers	134	134	134	134	134
Truck roundtrips per hour	6	6	6	6	6
Truck Quayside (numeric)	**22.30**	**22.30**	**22.30**	**22.30**	**22.30**
Inspection Operations					
Moves Inspection Area/day	8	16	24	28	28
Inspection Moves/hour	0.34	0.67	1.01	1.17	1.16
Truck roundtrips per hour	4	4	4	4	4
Tractors inspection (numeric)	**0.09**	**0.17**	**0.25**	**0.29**	**0.29**
Truck for operation (numeric)	**22.38**	**22.47**	**22.55**	**22.59**	**22.59**
Availability	85%	85%	85%	85%	85%
Operating Hours per TTU p.a. [h]	7,364	7,364	7,364	7,364	7,364
Calculated Total Trucks	27	27	27	27	27
Manual adjustment					
Total Trucks	**27**	**27**	**27**	**27**	**27**

Source: HPC, 2011

Predominantly dependent on the maximum number of quay cranes deployed, 27 hostler units are required to meet operational requirements throughout the volume slices suggesting improved utilization as the volume increases.

4.2.2.2 Terminal Chassis

In general the number of required chassis is close to the number of trucks on the terminal. Due to higher availabilities the number of bombcarts is slightly lower.

The requirements for quayside operations and inspections are the same as for trucks. The requirement for the OOG operations depends on the total container volume on the terminal. Thus, the number of needed chassis for this task is lower in comparison to the conventional terminal alternative.

Table 48: Requirements Truck Chassis

Volume Slice	0	5	10	15	20
Chassis					
Quayside Operations					
Chassis per truck quayside operation	1	1	1	1	1
Chassis quayside	**22.30**	**22.30**	**22.30**	**22.30**	**22.30**
Inspection Operations					
Chassis per truck inspection operation	1	1	1	1	1
Chassis inspection	**0.09**	**0.17**	**0.25**	**0.29**	**0.29**
OOG Operations					
Annual OOG units (bx)	96	187	282	325	324
Percentage of chassis storage	10%	10%	10%	10%	10%
Dwell time	5.73	5.73	5.73	5.73	5.73
Days per year	365	365	365	365	365
Peak Factor	1.2	1.2	1.2	1.2	1.2
Chassis OOG Storage	**0.18**	**0.35**	**0.53**	**0.61**	**0.61**
Subtotal Chassis	**23**	**23**	**23**	**23**	**23**
Equipment Availability Chassis	90%	90%	90%	90%	90%
Calculated Total Chassis	26	26	26	26	26
Manual adjustment					
Total Chassis	**26**	**26**	**26**	**26**	**26**

Source: HPC, 2011

In summary a number of 26 bombcarts on the terminal are sufficient.

4.2.3 Yard and Staging Area

4.2.3.1 Standard Dry

The calculation to determine the number of required static slots results in nearly 3,700 TEU in the first volume slice. This amount increases to about 13,500 TEU at most.

Table 49: Slot requirements for dry container yard

Volume Slice	0	5	10	15	20
Full Container Yard (incl. Reefer)					
Total TEUs	*155,558*	*319,272*	*487,834*	*567,997*	*568,201*
Full Import (TEU)	108,638	222,972	340,692	396,676	396,818
Dwell Time (days)	*5.40*	*5.40*	*5.40*	*5.40*	*5.40*
Full Export (TEU)	39,544	81,160	124,010	144,388	144,440
Dwell Time (days)	*5.68*	*5.68*	*5.68*	*5.68*	*5.68*
Full Transhipment (TEU)	0	0	0	0	0
Dwell Time (days)	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Percentage of MTs in full container yard	*10%*	*10%*	*10%*	*10%*	*10%*
MTs Full Cont. Yard	7,376	15,140	23,133	26,934	26,944
Dwell Time (days)	*10.84*	*10.84*	*10.84*	*10.84*	*10.84*
Avg. Dwell Time Full Cont. Yard	***5.73***	***5.73***	***5.73***	***5.73***	***5.73***
Peak Factor	1.2	1.2	1.2	1.2	1.2
Operational to static slot conversion	89%	89%	89%	89%	89%
Max. Yard Utilization	90%	90%	90%	90%	90%
Days per Year	365	365	365	365	365
Slots Import	*2,420*	*4,966*	*7,588*	*8,835*	*8,838*
Slots Export	*926*	*1,900*	*2,904*	*3,381*	*3,382*
Slots Transhipment	*0*	*0*	*0*	*0*	*0*
Slots MT Domestic	*330*	*677*	*1,034*	*1,204*	*1,205*
No. of Slots by Volume Slices	**3,675**	**7,543**	**11,526**	**13,420**	**13,425**

Source: HPC, 2011

In comparison to the numbers from the drawn layout, which are shown in the table below, the total slot requirements for dry containers and reefers are met.

Table 50: Slot capacities dry container final build-out

Sections	Reefer Plugs	Ground Slots (TEU) Dry	Ground Slots (TEU) Reef		Max Capacity (TEU) Dry	Max Capacity (TEU) Reef	
A	0	266	0		1,330	0	
B	1,092	784	546		3,920	2,184	
C	548	693	274		3,465	1,096	
D	0	364	0		1,820	0	
Sum	**1,640**	**2,107**	**+ 820**	**= 2,927**	**10,535**	**+ 3,280**	**= 13,815**

Source: HPC, 2011

The terminal layout for the Automated Terminal in Terminal alternative supports 1,640 reefer plugs and about 2,930 TEU ground slots for dry container and reefer. In a 100% occupation scenario the ground slots will be able to hold about 13,800 TEU.

4.2.3.2 Reefer Operations

Table 51 below shows the requirements of reefer containers to slots, plugs and needed racks.

Table 51: Slot requirements for reefer racks

Volume Slice	0	5	10	15	20
Reefer Slots					
Reefer percentage	21%	21%	21%	21%	21%
Total reefer TEU annually	32,140	65,964	100,791	117,353	117,395
avg. dwell time (see full cont. yard)	5.73	5.73	5.73	5.73	5.73
Peak Factor	1.2	1.2	1.2	1.2	1.2
Avg. Yard Utilization	80%	80%	80%	80%	80%
Days per Year	365	365	365	365	365
No. of Reefer Slots	**760**	**1,559**	**2,382**	**2,773**	**2,774**
TEU Factor	1.6	1.6	1.6	1.6	1.6
No. of Reefer Plugs	**491**	**1,006**	**1,537**	**1,790**	**1,790**
Height of Reefer Rack	4	4	4	4	4
Width of Reefer Rack	6.5	6.5	6.5	6.5	6.5
No. of Reefer Racks	**19**	**39**	**60**	**69**	**69**

Source: HPC, 2011

The terminal layout supports in the final build-out 3,280 TEU static slots and 1,640 reefer plugs. The capacity of static slots is sufficient for all volume slices but the amount of reefer plugs is already too short before slice 15.

Table 52: Slot capacities reefer container final build-out

Sections	Reefer Plugs	Ground Slots (TEU) Reef	Max Capacity (TEU) Reef
A	0	0	0
B	1,092	546	2,184
C	548	274	1,096
D	0	0	0
Sum	**1,640**	**820**	**3,280**

Source: HPC, 2011

4.2.3.3 MT Operations

Empty container volumes also increase throughout the scenario. From the first slice until slices 15 the volumes are growing step by step. Due to capacity limitations the empty volumes remain static. The capacity is limited to about 10,800 TEU slots.

Table 53: Slot requirements for MT container blocks

Volume Slice	0	5	10	15	20
MT Cont. Yard					
MT Domestic	66,388	136,257	208,195	242,406	242,493
Dwell Time (days)	*10.84*	*10.84*	*10.84*	*10.84*	*10.84*
Peak Factor	1.2	1.2	1.2	1.2	1.2
Max. Yard Utilization	80%	80%	80%	80%	80%
Stacking height	6	6	6	6	6
Days per Year	365	365	365	365	365
No. of Slots	**2,957**	**6,070**	**9,275**	**10,799**	**10,803**
No. of Ground Slot	**493**	**1,012**	**1,546**	**1,800**	**1,800**

Source: HPC, 2011

The terminal layout supports a maximum capacity for empty containers of about 10,100 TEU slots. This amount covers the requirements until inclusively volume slice 11.

Table 54: Slot capacities MT container final build-out

Sections	Ground Slots (TEU) MT	Max Capacity (TEU) MT
A	0	0
B	1,322	6,677
C	384	1,728
D	376	1,692
Sum	**2,082**	**10,097**

Source: HPC, 2011

4.2.3.4 Stacking Devices

The following table shows the adjusted volume amounts for import container and export container according to the capacity analysis. Due to yard restrictions for the conventional operations the volumes are lower in comparison to the conventional terminal alternative. In the final slice a total amount of almost 1.1M RTG moves per year will be executed.

Table 55: Calculations of RTG Total Moves

Volume Slice	0	5	10	15	20
Yard Moves Quayside (container)					
Import full [box]	70,089	137,151	206,398	238,523	237,549
Export full [box]	25,512	49,922	75,128	86,821	86,467
Transhipment [box]	0	0	0	0	0
Productive Moves to Quayside [box]	95,601	187,074	281,526	325,344	324,016
Shuffle Import	0%	0%	0%	0%	0%
	0	0	0	0	0
Shuffle Export	5%	5%	5%	5%	5%
	1,276	2,496	3,756	4,341	4,323
Shuffle Transhipment	5%	5%	5%	5%	5%
	0	0	0	0	0
Unproductive Moves Quayside	1,276	2,496	3,756	4,341	4,323
Total Yard Moves Quayside	96,877	189,570	285,283	329,686	328,339
Yard Moves Landside					
Import Full [box]	70,089	137,151	206,398	238,523	237,549
Export Full [box]	25,512	49,922	75,128	86,821	86,467
Productive Moves Landside [box]	95,601	187,074	281,526	325,344	324,016
Shuffle Import	1	1	1	1	1
	70,089	137,151	206,398	238,523	237,549
Shuffle Export	0%	0%	0%	0%	0%
	0	0	0	0	0
Unproductive Moves Landside	70,089	137,151	206,398	238,523	237,549
Yard Moves Inspection					
Import Full	70,089	137,151	206,398	238,523	237,549
Inspection	2%	2%	2%	2%	2%
	2,804	5,486	8,256	9,541	9,502
Shuffle Import	1	1	1	1	1
	1,402	2,743	4,128	4,770	4,751
Inspection Moves Landside	4,205	8,229	12,384	14,311	14,253
Total Yard Moves Landside	169,895	332,454	500,309	578,179	575,818
Housekeeping Moves	20%	20%	20%	20%	20%
	53,354	104,405	157,118	181,573	180,831
Total RTG-Moves	320,126	626,429	942,710	1,089,438	1,084,989

Source: HPC, 2011

To determine the required number of RTG devices the average handling volume can be used. According to the total volume throughput of this terminal alternative and the expected average crane performance in the last slice more than 56,000 working hours per year for RTG are estimated. The process to deduce the number of devices from the number of working hours is the same in all layout variants. Thus, in the final slice the terminal should be equipped with twelve RTGs to cover the average requirements.

Table 56: RTG requirements by Handling Volumes

Volume Slice	0	5	10	15	20
Assumed average RTG Performance					
Quayside Operations [mvs/h]	20	20	20	20	20
Landside Operations [mvs/h]	13	13	13	13	13
Housekeeping [mvs/h]	13	13	13	13	13
Average Performance [mvs/h]	15.02	15.02	15.02	15.02	15.02
Required RTG Working h p.a.					
Quayside	4,780	9,354	14,076	16,267	16,201
Landside	7,677	15,023	22,608	26,127	26,021
Housekeeping	4,104	8,031	12,086	13,967	13,910
Total RTG Working hours p.a.	16,562	32,408	48,771	56,362	56,132
Assumed avg. RTG utilization (24/7)	65%	65%	65%	65%	65%
Days per year	361	361	361	361	361
Hours per day	24	24	24	24	24
Gross Annual average RTG working h	5,632	5,632	5,632	5,632	5,632
Equipment Availability	85%	85%	85%	85%	85%
Net Annual average RTG working h	4,787	4,787	4,787	4,787	4,787
Total Productive Moves per RTG p.a.	71,900	71,900	71,900	71,900	71,900
Calculated Number of RTGs by handling volumes	*3.46*	*6.77*	*10.19*	*11.77*	*11.73*
Calculated Number of RTGs by handling volumes	4	7	11	12	12
Manual adjustment	0	0	-1	0	0
Number of RTGs by handling volumes	4	7	10	12	12

Source: HPC, 2011

Furthermore, the following table shows the calculation for RTG requirements based on peak performance. According to the previously shown pattern the amount of total required RTGs in the final slice is 16.

Table 57: RTG Requirements Peak Performance

Volume Slice	0	5	10	15	20
Peak Performance Requirements Container Terminal					
Quayside					
Conventional quay cranes	5	5	5	5	5
Containers/h/conventional QC	35.68	35.68	35.68	35.68	35.68
Tandem quay cranes	0	0	0	0	0
Containers/h/tandem QC	38.46	38.46	38.46	38.46	38.46
Peak QC utilization	75%	75%	75%	75%	75%
Quayside containers/h	134	134	134	134	134
MT share	33%	33%	33%	33%	33%
MT percentage to full container yard	10%	10%	10%	10%	10%
Quayside container to full container yard in peak hour	94	94	94	94	94
Productivity quayside	20	20	20	20	20
RTGs quayside (numeric)	4.69	4.69	4.69	4.69	4.69
Landside					
Hourly landside moves	26	51	77	89	89
Import share on domestic container	73%	73%	73%	73%	73%
Import containers	19	38	57	66	65
Shuffling on import	1	1	1	1	1
Total landside container / peak hour	46	89	134	155	154
MT share	33%	33%	33%	29%	23%
MT percentage to full container yard	10%	10%	10%	10%	10%
Landside container to full container yard in peak hour	32	62	94	109	108
Productivity landside	13	13	13	13	13
RTGs landside (numeric)	2.45	4.80	7.23	8.35	8.32
Total numeric RTGs	7.14	9.49	11.92	13.04	13.01
Availability	85%	85%	85%	85%	85%
Total RTG requirements	9	12	15	16	16
RTGs to be employed	9	12	15	16	16

Source: HPC, 2011

4.2.4 Gate

The assumptions and calculations presented in Section 3.3.3 were used to generate the results shown in Table 58 below, for the fully built out conventional terminal with an automated FastShip terminal within the conventional terminal. As stated in Section 1, the FastShip gate lanes will be dedicated to FastShip only, and Packer Avenue will have one dedicated FastShip inbound lane, and one dedicated outbound lane. It should be noted that the conventional gate calculations assume a 10 hour working day as exists today. The number of conventional gate lanes could be reduced should the operator decide to extend the gate hours. FastShip dedicated gates will be required to be staffed 24 hours a day when a FastShip is at port in order to meet the load out requirements. When there is no FastShip

at port, the dedicated FastShip lanes can be closed or used to alleviate conventional gate queuing.

Table 58: FastShip aTnT Gate Results Summary

Infrastructure	Number	Unit
In-Gate		
Conventional Security Lanes	2	Lanes
Conventional OCR Lanes	2	Lanes
Conventional Pedestals and Weigh Scales	11	Lanes
Conventional Queue Space	32	Truck Lengths
FastShip Security Lanes	1	Lane
FastShip OCR Lanes	1	Lane
FastShip Pedestals and Weigh Scales	5	Lanes
FastShip Queue Space	16	Truck Lengths
Out-Gate		
Conventional RPM Lanes	2	Lanes
Conventional OCR Lanes	2	Lanes
Conventional Pedestals	7	Lanes
Conventional Security Lanes	2	Lanes
Conventional Queue Space	10	Trucks Lengths
FastShip RPM Lanes	1	Lanes
FastShip OCR Lanes	1	Lanes
FastShip Pedestals	4	Lanes
FastShip Security Lanes	1	Lanes
FastShip Queue Space	5	Trucks Lengths
General Gate Structure		
Acreage	12.7	Acres
Total PAMT Lanes	5	Lanes
FastShip PAMT Dedicated Lanes (Each Way)	1	Lane

Source: Halcrow, 2011

4.3 Manual Terminal in Terminal FastShip

4.3.1 Quay

The results of the calculated resources are equal to the *Alternative Automated Terminal in Terminal FastShip*. For details refer to chapter ‘4.2.1 Quay’ on page 59.

4.3.2 Horizontal Transport

4.3.2.1 Terminal Trucks

The results of the calculated resources are equal to the *Alternative Automated Terminal in Terminal FastShip*. For details refer to chapter ‘4.2.2.1 Terminal Hostlers’ on page 61.

4.3.2.2 Terminal Chassis

The results of the calculated resources are equal to the *Alternative Automated Terminal in Terminal FastShip*. For details refer to chapter ‘4.2.2.2 Terminal Chassis’ on page 62.

4.3.3 Yard and Staging Area

The results of the calculated resources are equal to the *Alternative Automated Terminal in Terminal FastShip*. For details refer to chapter ‘4.2.3.4 Stacking Devices’ on page 65.

4.3.4 Gate

As stated in Section 3.4.3, the mTnT option has the same conventional and FastShip throughputs as the aTnT layout. Therefore, the results for this option are the same as in Section 4.2.4 above.

4.4 Manual Integrated FastShip

In this alternative, FastShip operations are integrated into the conventional container yard. Thus, the conventional yard capacity is being reduced not only in Section A but throughout all RTG blocks.

4.4.1 Quay

According to the handling volumes the terminal should be equipped with up to four offshore gantry cranes. The results of this calculation are very similar to previously taken considerations based on handling volumes.

Table 59: Quay Crane Requirements

Volume Slice	0	5	10	15	20
Annual quayside container	148,847	291,267	438,325	539,357	537,169
Conventional Quay Cranes					
Quayside cont. conventional	148,847	291,267	438,325	539,357	537,169
Container per conventional QC move	1.08	1.08	1.08	1.08	1.08
Total moves	137,683	269,422	405,451	498,905	496,881
Cont. p.a./conventional crane	135,000	135,000	135,000	135,000	135,000
Numeric result of conventional quay cranes	1.02	2.00	3.00	3.70	3.68
Calculated No. of conventional quay cranes by utilization	2	2	4	4	4
Manual adjustment	0	0	-1	0	0
No. of conventional quay cranes by utilization	2	2	3	4	4

Source: HPC, 2011

The relevant considerations for the final adjustments for the quay crane calculations are the same as in the terminal in terminal-in-terminal alternatives. In the following table a total of five cranes has been calculated to cover the move requirements at the quayside.

Table 60: Final Adjustments for Quay Crane Calculations

Volume Slice	0	5	10	15	20
Final Adjustments					
Min. Number by operational reasons conventional QC	5	5	5	5	5
Length of quay (m)	945	945	945	945	945
Min. space per crane (m)	100	100	100	100	100
Max. number of quay cranes	9	9	9	9	9
No of conventional cranes	5	5	5	5	5
Decision on quay crane allocation					
Number of conventional cranes	5	5	5	5	5
Moves per conventional crane/year	135,000	135,000	135,000	135,000	135,000
Percentage of quayside containers conventional crane	100.0%	100.0%	100.0%	100.0%	100.0%
Moves conventional crane	148,847	291,267	438,325	539,357	537,169
per crane	29,769	58,253	87,665	107,871	107,434
Number of required quay cranes	5	5	5	5	5
Total number of quay cranes	5	5	5	5	5
No. of Conventional Quay Cranes	5	5	5	5	5

Source: HPC, 2011

4.4.2 Horizontal Transport

The requirements for the horizontal transports are mainly driven by the configuration of the lifting equipment at the quayside. In this case for all volume slices the number of cranes will be five. Consequently, the derived number of dedicated hostlers and chassis will be constant too.

4.4.2.1 Terminal Hostlers

To cover the requirements of the internal terminal traffic a total of 27 terminal trucks has been calculated.

Table 61: Requirements Terminal Hostlers

Volume Slice	0	5	10	15	20
Tractors					
Quayside Operations					
Number of conventional QC	5	5	5	5	5
Performance conventional QC (cont./h)	35.68	35.68	35.68	35.68	35.68
Peak QC utilization	75%	75%	75%	75%	75%
Total quayside containers	134	134	134	134	134
Truck round trips per hour	6	6	6	6	6
Truck Quayside (numeric)	**22.30**	**22.30**	**22.30**	**22.30**	**22.30**
Inspection Operations					
Moves Inspection Area/day	8	16	24	28	28
Inspection moves/hour	0.34	0.67	1.01	1.18	1.17
Truck round trips per hour	4	4	4	4	4
Tractors inspection (numeric)	**0.09**	**0.17**	**0.25**	**0.29**	**0.29**
Truck for operation (numeric)	**22.38**	**22.47**	**22.55**	**22.61**	**22.61**
Availability	85%	85%	85%	85%	85%
Calculated Total Trucks	27	27	27	27	27
Manual adjustment	0	0	0	0	0
Total Trucks	**27**	**27**	**27**	**27**	**27**

Source: HPC, 2011

4.4.2.2 Terminal Chassis

The inventory for the terminal owned chassis (bombcarts) counts 26 devices.

Table 62: Requirements Truck Chassis

Volume Slice	0	5	10	15	20
Chassis					
Quayside Operations					
Chassis per truck quayside operation	1	1	1	1	1
Chassis quayside	**22.30**	**22.30**	**22.30**	**22.30**	**22.30**
Inspection Operations					
Chassis per truck inspection operation	1	1	1	1	1
Chassis inspection	**0.09**	**0.17**	**0.25**	**0.31**	**0.31**

Volume Slice	0	5	10	15	20
OOG Operations					
Annual OOG units (bx)	96	187	282	346	345
Percentage of chassis storage	10%	10%	10%	10%	10%
Dwell time	5.73	5.73	5.73	5.73	5.73
Days per year	365	365	365	365	365
Peak Factor	1.2	1.2	1.2	1.2	1.2
Chassis OOG Storage	**0.18**	**0.35**	**0.53**	**0.65**	**0.65**
Subtotal Chassis	**23**	**23**	**23**	**23**	**23**
Equipment Availability Chassis	90%	90%	90%	90%	90%
Calculated Total Chassis	26	26	26	26	26
Manual adjustment	0	0	0	0	0
Total Chassis	**26**	**26**	**26**	**26**	**26**

Source: HPC, 2011

4.4.3 Yard and Staging Area

4.4.3.1 Stacking Devices

According to the calculated volume slices the lifting requirements for the RTG devices have been determined. In the first slice the RTGs must be able to handle nearly 100,000 moves per year at the quayside only. This requirement grows to about 350,000 moves per year. At the landside the requirements vary between 170,000 moves and about 613,000 moves per year.

Table 63: Calculations of RTG Total Moves

Volume Slice	0	5	10	15	20
Yard Moves Quayside (container)					
Import full [box]	70,089	137,151	206,398	253,972	252,942
Export full [box]	25,512	49,922	75,128	92,444	92,069
Transhipment [box]	0	0	0	0	0
Productive Moves to Quayside [box]	95,601	187,074	281,526	346,416	345,011
Shuffle Import	0%	0%	0%	0%	0%
	0	0	0	0	0
Shuffle Export	5%	5%	5%	5%	5%
	1,276	2,496	3,756	4,622	4,603
Shuffle Transhipment	5%	5%	5%	5%	5%
	0	0	0	0	0
Unproductive Moves Quayside	1,276	2,496	3,756	4,622	4,603
Total Yard Moves Quayside	96,877	189,570	285,283	351,039	349,615
Yard Moves Landside					
Import Full [box]	70,089	137,151	206,398	253,972	252,942
Export Full [box]	25,512	49,922	75,128	92,444	92,069
Productive Moves Landside [box]	95,601	187,074	281,526	346,416	345,011
Shuffle Import	1	1	1	1	1
	70,089	137,151	206,398	253,972	252,942
Shuffle Export	0%	0%	0%	0%	0%
	0	0	0	0	0
Unproductive Moves Landside	70,089	137,151	206,398	253,972	252,942
Yard Moves Inspection					
Import Full	70,089	137,151	206,398	253,972	252,942
Inspection	2%	2%	2%	2%	2%
	2,804	5,486	8,256	10,159	10,118
Shuffle Import	1	1	1	1	1
	1,402	2,743	4,128	5,079	5,059
Inspection Moves Landside	4,205	8,229	12,384	15,238	15,177
Total Yard Moves Landside	169,895	332,454	500,309	615,627	613,130
Housekeeping Moves	20%	20%	20%	20%	20%
	53,354	104,405	157,118	193,333	192,549
Total RTG-Moves	320,126	626,429	942,710	1,159,998	1,155,293

Source: HPC, 2011

In summary this produces a total lift requirement between about 320,000 and 1.16M lifts per year.

Based on average handling volumes the number of required RTGs grows from four to 13 devices.

Table 64: RTG requirements by Handling Volumes

Volume Slice	0	5	10	15	20
Assumed average RTG Performance					
Quayside Operations [mvs/h]	20	20	20	20	20
Landside Operations [mvs/h]	13	13	13	13	13
Housekeeping [mvs/h]	13	13	13	13	13
Average Performance [mvs/h]	15.02	15.02	15.02	15.02	15.02
Required RTG Working h p.a.					
Quayside	4,780	9,354	14,076	17,321	17,251
Landside	7,677	15,023	22,608	27,820	27,707
Housekeeping	4,104	8,031	12,086	14,872	14,811
Total RTG Working hours p.a.	16,562	32,408	48,771	60,012	59,769
Assumed avg. RTG utilization (24/7)	65%	65%	65%	65%	65%
Days per year	361	361	361	361	361
Hours per day	24	24	24	24	24
Gross Annual average RTG working h	5,632	5,632	5,632	5,632	5,632
Equipment Availability	85%	85%	85%	85%	85%
Net Annual average RTG working h	4,787	4,787	4,787	4,787	4,787
Total Productive Moves per RTG p.a.	71,900	71,900	71,900	71,900	71,900
Calculated Number of RTGs by handling volumes	*3.46*	*6.77*	*10.19*	*12.54*	*12.49*
Calculated Number of RTGs by handling volumes	4	7	11	13	13
Manual adjustment	0	-1	-1	0	0
Number of RTGs by handling volumes	4	6	10	13	13

Source: HPC, 2011

Opposite to considerations on average volumes the peak performance results in a significantly higher count. Putting the quayside and landside requirements together the count of RTG devices, which should be deployed to the terminal, varies from nine to 16 lifting devices.

Table 65: RTG Requirements by Peak Performance

Volume Slice	0	5	10	15	20
Peak Performance Requirements Container Terminal					
Quayside					
Conventional quay cranes	5	5	5	5	5
Containers/h/conventional QC	35.68	35.68	35.68	35.68	35.68
Peak QC utilization	75%	75%	75%	75%	75%
Quayside containers/h	134	134	134	134	134
MT share	33%	33%	33%	33%	33%
MT percentage to full container yard	10%	10%	10%	10%	10%
Quayside container to full container yard in peak hour	94	94	94	94	94
Productivity quayside	20	20	20	20	20
RTGs quayside (numeric)	4.69	4.69	4.69	4.69	4.69
Landside					
Hourly landside moves	26	51	77	95	95
Import share on domestic container	73%	73%	73%	73%	73%
Import containers	19	38	57	70	69
Shuffling on import	1	1	1	1	1
Total landside container / peak hour	46	89	134	165	164
MT share	33%	33%	33%	33%	33%
MT percentage to full container yard	10%	10%	10%	10%	10%
Landside container to full container yard in peak hour	32	62	94	116	115
Productivity landside	13	13	13	13	13
RTGs landside (numeric)	2.45	4.80	7.23	8.89	8.86
Total numeric RTGs	7.14	9.49	11.92	13.58	13.54
Availability	85%	85%	85%	85%	85%
Total RTG requirements	9	12	15	16	16
RTGs to be employed	9	12	15	16	16

Source: HPC, 2011

4.4.3.2 Standard Dry

The calculation to determine the number of required static slots result in the first volume slice nearly 3,700 TEU. This amount rises to about 14,300 TEU slots in the final slice.

Table 66: Slot requirements for dry container yard

Volume Slice	0	5	10	15	20
Full Container Yard (incl. Reefer)					
Total TEUs	*155,558*	*319,272*	*487,834*	*604,785*	*605,020*
Full Import (TEU)	108,638	222,972	340,692	422,368	422,531
Dwell Time (days)	*5.40*	*5.40*	*5.40*	*5.40*	*5.40*
Full Export (TEU)	39,544	81,160	124,010	153,739	153,799
Dwell Time (days)	*5.68*	*5.68*	*5.68*	*5.68*	*5.68*
Full Transhipment (TEU)	0	0	0	0	0
Dwell Time (days)	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Percentage of MTs in full container yard	*10%*	*10%*	*10%*	*10%*	*10%*
MTs Full Cont. Yard	7,376	15,140	23,133	28,678	28,690
Dwell Time (days)	*10.84*	*10.84*	*10.84*	*10.84*	*10.84*
Avg. Dwell Time Full Cont. Yard	***5.73***	***5.73***	***5.73***	***5.73***	***5.73***
Peak Factor	1.2	1.2	1.2	1.2	1.2
Operational to static slot conversion	89%	89%	89%	89%	89%
Max. Yard Utilization	90%	90%	90%	90%	90%
Days per Year	365	365	365	365	365
Slots Import	*2,420*	*4,966*	*7,588*	*9,407*	*9,411*
Slots Export	*926*	*1,900*	*2,904*	*3,600*	*3,601*
Slots Transhipment	*0*	*0*	*0*	*0*	*0*
Slots MT Domestic	*330*	*677*	*1,034*	*1,282*	*1,283*
No. of Slots by Traffic Forecast	**3,675**	**7,543**	**11,526**	**14,289**	**14,294**

Source: HPC, 2011

In comparison to the numbers from the drawn layout, which are shown in the table below, the total slot requirements for dry containers and reefers will not be fulfilled. The layout provides a total number of 13,560 TEU slots for dry containers and reefers. The requirement for static slots demands a higher volume beginning in slice 13 with 13,915 TEU.

Table 67: Slot capacities dry container final build-out

Sections	Reefer Plugs	Ground Slots (TEU) Dry	Ground Slots (TEU) Reef		Max Capacity (TEU) Dry	Max Capacity (TEU) Reef	
A	772	270	386		1,350	1,544	
B	924	672	462		3,360	1,848	
C	464	594	232		2,970	928	
D	0	312	0		1,560	0	
Sum	**2,160**	**1,848**	**+ 1,080**	**= 2,928**	**9,240**	**+ 4,320**	**= 13,560**

Source: HPC, 2011

4.4.3.3 Reefer Operations

A detailed view on the reefer operations shows a requirement of nearly 3,000 TEU reefer slots in the final slice and about 1,900 plugs.

Table 68: Slot requirements for reefer racks

Volume Slice	0	5	10	15	20
Reefer Slots					
Reefer percentage	21%	21%	21%	21%	21%
Total reefer TEU annually	32,140	65,964	100,791	124,954	125,002
avg. dwell time (see full cont. yard)	5.73	5.73	5.73	5.73	5.73
Peak Factor	1.2	1.2	1.2	1.2	1.2
Avg. Yard Utilization	80%	80%	80%	80%	80%
Days per Year	365	365	365	365	365
No. of Reefer Slots	**760**	**1,559**	**2,382**	**2,953**	**2,954**
TEU Factor	1.6	1.6	1.6	1.6	1.6
No. of Reefer Plugs	**491**	**1,006**	**1,537**	**1,906**	**1,906**
Height of Reefer Rack	4	4	4	4	4
Width of Reefer Rack	6.5	6.5	6.5	6.5	6.5
No. of Reefer Racks	**19**	**39**	**60**	**74**	**74**

Source: HPC, 2011

The proposed terminal layout in this alternative covers the above mentioned reefer requirements. It provides 2,160 reefer plugs and a maximum capacity of 4,320 TEU static slots.

Table 69: Slot capacities reefer container final build-out

Sections	Reefer Plugs	Ground Slots (TEU) Reef	Max Capacity (TEU) Reef
A	772	386	1,544
B	924	462	1,848
C	464	232	928
D	0	0	0
Sum	**2,160**	**1,080**	**4,320**

Source: HPC, 2011

4.4.3.4 MT Operations

Empty container volumes also increase throughout the scenario. From the first slice until slices 15 the volumes are growing step by step. Due to capacity limitations the empty volumes remain static. The capacity is limited to about 11,500 TEU slots.

Table 70: Slot requirements for MT container blocks

Volume Slice	0	5	10	15	20
MT Cont. Yard					
MT Domestic	66,388	136,257	208,195	258,106	258,206
Dwell Time (days)	*10.84*	*10.84*	*10.84*	*10.84*	*10.84*
Peak Factor	1.2	1.2	1.2	1.2	1.2
Max. Yard Utilization	80%	80%	80%	80%	80%
Stacking height	6	6	6	6	6
Days per Year	365	365	365	365	365
No. of Slots	**2,957**	**6,070**	**9,275**	**11,498**	**11,503**
No. of Ground Slot	**493**	**1,012**	**1,546**	**1,916**	**1,917**

Source: HPC, 2011

The terminal layout supports a maximum capacity for empty containers of about 13,000 TEU slots. This number covers the requirements in volume slices.

Table 71: Slot capacities MT container final build-out

Sections	Ground Slots (TEU) MT	Max Capacity (TEU) MT
A	646	2,902
B	1,322	6,677
C	384	1,728
D	376	1,692
Sum	**2,728**	**12,999**

Source: HPC, 2011

4.4.4 Gate

Since the FastShip throughput for the mInt option is the same as the aTnT and mTnT options, the FastShip dedicated gate results are the same. The conventional throughput is slightly higher for the mInt option, so more conventional gate lanes are required.

The assumptions and calculations presented in Section 2 were used to generate the results shown in Table 72 below, for the fully built out conventional terminal with a manual integrated FastShip terminal. As stated in Section 2, the FastShip gate lanes will be dedicated to FastShip only, and Packer Avenue will have one dedicated FastShip lane into PAMT, and one dedicated lane out.

It should be noted that the gate calculations for the conventional cargo assume a 10 hour working day as exists today. The number of conventional gate lanes could be reduced should the operator decide to extend the gate hours. FastShip dedicated gates will be required to be staffed 24 hours a day when a FastShip is at port in order to meet the load out

requirements. When there is no FastShip at port, the dedicated FastShip lanes can be closed or used to alleviate conventional gate queuing.

Table 72: FastShip mInt Gate Results Summary

Infrastructure	Number	Unit
In-Gate		
Conventional Security Lanes	2	Lanes
Conventional OCR Lanes	2	Lanes
Conventional Pedestals and Weigh Scales	12	Lanes
Conventional Queue Space	32	Truck Lengths
FastShip Security Lanes	1	Lane
FastShip OCR Lanes	1	Lane
FastShip Pedestals and Weigh Scales	5	Lanes
FastShip Queue Space	16	Truck Lengths
Out-Gate		
Conventional RPM Lanes	2	Lanes
Conventional OCR Lanes	2	Lanes
Conventional Pedestals	8	Lanes
Conventional Security Lanes	2	Lanes
Conventional Queue Space	10	Trucks Lengths
FastShip RPM Lanes	1	Lanes
FastShip OCR Lanes	1	Lanes
FastShip Pedestals	4	Lanes
FastShip Security Lanes	1	Lanes
FastShip Queue Space	5	Trucks Lengths
General Gate Structure		
Acreage	12.7	Acres
Total PAMT Lanes	5	Lanes
FastShip PAMT Dedicated Lanes (Each Way)	1	Lane

Source: Halcrow, 2011

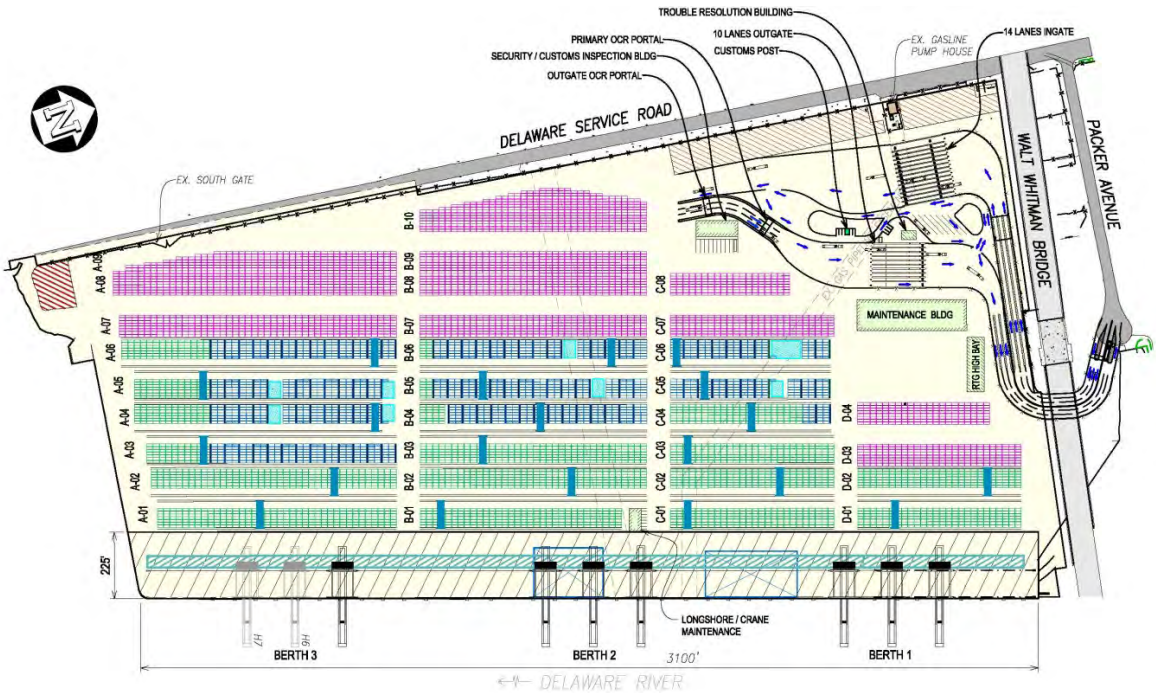
5. TERMINAL LAYOUT

Four different full build-out configurations have been developed for this final deliverable. The first full build-out configuration depicts a modern conventional container terminal utilizing updated quay cranes for ship loading and unloading operations as well as rubber tired gantry cranes for yard operations. The second full build-out configuration depicts an automated terminal for FastShip within the conventional container terminal. The third full build-out configuration depicts a manual terminal for FastShip within the conventional container terminal. The fourth full build-out option depicts a manual terminal for FastShip integrated into the conventional container terminal.

5.1 Conventional Containers Conventional Containers

This full build-out configuration details the conversion of the Packer Avenue Marine Terminal into a fully modernized conventional container terminal.

Figure 14: Conventional Container Terminal – Full Build-Out

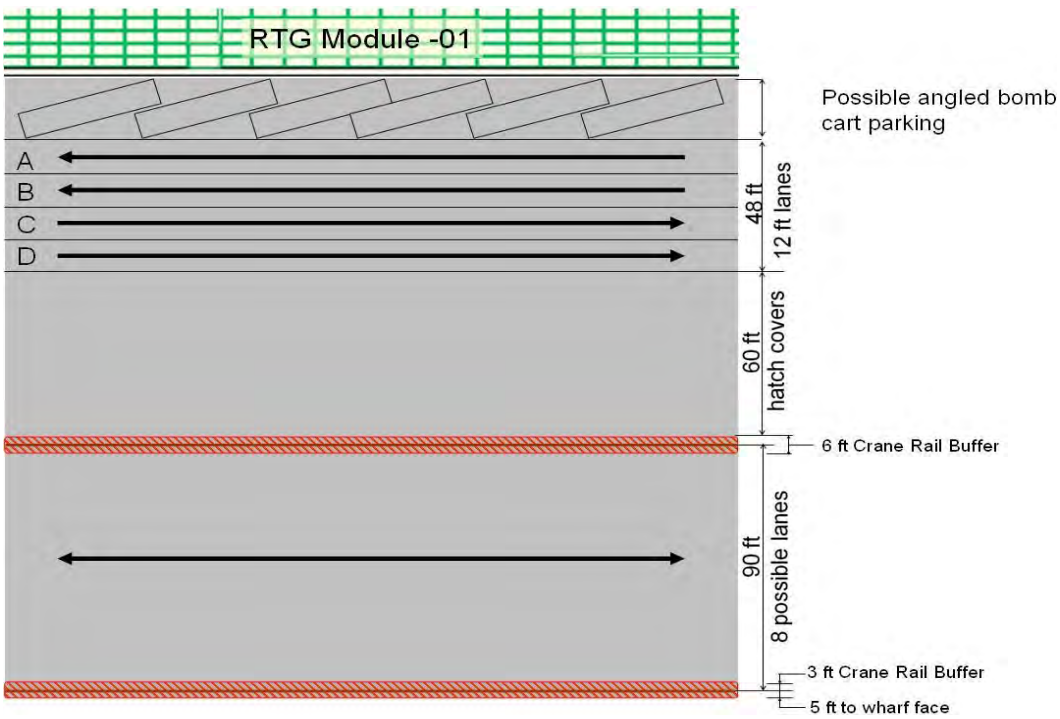


Source: TEC, 2011

5.1.1 Quay

The quay for the container terminal has a total berth length of 3100' and can load and unload three of the larger modern container ships simultaneously with three upgraded quay cranes per berth. The concrete deck of the quay has a 225' wide laydown area. The 90' span beneath the quay cranes from rail center to rail center can be used for up to 8 truck lanes.

Figure 15: Conventional Container Terminal – General Quay Layout



Source: HPC, 2011

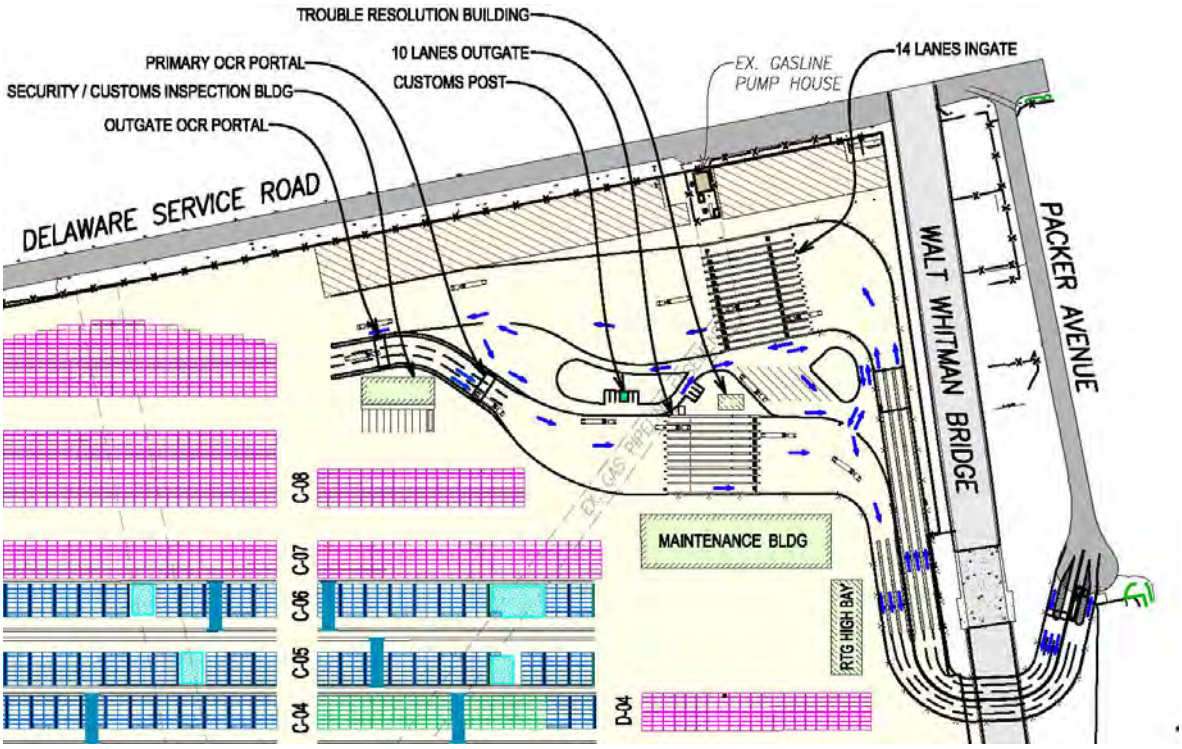
5.1.2 Yard

The conventional container yard consists of approximately 60 acres of concrete pavement divided into four modules. Each module is serviced by rubber tired gantry cranes and houses varying numbers of ground slots for import and export containers as well as reefers and empty containers.

5.1.3 Gate

Access to the facility is through Packer Avenue with three lanes of traffic inbound to the gate facility and three lanes of traffic outbound from the gate facility. At full build-out the inbound gate will have fourteen lanes and the outbound gate ten lanes.

Figure 16: Conventional Container Terminal – Gate Flow

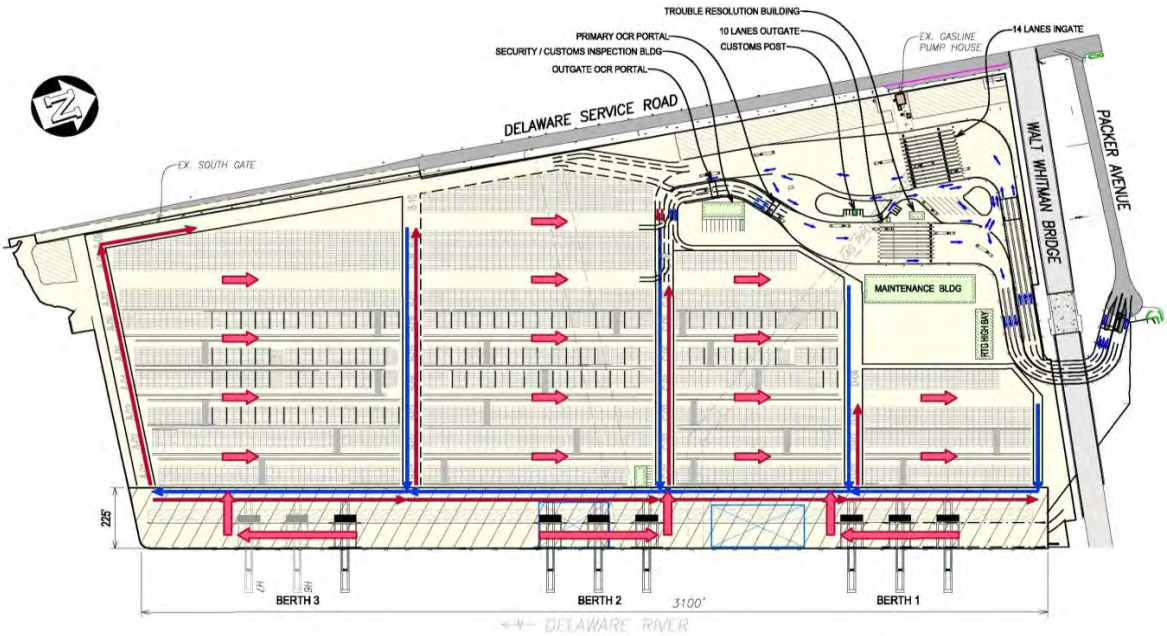


Source: Halcrow, 2011

5.1.4 Traffic Flow

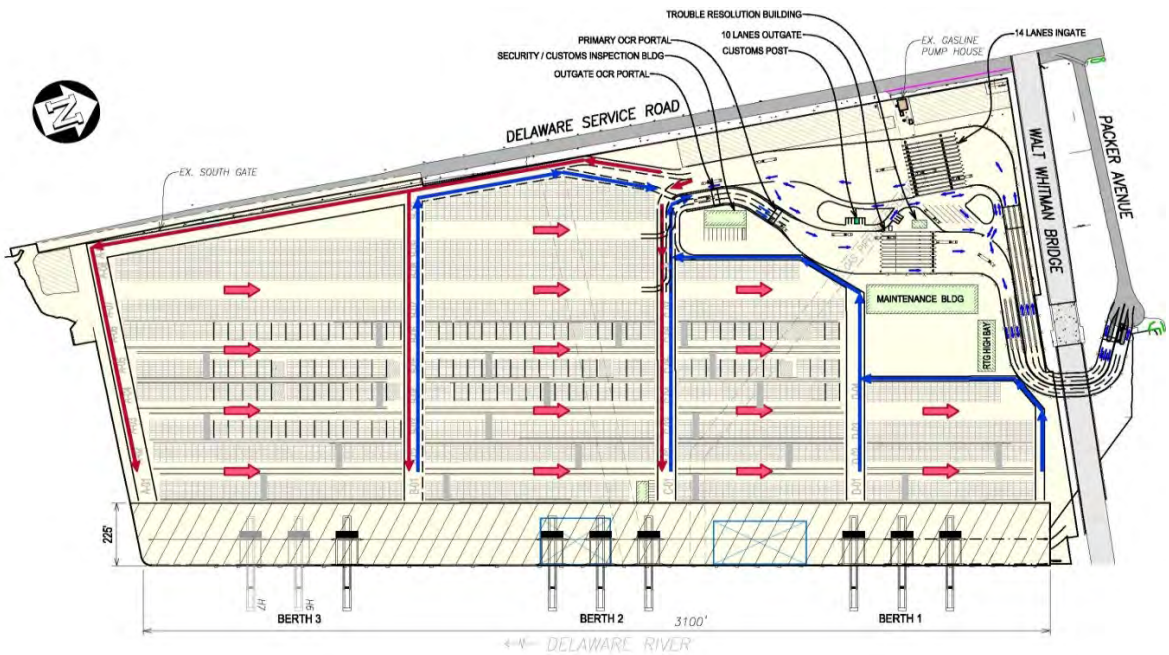
The yard area of the container terminal has been laid out to allow for truck traffic to flow counterclockwise around each module. The trucks will enter through the inbound gate, proceed to one of the four modules and head between the stacks of containers to receive their load from the rubber tired gantry cranes. The trucks will then complete the counterclockwise loop and proceed to the outbound gate.

Figure 17: Conventional Container Terminal – Internal Traffic Flow



Source: Halcrow, 2011

Figure 18: Conventional Container Terminal – External Traffic Flow



Source: Halcrow, 2011

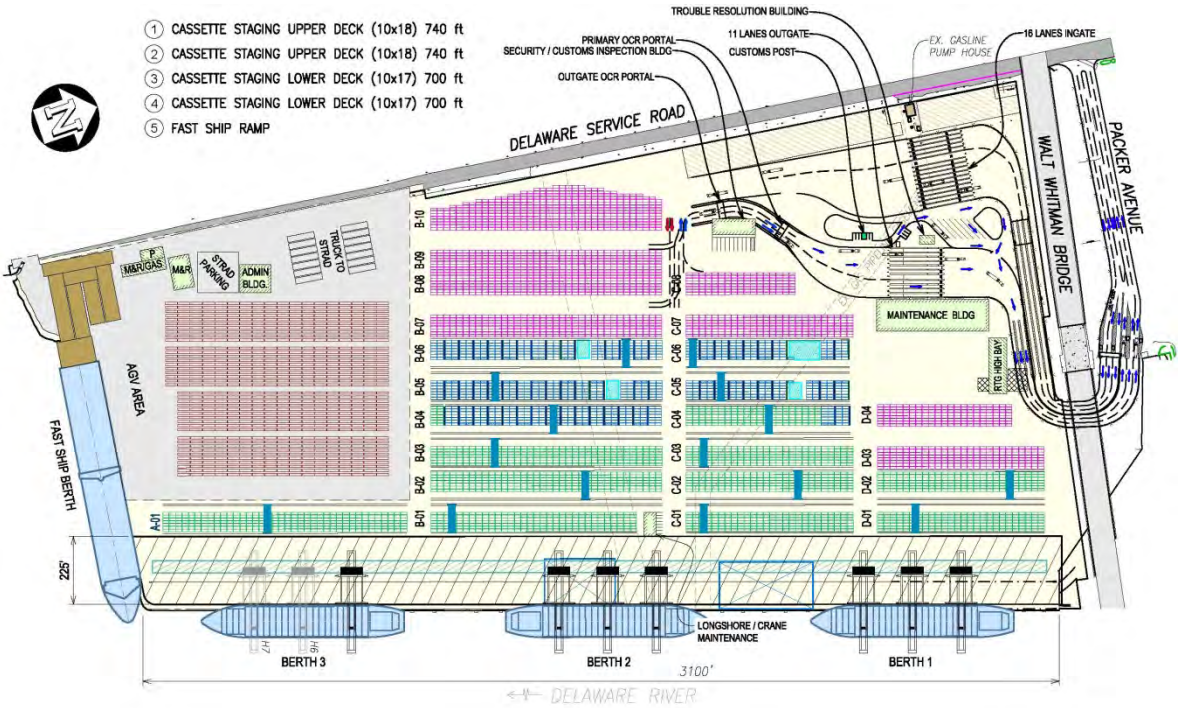
5.1.5 Buildings

The full build-out configuration of the modernized conventional container terminal includes the removal of the existing maintenance building, refrigerated warehouses, customs radiation scanning portal, and gate complex. The full build-out configuration includes the addition of a maintenance building, a security/customs inspection building, a trouble resolution building, a quay crane maintenance building and an RTG high bay in the shared areas.

5.2 Automated Terminal in Terminal FastShip

This full build-out configuration details the conversion of the Packer Avenue Marine Terminal into a fully modernized conventional container terminal that includes an automated terminal for FastShip within the conventional container terminal.

Figure 19: Automated Terminal in Terminal FastShip



Source: TEC, 2011

5.2.1 Quay

The quay for the container portion of the terminal has a total berth length of 3,100-ft and can load and unload three of the larger modern container ships simultaneously with three

upgraded quay cranes per berth. The concrete deck of the quay has a 225-ft wide laydown area. The 90-ft span beneath the quay cranes from rail center to rail center can be used for up to 8 truck lanes.

The quay of the self-contained automated FastShip terminal has one berth sized to house a FastShip and includes a FastShip ramp.

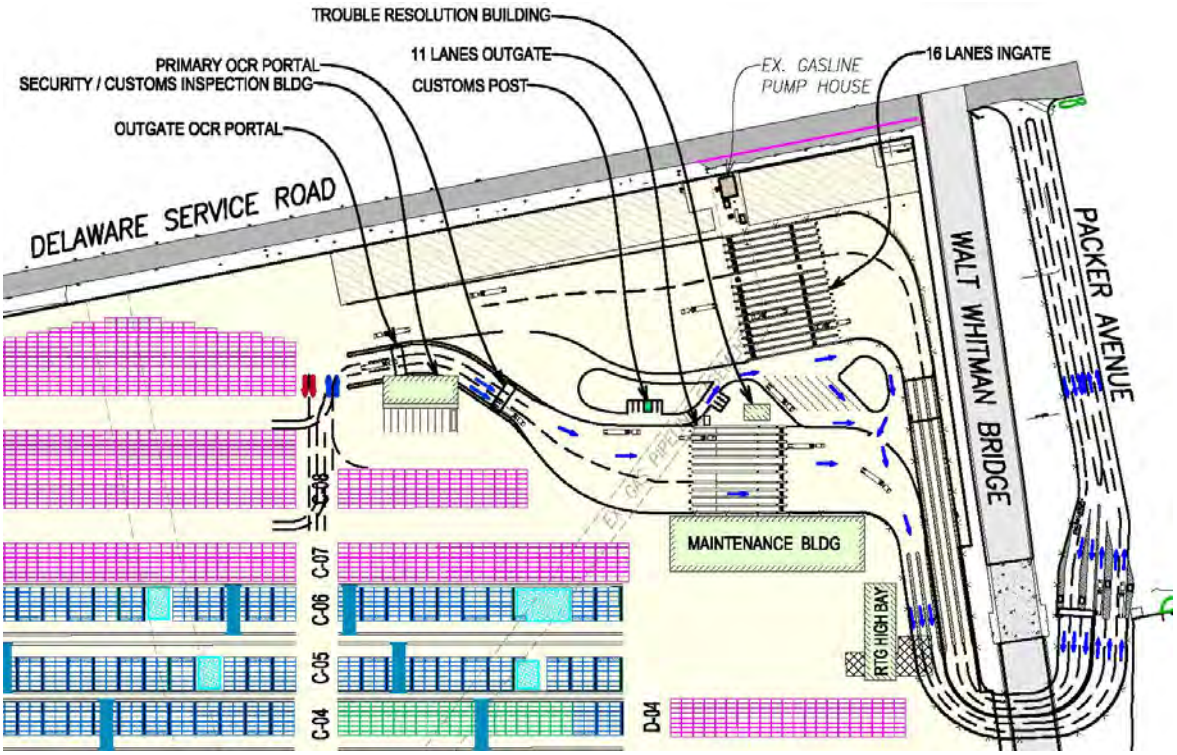
5.2.2 Yard

The conventional container yard consists of approximately 45 acres of concrete pavement divided into four modules. Each module is serviced by rubber tired gantry cranes and houses varying numbers of ground slots for import and export containers as well as reefers and empty containers. The automated FastShip terminal yard consists of approximately 15 acres of concrete pavement utilized by AGV's to move cassettes from the FastShip to the terminal and from the terminal to the FastShip.

5.2.3 Gate

Access to the facility is through Packer Avenue with three lanes of traffic inbound to the gate facility and three lanes of traffic outbound from the gate facility. At full build-out the inbound gate will have sixteen lanes and the outbound gate eleven lanes.

Figure 20: Automated Terminal in Terminal FastShip – Gate Flow



Source: Halcrow, 2011

5.2.4 Traffic Flow

The yard area of the container terminal has been laid out to allow for truck traffic to flow counterclockwise around each module. The trucks will enter through the inbound gate, proceed to one of the four modules and head between the stacks of containers to receive their load from the rubber tired gantry cranes. The trucks will then complete the counterclockwise loop and proceed to the outbound gate. Within the FastShip terminal, trucks will not have access to the AGV area and will be required to park at the northwestern corner of the terminal to receive and unload their cargo. Once there, the SC will unload the cassettes onto the trucks or unload the trucks onto the cassettes. The trucks can then exit the FastShip terminal between container stacks B9 and 10 and proceed to the outbound gate or head back into the container stacks of Modules A-D to pick up a conventional container load before exiting PAMT.

5.2.5 Buildings

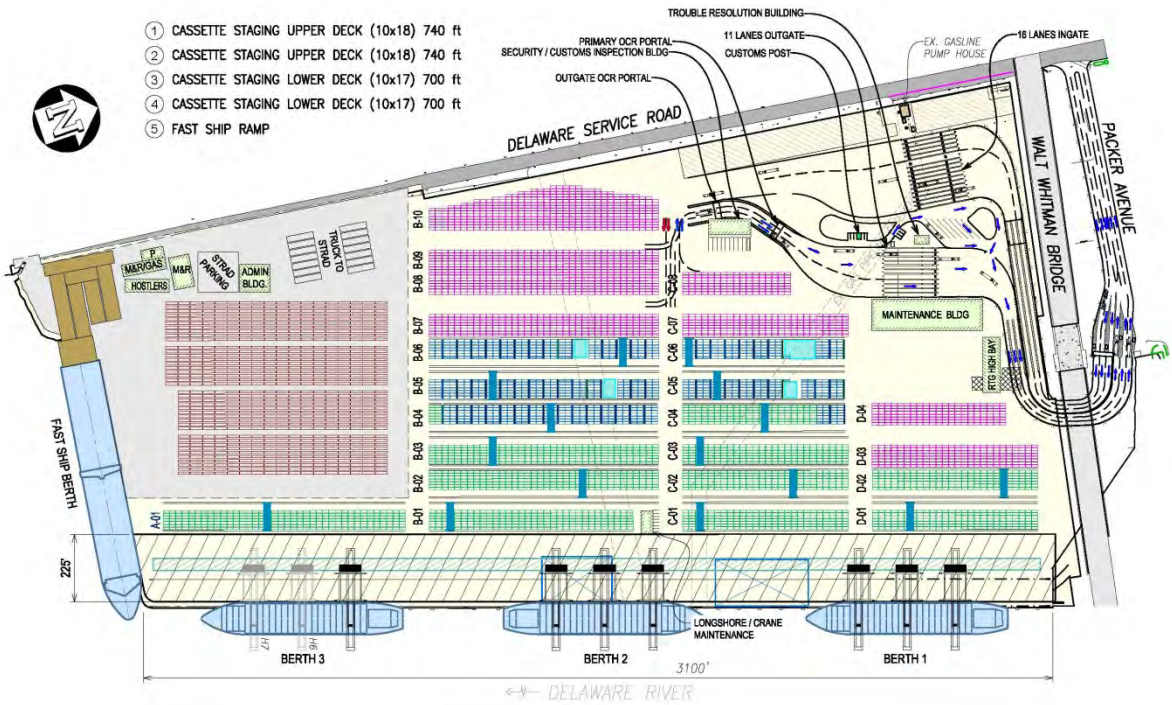
The full build-out configuration includes the addition of a maintenance building, a security/customs inspection building, a trouble resolution building, a quay crane

maintenance building and an RTG high bay in the shared areas. The FastShip terminal will receive an administration building as well as a maintenance building and a fueling station.

5.3 Manual Terminal in Terminal FastShip

This full build-out configuration details the conversion of the Packer Avenue Marine Terminal into a fully modernized conventional container terminal that includes a manually unloaded terminal for FastShip within the conventional container terminal.

Figure 21: Manual Terminal in Terminal FastShip



Source: TEC, 2011

5.3.1 Quay

The quay for the container terminal has a total berth length of 3,100-ft and can load and unload three of the larger modern container ships simultaneously with three upgraded quay cranes per berth. The concrete deck of the quay has a 225-ft wide laydown area. The 90' span beneath the quay cranes from rail center to rail center can be used for up to 8 truck lanes.

The quay of the self-contained manually unloaded FastShip terminal has one berth sized to house a FastShip and includes a FastShip ramp.

5.3.2 Yard

The conventional container yard consists of approximately 60 acres of concrete pavement divided into four modules. Each module is serviced by rubber tired gantry cranes and houses varying numbers of ground slots for import and export containers as well as reefers and empty containers. The self-contained manually unloaded FastShip terminal yard consists of approximately 15 acres of concrete pavement utilized by hostlers to move cassettes from the FastShip to the terminal and from the terminal to the FastShip.

5.3.3 Gate

The gate for this layout is the same as in Section 5.2.3 because both the conventional and FastShip throughout are the same.

5.3.4 Traffic Flow

The yard area of the container terminal has been laid out to allow for truck traffic to flow counterclockwise around each module. The trucks will enter through the inbound gate, proceed to one of the four modules and head between the stacks of containers to receive their load from the rubber tired gantry cranes. The trucks will then complete the counterclockwise loop and proceed to the outbound gate. Within the FastShip terminal, trucks will not have access to the hostler clearing area and will be required to park at the northwestern corner of the terminal to receive and unload their cargo. Once there, the SC will unload the cassettes onto the trucks or unload the trucks onto the cassettes. The trucks can then exit the FastShip terminal between container stacks B9 and 10 and proceed to the outbound gate or head back into the container stacks of Modules A-D to pick up a conventional container load before exiting PAMT.

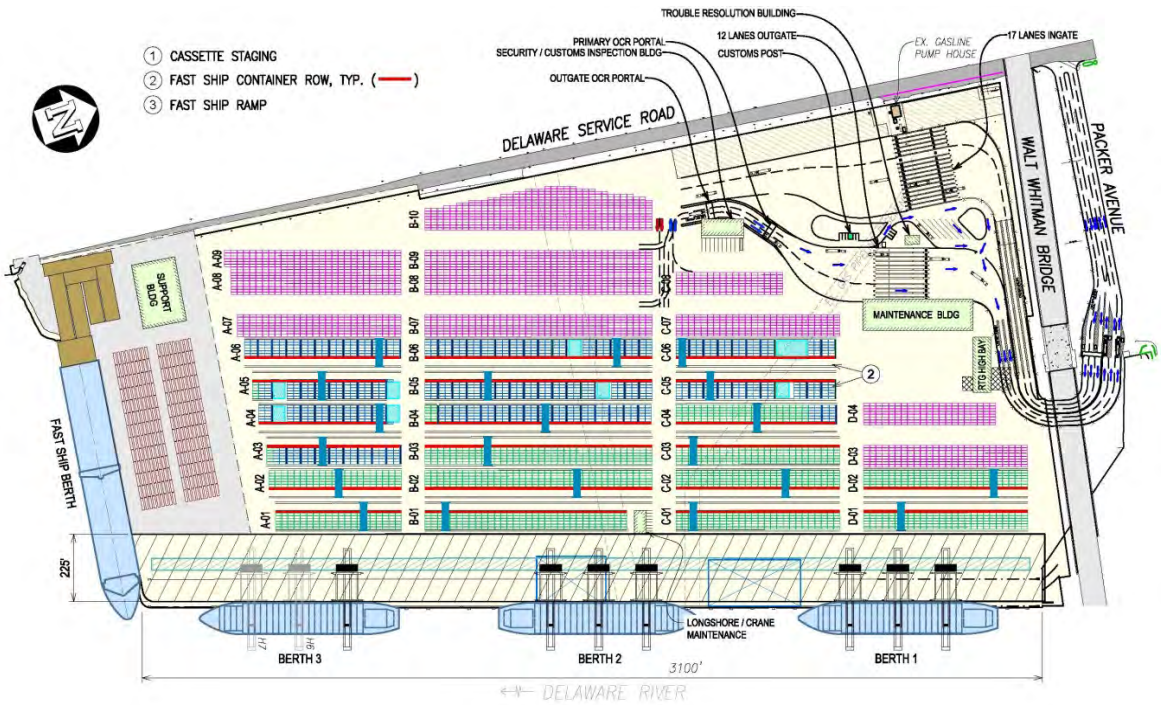
5.3.5 Buildings

The full build-out configuration includes the addition of a maintenance building, a security/customs inspection building, a trouble resolution building, a quay crane maintenance building and an RTG high bay in the shared areas. The FastShip terminal will receive an administration building as well as a maintenance building and a fueling station.

5.4 Manual Integrated FastShip

This full build-out configuration details the conversion of the Packer Avenue Marine Terminal into a fully modernized conventional container terminal integrated with a manually unloaded terminal for FastShip.

Figure 22: Manual Integrated FastShip



Source: TEC, 2011

5.4.1 Quay

The quay for the container terminal has a total berth length of 3,100-ft and can load and unload three of the larger modern container ships simultaneously with three upgraded quay cranes per berth. The concrete deck of the quay has a 225-ft wide laydown area. The 90-ft span beneath the quay cranes from rail center to rail center can be used for up to 8 truck lanes.

The integrated and manually unloaded FastShip terminal has one berth sized to house a FastShip and includes a FastShip ramp.

5.4.2 Yard

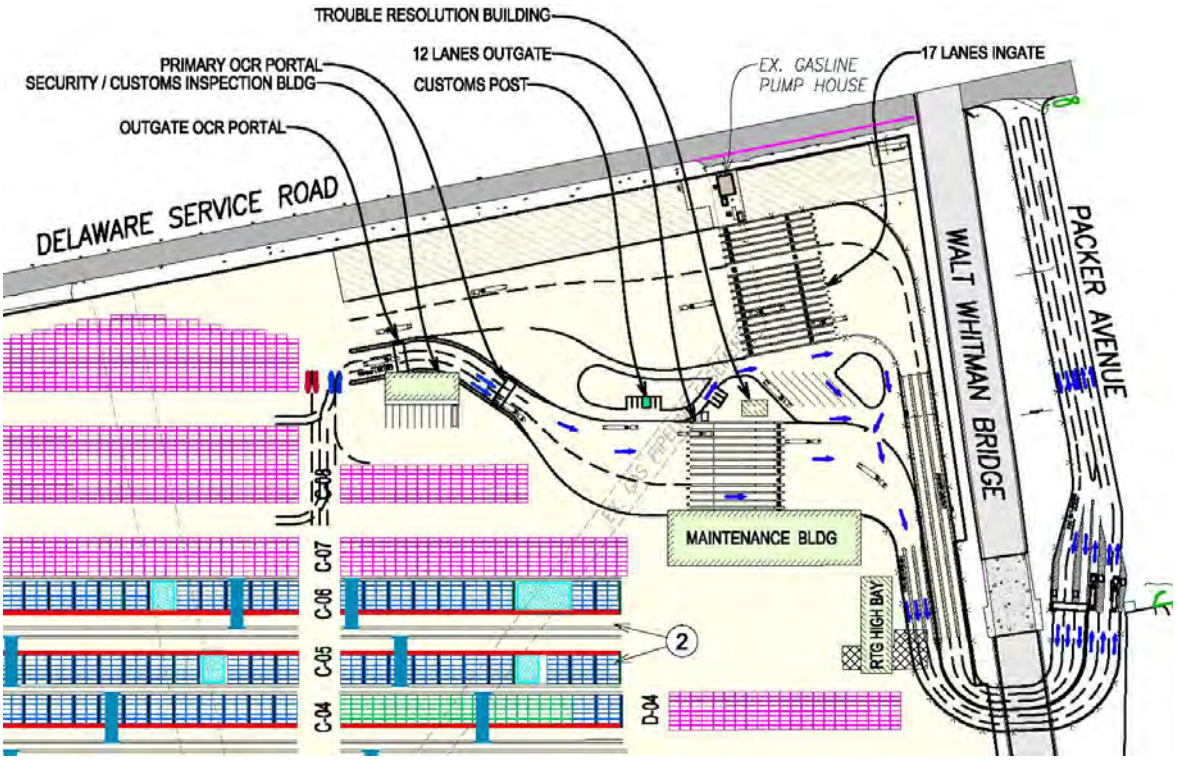
The conventional container yard consists of approximately 45 acres of concrete pavement divided into four modules. Each module is serviced by rubber tired gantry cranes and houses varying numbers of ground slots for import and export containers as well as reefers and empty containers. The manually unloaded FastShip terminal yard consists of approximately 15 acres of concrete pavement utilized by hostlers to move cassettes from the FastShip to the terminal and from the terminal to the FastShip. The FastShip terminal is

integrated into the conventional container terminal as ground slots are available near the rubber tire gantry cranes for cargo from the FastShip instead of within the self-contained manually unloaded FastShip terminal as detailed in Section 5.3.

5.4.3 Gate

Access to the facility is through Packer Avenue with three lanes of traffic inbound to the gate facility and three lanes of traffic outbound from the gate facility. At full build-out the inbound gate will have seventeen lanes and the outbound gate twelve lanes.

Figure 23: Manually Integrated Terminal FastShip – Gate Flow



Source: Halcrow, 2011

5.4.4 Traffic Flow

The yard area of the container terminal has been laid out to allow for truck traffic to flow counterclockwise around each module. The trucks will enter through the inbound gate, proceed to one of the four modules and head between the stacks of containers to receive their load from the rubber tired gantry cranes. The trucks will then complete the counterclockwise loop and proceed to the outbound gate.

5.4.5 Buildings

The full build-out configuration includes the addition of a maintenance building, a security/customs inspection building, a trouble resolution building, a quay crane maintenance building and an RTG high bay in the shared areas. The manually integrated FastShip terminal will receive a support building.

5.5 Shared Areas

5.5.1 Customs Inspection Area

A building with associated parking has been provided for security, customs and inspection of cargo containers near the gate complex. It will be built in Phase 1 when the gate complex is upgraded near the end of construction of Section B.

5.5.2 Buildings

The full build-out configuration includes the addition of a maintenance building, a security/customs inspection building, a trouble resolution building, a quay crane maintenance building and an RTG high bay in the shared areas.

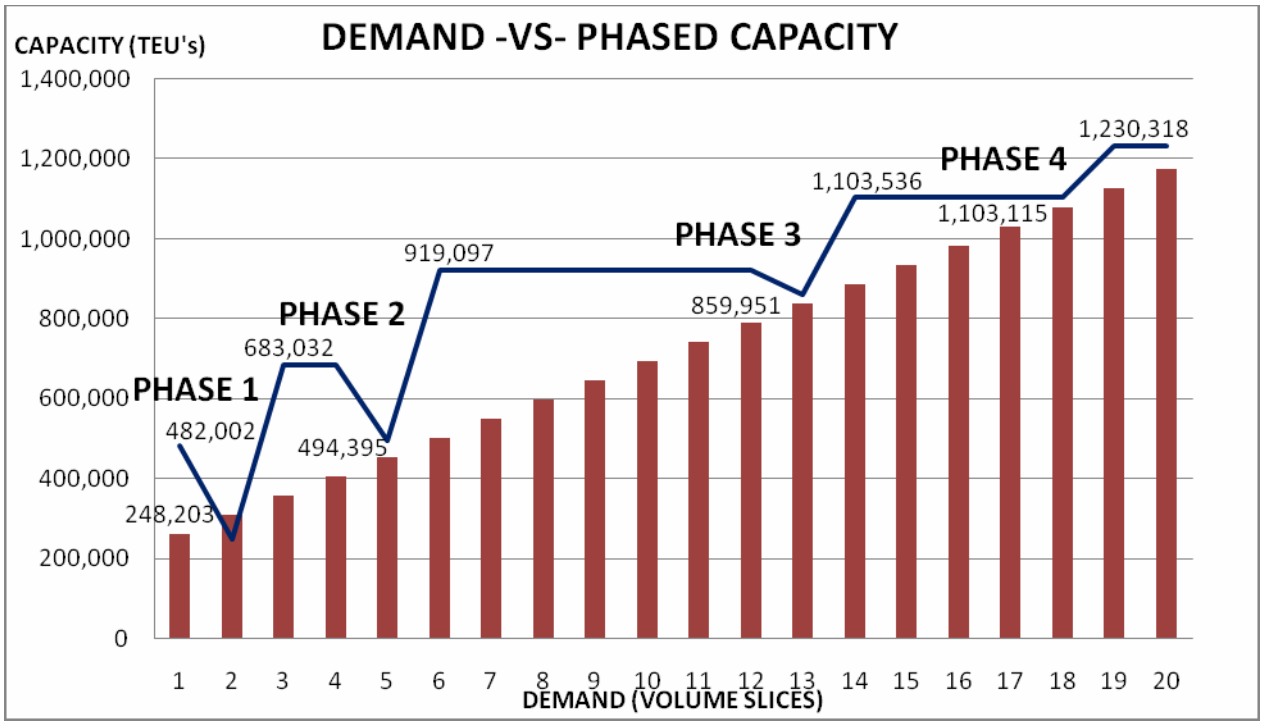
6. TRANSITION PLAN

6.1 Conventional Transition Plan

The conversion of PAMT into a modern conventional container terminal, while allowing it to stay open for business, requires that construction is performed in phases and timed properly so as to have sufficient yard and reefer capacity at the terminal during construction to meet forecasted demand. In lieu of an actual forecasted future demand, incrementally increasing volume slices have been used to determine future demand without a specified target date.

The table below shows the volume slices indicating a steady increase in demand over a period of time plotted versus the yard capacity from existing conditions through the varying phases of construction until the ultimate conversion into a modern conventional container terminal.

Figure 24: Demand versus Annual Phased Yard Capacity



From the Figure above, if construction of Phase 1 started today, the yard capacity of PAMT during construction would be about the same as the current demand, volume slice 1. This indicates that construction of Phase 1 should begin soon.

The table below shows the total annual yard and reefer capacities throughout the various phases of development of the terminal into a modern conventional container terminal.

Table 73: Annual Yard and Reefer Capacities By Phase

Phase	Total Yard Capacity (TEU/yr)	Reefer Capacity (TEU/yr)
Existing	482,002	25,156
During Construction of Phase 1	248,203	20,318
Phase 1 Complete (B)	683,032	112,191
During Construction of Phase 2	494,395	95,154
Phase 1 Complete (B+A)	919,097	204,863
During Construction of Phase 3	859,951	202,003
Phase 1 Complete (B+A+C)	1,103,536	248,108
During Construction of Phase 4	1,103,115	247,687
Phase 1 Complete (B+A+C+D)	1,230,318	247,687

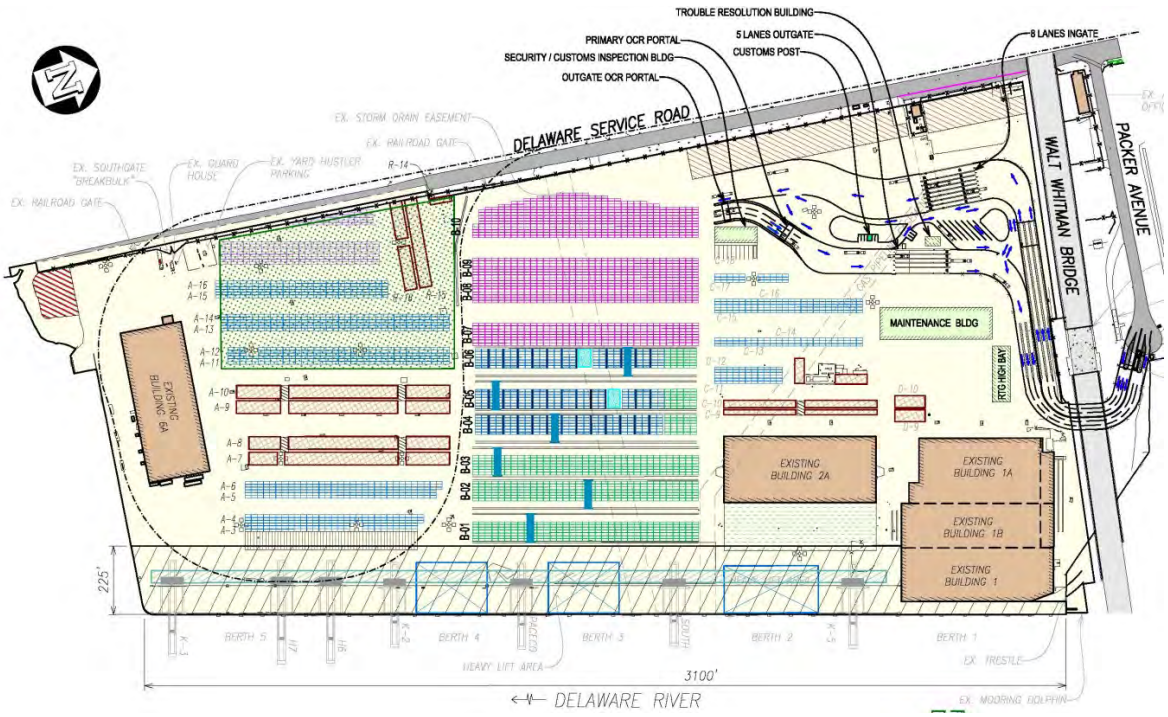
As determined in previous deliverables, the conversion of PAMT into a modern conventional container terminal will begin with the re-construction of Module B. This section of PAMT is a logical starting point for construction as there are no existing refrigerated warehouses to be removed. The existing annual reefer capacity at PAMT is 25,156 TEU. During construction of Phase 1, the annual reefer capacity would dip to 20,318 TEU. After construction of Phase 1 the annual reefer capacity would be 112,191 TEU. Due to the quantity of reefer plugs to be constructed in Section B, the terminal will have sufficient reefer capacity during construction of the subsequent phases when the large refrigerated warehouses are removed.

6.1.1 Existing Gate Operations

As discussed in Section 3.1, the existing gate structure and processes can accommodate 350,000 TEU annually. With the modifications discussed in that section, the existing gate infrastructure could process up to 450,000 TEU annually. For a throughput beyond that, a new gate system will be required. Section 2.1 discusses the processes of the proposed gate system.

6.1.2 Phase 1 – Module B

Figure 25: Phase 1 – Module B



Source: TEC, 2011

The conversion of PAMT into a modern conventional container terminal will begin with the re-construction of Module B. The existing annual yard capacity at PAMT is 482,002 TEU. During construction of Phase 1, the annual yard capacity would dip to 248,203 TEU. After construction of Phase 1 the annual yard capacity would be 683,032 TEU.

Construction work in this phase would entail the reconstruction of the existing uneven paved yard area which would allow for greater stacking heights of the dry and reefer containers. Rubber tired gantry cranes will be installed to obtain greater stacking heights of the dry and reefer containers in the yard. The MT containers will continue to be stacked 6 high.

Construction of this phase would remove 115 ground slots for reefers stacked 1 high and replace them with 546 ground slots for reefers stacked 4 high. This increase in reefer capacity will be used to service the refrigerated containers that will be displaced when the refrigerated warehouses are removed in Phases 3 and 4.

Removal and re-construction of the gate complex will be required when the yard capacity grows to 450,000 TEU per year near the end of Phase 1. The re-construction will require the removal of the existing customs radiation scanning portal as well as the existing vehicle service building. The 20' chassis storage area will be removed as well as a portion of the 40' and 45' chassis storage areas. New buildings constructed for this phase will include the addition of a maintenance building, a security/customs inspection building, an outgate OCR portal, a trouble resolution building, and an RTG high bay in the shared areas.

6.1.2.1 Phase 1 – Gate

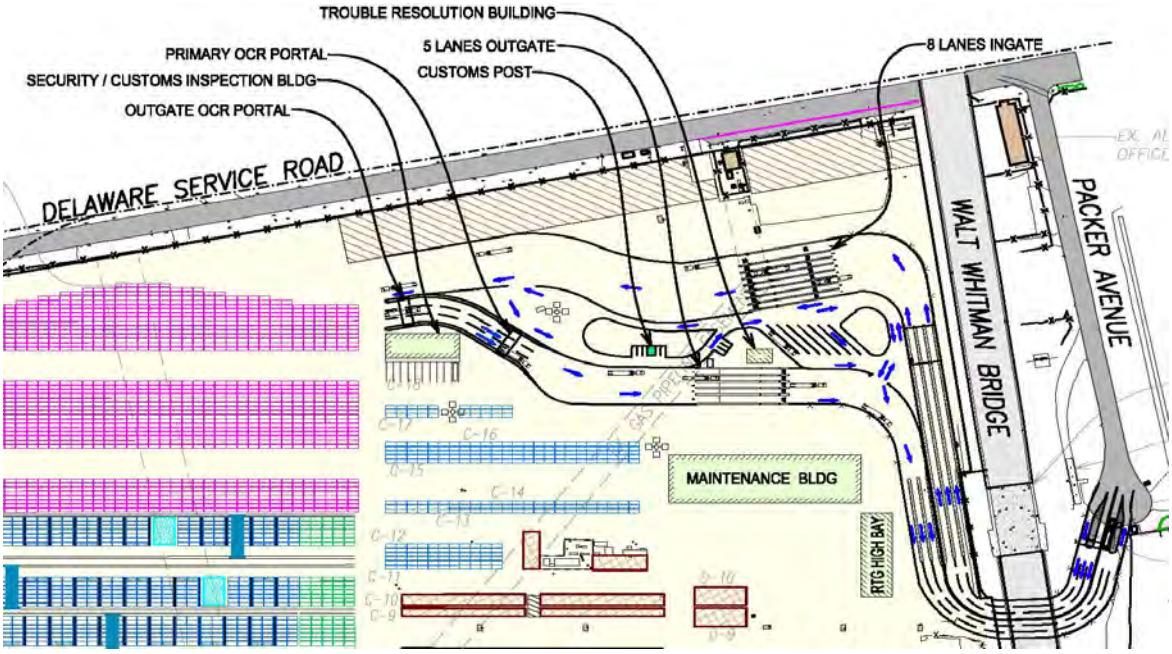
In this phase, the yard section B would be densified into RTG stacks while initially keeping the existing gate infrastructure. Due to the fact that the new stacks will not immediately increase the throughput to the full 683,000 TEU per year, the exiting gate can remain in use until the throughput reached about 450,000 TEU per year if the modifications described in Section 3.1 are implemented. As section B begins to fill up, the new gate will have to be implemented.

However, it is important to note that the gate would need to be upgraded prior to the terminal reaching approximately 450,000 TEU per year so that when existing gate infrastructure is taken offline during construction, throughput will not exceed the reduced capacity. The trigger for such a decision and forward planning in advance could be made following a change in the market or inclusion of a new carrier. During construction, temporary gates may be required as the new gate is in the same location as the existing gates. The existing rail gate could be used as a temporary in gate, and the south gate could be used as a temporary out gate. A weigh scale would be required at the temporary gate and some yard space adjacent to the temporary gates may be required for gate processes.

When section B is built out, 8 new in gate lanes and 6 out gate lanes will be required. The layout should be such that as the phasing continues, it is easy to expand the gate by adding additional in and out lanes. Therefore, the plan is such that space has been allocated for the gate to be built out to the size required by FastShip. The Phase 1 gate layout, as illustrated below in Figure 26, is the same as the final build-out but with fewer lanes.

It is recommended that all the civil construction work required for the Fast-Ship-sized gate be completed at this stage. While fewer pedestal lanes are required for Phase 1, the cost premium to build all lanes and place empty conduits for future expansion is significantly less than the cost will be to remobilize a contractor later in the expansion process. Therefore, civil work such as curbs, conduits, paving, striping, camera bridges, and fencing be installed at this stage. Then, in later stages, PRPA can install pedestals, cameras, scales, and other gate specific infrastructure as required by the throughput and transition plan.

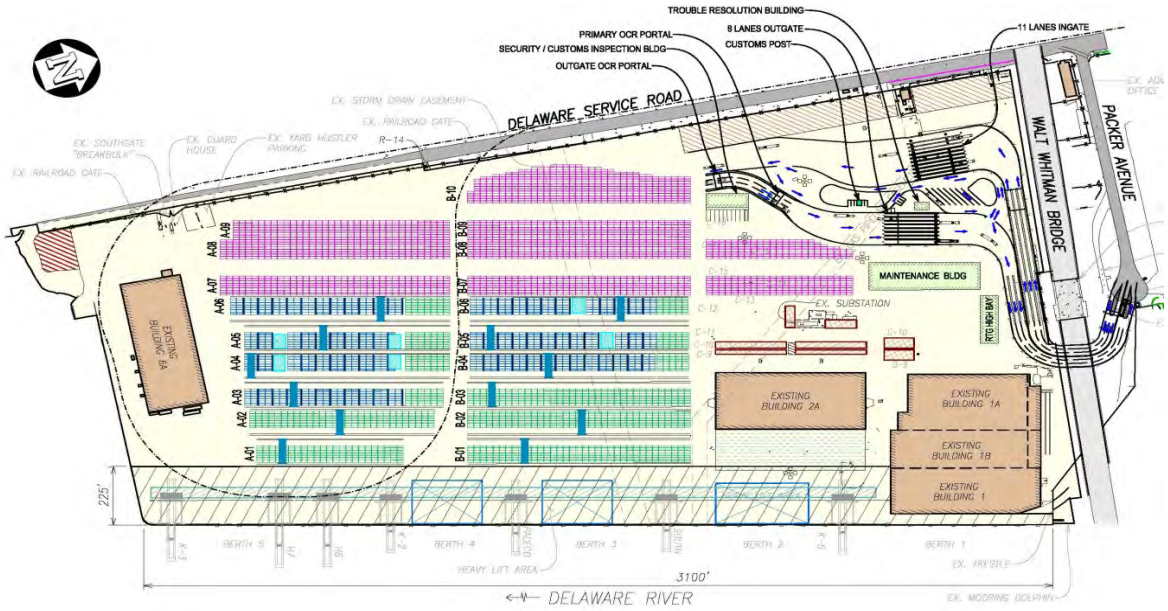
Figure 26: Phase 1 - Upgraded Gate



Source: Halcrow, 2011

6.1.3 Phase 2 – Module B + A

Figure 27: Phase 2 – Module B + A



Source: TEC, 2011

The next phase of the conversion of PAMT into a modern conventional container terminal continues with the re-construction of Module A. As with Module B, this section does not entail the removal of any refrigerated warehouses. After construction of Phase 1 the annual yard capacity would be 683,032 TEU. During construction of Phase 2, the annual yard capacity would dip to 494,395 TEU. After construction of Phase 2 the annual yard capacity would be 919,097 TEU.

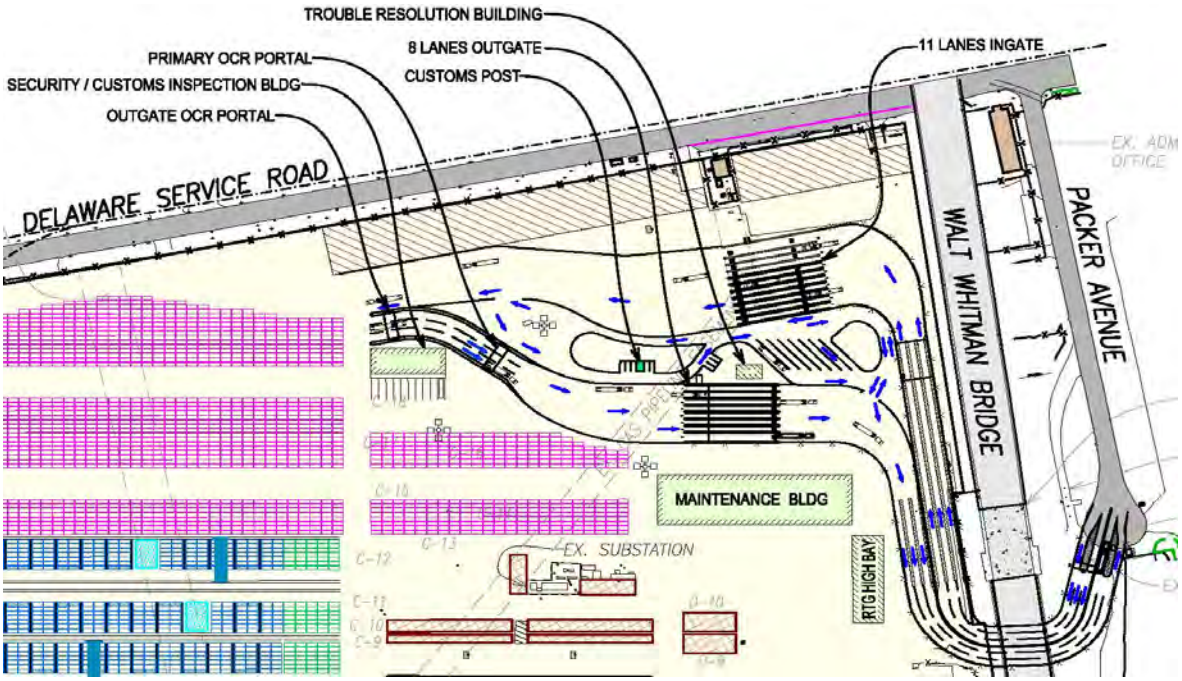
Construction work in this phase would entail tying in the reconstruction of the existing uneven paved yard area to Module B to create a contiguous container yard area. The reconstructed paving would allow for greater stacking heights of the dry and reefer containers. Rubber tired gantry cranes will be installed to obtain greater stacking heights of the dry and reefer containers in the yard. The MT containers will continue to be stacked 6 high.

Construction of this phase would remove 405 ground slots for reefers stacked 1 high and replace them with 652 ground slots for reefers stacked 4 high. At the end of construction of Module A, the annual reefer capacity of Modules B+A will be 201,582 TEU.

6.1.3.1 Phase 2 – Gate

At this stage, PAMT can accommodate a throughput up to 919,097 TEU. Additional in and out gate pedestal lanes are required, as shown in Figure 28. Because the Phase 1 gate layout leaves space for additional lanes, no disruption will occur during construction.

Figure 28: Phase 2 Gate



Source: Halcrow, 2011

6.1.4 Phase 3 – Module B + A + C

Figure 29: Phase 3 – Module B + A + C

Source: TEC, 2011

The next phase of the conversion of PAMT into a modern conventional container terminal continues with the re-construction of Module C. This module contains a large refrigerated warehouse that will be removed as well as a reach stacker container yard and some reefers. After construction of Phase 2 the annual yard capacity would be 919,097 TEU. During construction of Phase 3, the annual yard capacity would dip to 859,951 TEU. After construction of Phase 3 the annual yard capacity would be 1,103,536 TEU.

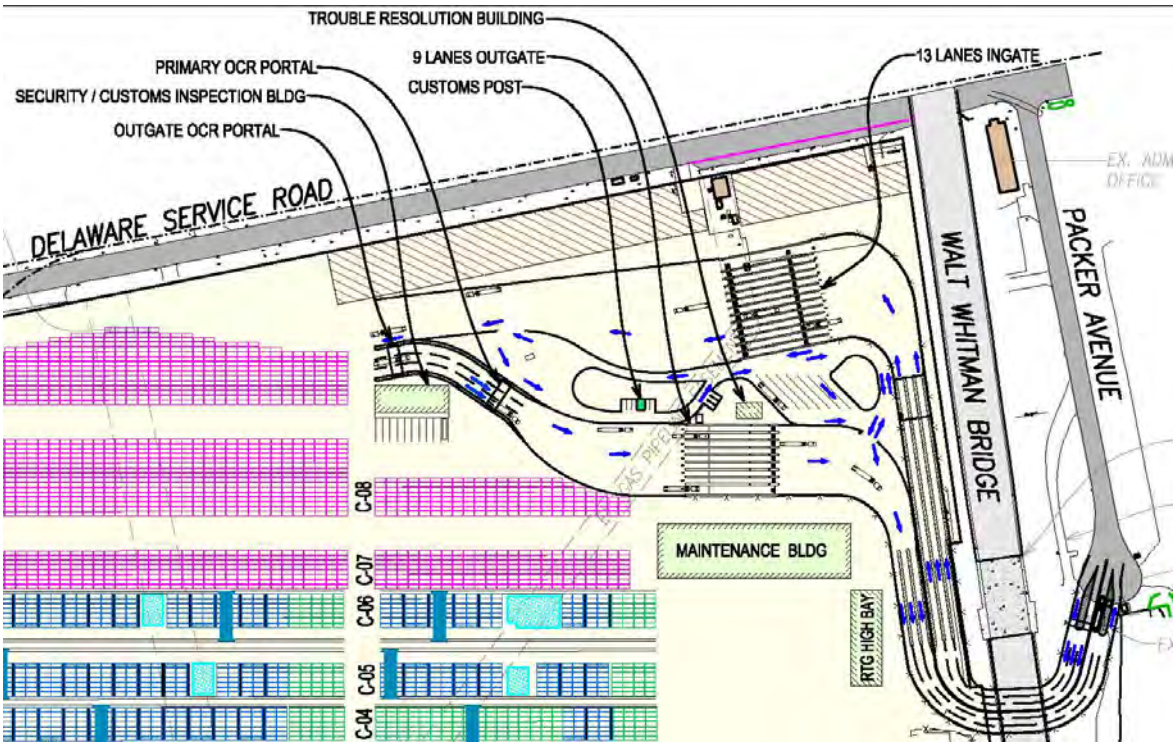
Construction work in this phase would entail tying in the reconstruction of the existing uneven paved yard area to Modules B+A to create a contiguous container yard area. The reconstructed paving would allow for greater stacking heights of the dry and reefer containers. Rubber tired gantry cranes will be installed to obtain greater stacking heights of the dry and reefer containers in the yard. The MT containers will continue to be stacked 6 high.

Construction of this phase would remove 68 ground slots for reefers stacked 1 high and replace them with 274 ground slots for reefers stacked 4 high. At the end of construction of Module C, the annual reefer capacity of Modules B+A+C will be 247,687 TEU.

6.1.4.1 Phase 3 – Gate

At this stage, PAMT can accommodate an annual throughput up to 1,103,000 TEU. Additional in and out gate pedestal lanes are required, as shown in Figure 30. Again, because the Phase 1 gate layout leaves space for additional lanes, no disruption will occur during construction.

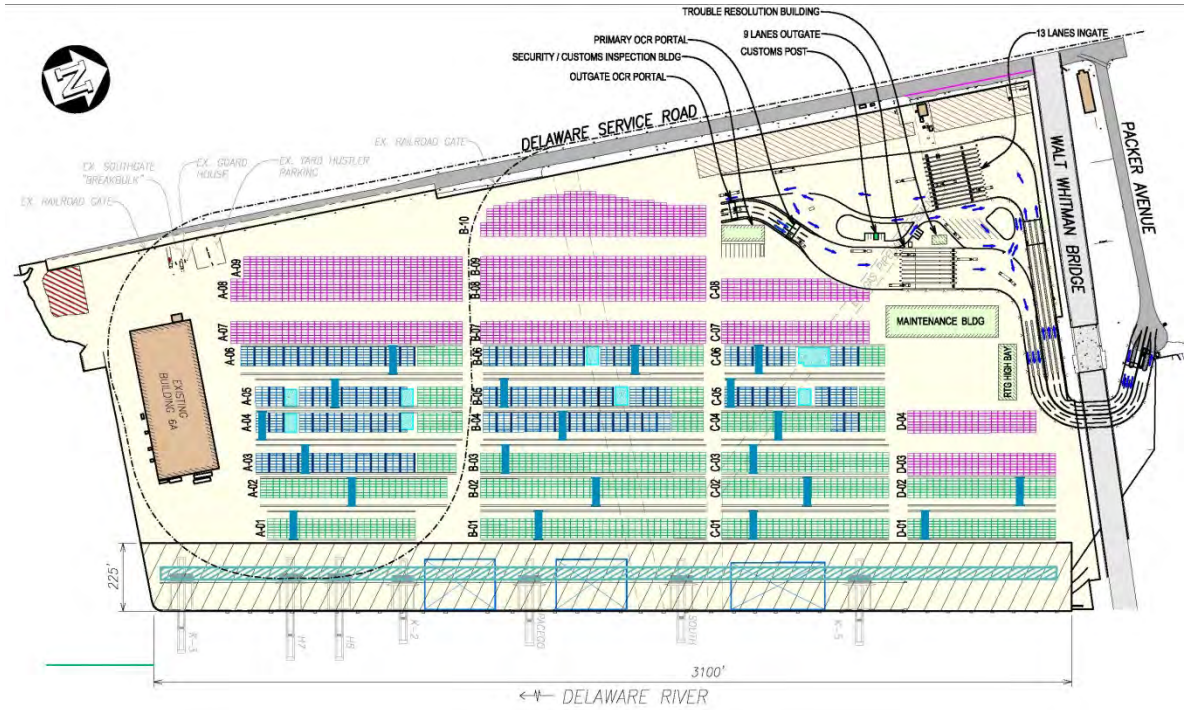
Figure 30: Phase 3 Gate



Source: Halcrow, 2011

6.1.5 Phase 4 – Module B + A + C + D

Figure 31: Phase 4 – Module B + A + C + D



Source: TEC, 2011

The next phase of the conversion of PAMT into a modern conventional container terminal continues with the re-construction of Module D. Work in this phase entails the removal of three large refrigerated warehouses and reconstruction of a contiguous concrete yard area, tying into Modules B+A+C. After construction of Phase 3 the annual yard capacity would be 1,103,536 TEU. During construction of Phase 4, the annual yard capacity would dip to 1,103,115 TEU. After construction of Phase 4 the annual yard capacity would be 1,230,318 TEU.

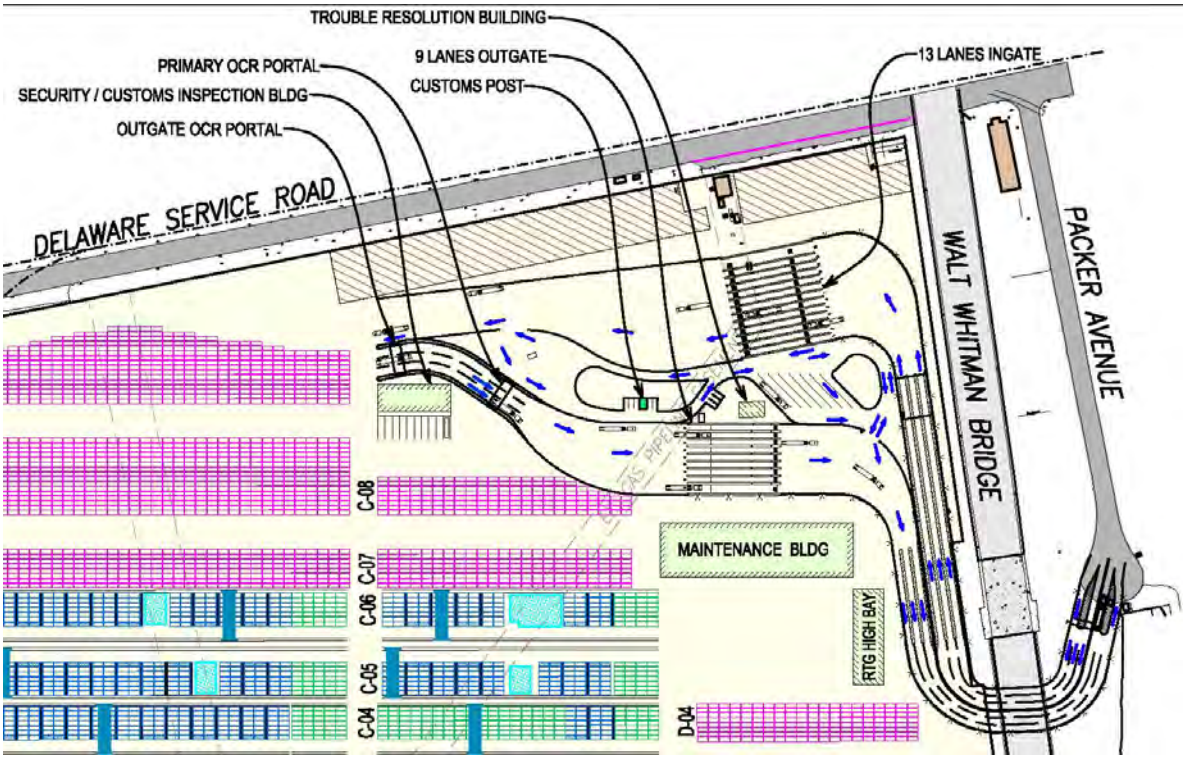
Construction work in this phase would entail tying in the reconstruction of the existing uneven paved yard area to Modules B + A + C to create a contiguous container yard area. The reconstructed paving would allow for greater stacking heights of the dry containers. Rubber tired gantry cranes will be installed to obtain greater stacking heights of the dry containers in the yard. The MT containers will continue to be stacked 6 high.

Construction of this phase would remove 10 ground slots for reefers stacked 1 high. At the end of construction of Module C, the annual reefer capacity of Modules B+A+C+D will be 247,687 TEU.

6.1.5.1 Phase 4 – Gate

At this stage, PAMT can accommodate an annual throughput up to 1,167,000 TEU. Additional in and out gate pedestal lanes are required, as shown in Figure 32.

Figure 32: Phase 4 Gate



Source: Halcrow, 2011

6.1.6 Subsequent Phases to Full Build-Out

The full build-out of the modern conventional container terminal will include strengthening the wharf area and replacement of seven of the nine existing quay cranes with larger models (H6 & H7 will remain). Existing building 6A, adjacent to Module A, will be removed and the area will be reconstructed with concrete and tied into the yard area from Phases 1, 2, 3 and 4.

6.1.6.1 Full Build-Out – Gate

The final transition of the terminal, converting the South end of Section A from Building 6 to an RTG yard increases the annual throughput to 1,230,000 TEU. Because the increase is small, no additional gate improvements are required at this stage. Therefore, the gate will remain as shown in Figure 32. Figure 32 shows space for additional pedestal lanes in each

direction. This is for the addition of lanes when FastShip arrives. Because FastShip containers have a small delivery window, they have a higher peak factor. Therefore, additional gate lanes are requires, as discussed below, and space is reserved in the gate layout accordingly.

6.2 FastShip Integration Phase

6.2.1 FastShip – Terminal-In Terminal Options

Implementation of construction of the FastShip terminal in the container terminal would occur after Phase 4 and subsequent to full build-out after building 6A is removed. The self-contained automated or manually unloaded FastShip terminal includes the construction of one berth sized to house a FastShip and includes a FastShip ramp. The self-contained FastShip terminal would utilize approximately 15 acres of yard area that was assigned to Module A of the conventional container terminal and would take away from the overall reefer plug capacity of the container terminal.

6.2.2 FastShip – Integrated

Integration of the FastShip terminal into the container terminal would occur after Phase 4 and subsequent to full build-out after building 6A is removed. The integrated manually unloaded FastShip terminal includes one berth sized to house a FastShip and includes a FastShip ramp. The integrated manually unloaded FastShip terminal would utilize roughly 8 acres of yard area that was assigned to Module A of the conventional container terminal. The FastShip containers could be stored in the conventional container yard and loaded onto trucks with the rubber tired gantry cranes.

7. INVESTMENT COST ASSESSMENT

7.1 Equipment

The depicted investment costs in the following tables are based on the summary of devices, which are required for each terminal layout in the last volume slice. The costs do not include civil works, such as, pavement, runway beams, or the creation or demolition of buildings. The purpose of the presented amounts is to give an impression about the level of the expected investments and the ability to rank the different layout alternatives according to their price.

Depending on the layout alternative different devices are required for the operation. The following table gives an overview of the configurations which have been described in detail in the latter sections. All the depicted sums are related to the highest capacity throughput of each alternative.

Table 74: Overview Summarized Devices

	Conventional	Manual TnT	Automated TnT	Manual Integrated
Quay Cranes	6	5	5	5
Hostlers Conventional	32	27	27	27
Chassis Conventional	31	26	26	26
RTGs Conventional	21	16	16	16
Hostlers FastShip RTGs				14
Hostlers FastShip Staging		24		24
Chassis FastShip		23		37
AGVs			24	
RTGs FastShip				10
SCs FastShip		15	15	

Source: HPC, 2011

Not all of the above mentioned devices are required to be purchased new; considerable cost savings can be achieved by using existing trucks and bomb carts that meet modern performance specifications and requirements. Quay cranes must be evaluated for replacement on an individual case. The required productivity of 33 moves per hour can only be achieved by modern state-of-the-art offshore cranes probably only ensured by the newer cranes like H-6 and H-7. Furthermore it is assumed that all required FastShip cassettes are part of the vessel equipment. This precondition is related to the set of cassettes

which remains at the terminal for preparation of the next export journey to accelerate the vessel handling time.

The terminal operator must decide which equipment can remain and which equipment should be replaced. Therefore, the following financial equipment cost estimates are based on replacing all existing equipment. Consequently decisions for the further selection of the terminal alternative can be made under equal conditions.

For the determination of the estimated investment costs, unit prices are estimated for each device type. The following list of prices is based on similar experience on recent projects projects. Quay cranes are the most expensive part in the equipment list and the effective price varies in a range between $6.5m and $9m and depends on manufacturer, order size, and other factors such as air draft on the approach channel. Furthermore it should be noted that two different kinds of hostlers are priced below. Beside the conventional hostlers which operate between RTGs and quay cranes, FastShip hostlers are also presented. These trucks are equipped with a special hook that allows to pick-up and transport the particular FastShip chassis. Due to this feature, the FastShip hostler is assumed to be approximately 33% more expensive. Another piece of equipment that should be highlighted is the FastShip chassis, which are required for the horizontal transport of container from and to the FastShip staging area. Due to the special requirements and usage they are estimated to cost approximately $100,000.

Table 75: Single Prices of Devices

Devices	Single Price
Quay Cranes	$8.00m
Hostlers Conventional	$0.11m
Chassis Conventional	$0.02m
RTGs Conventional	$1.80m
Hostlers FastShip RTGs	$0.11m
Hostlers FastShip Staging	$0.15m
Chassis FastShip	$0.10m
AGVs	$0.80m
RTGs FastShip	$1.80m
SCs FastShip	$1.00m

Source: HPC, 2011

The following table gives an overview of the calculated investment costs. The total line shows that the cheapest alternative can be determined as the *Conventional Terminal Layout* even though this alternative includes one more quay crane than the other layouts. The most expensive alternative is the *Automated Terminal in Terminal Layout*. The price difference

is nearly $17m which is equal to about 20%. In opposite to this the *Manual Terminal in Terminal Layout* causes less than 4% more costs than the cheapest layout. The investment cost of the *Manual Integrated Layout* is more or less in the middle of the cheapest and the most expensive alternative.

The line *Equipment Investment/TEU* provides an overview of the relationship between total investment cost and maximal throughput of one year. The shown values should not to be confused with the key figure estimated costs per TEU. The long term investments must be deprecated according to their lifetime, which can be between ten and 25 years. Thus the effective costs per TEU will be significantly lower. The depicted equipment investments per TEU emphasize the first impression about the cheapest and most expensive alternative.

Table 76: Equipment Investment Overview

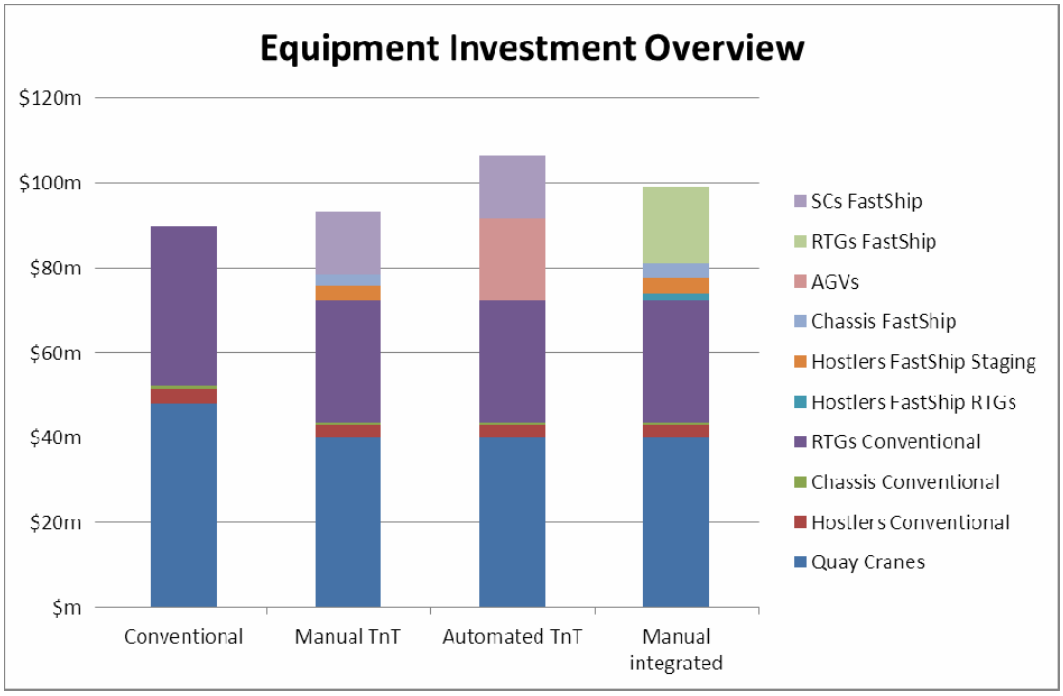
	Conventional	Manual TnT	Automated TnT	Manual Integrated
Quay Cranes	$48.00m	$40.00m	$40.00m	$40.00m
Hostlers Conventional	$3.52m	$2.97m	$2.97m	$2.97m
Chassis Conventional	$0.62m	$0.52m	$0.52m	$0.52m
RTGs Conventional	$37.80m	$28.80m	$28.80m	$28.80m
Hostlers FastShip RTGs				$1.54m
Hostlers FastShip Staging		$3.60m		$3.60m
Chassis FastShip		$2.30m		$3.70m
AGVs			$19.20m	
RTGs FastShip				$18.00m
SCs FastShip		$15.00m	$15.00m	
Total	**$89.94m**	**$93.19m**	**$106.49m**	**$99.13m**
Equipment Investment/TEU	$75.94	$84.80	$96.91	$85.88
Yearly Throughput [TEU]	1.18m	1.10m	1.10m	1.15m

Source: HPC, 2011

The graphical overview in the following figure illustrates the proportions of the investments. Obviously the most cost-intensive equipment types are the quay cranes, the RTGs, AGVs and the SCdle carrier. Investment costs for hostlers and chassis are more or less negligible.

The shown investment costs are totals for the whole lifetime of the transition plan. The next step of elaboration must establish a detailed procurement plan for each equipment type and also the estimated costs for civil engineering must be included.

Figure 33: Equipment Investment Overview



Source: HPC, 2011

7.1.1 Investment Costs for Conventional Layout According to Reconstruction Phases

The decision on a certain layout alternative should not be made solely based on the total investment costs. The procurement of the different devices will occur according to the throughput requirements and the reconstruction phases of the terminal. The following table contains an overview of the required number of the major devices in the different phases for the conventional layout alternative. Each column shows the number of devices that must be purchased in addition. The table does not contain procurements for replacement of old devices.

The depicted procurement plan shows substantial initial-costs for the first phase. The first phase starts in the first volume slice and lasts until slice number five. During this period of time the listed number of devices for Phase I is required. For the second phase - from slice six to twelve - four additional RTGs must be purchased. The following phase requires three additional RTGs and in the last phase one RTG more is required.

Table 77: Investment Costs for new Devices

Conventional Layout	Phase I	Phase II	Phase III	Phase IV
Quay Cranes	6	0	0	0
Hostlers Conventional	32	0	0	0
Chassis Conventional	31	0	0	0
RTGs Conventional	13	4	3	1

Conventional Layout	Phase I	Phase II	Phase III	Phase IV
Quay Cranes	$48.00m	$0.00m	$0.00m	$0.00m
Hostlers Conventional	$3.52m	$0.00m	$0.00m	$0.00m
Chassis Conventional	$0.62m	$0.00m	$0.00m	$0.00m
RTGs Conventional	$23.40m	$7.20m	$5.40m	$1.80m
Total	**$75.54m**	**$7.20m**	**$5.40m**	**$1.80m**

Source: HPC, 2011

For calculating the entire investment cost, the totals in the table above might be misleading. Typical devices like hostlers and chassis have shorter lifetimes than the duration of all twenty volume slices, e.g. with an estimated lifetime of about seven years, all 32 hostlers must be replaced during phase II and again in phase III. Also the lifetime of chassis and RTGs are shorter than 20 volume slices. Thus the required cash flow over the period of time can differ significantly from the shown investments costs in the table.

7.2 Gate

The new gate system will require various improvements, including demolition of the existing gate structures; new infrastructure such as pedestals, OCR cameras, scales, gate arms and associated infrastructure like conduit; civil works such as heavy duty pavments, drainage, curbs, and striping; and miscellaneous work such as traffic signage, area lighting, and fencing. Additionally, the two Fast Ship options require significant improvements to Packer Avenue, including its widening to 5 lanes and expansion of the terminal entrance at the end of Packer Avenue. The Integrated Fast Ship terminal has one additional lane inbound and outbound due to a slightly higher conventional throughput, as described earlier. Table 78 below outlined the investment costs for the new gate. A detailed cost estimate breakdown can be found in Appendix C. It should be noted that these estimates should be considered accurate to a level commensurate with the level of design contained in this report, which is 30%. As the design progresses, the cost estimates can be refined to a higher level of confidence. Design and construction contingencies of 10% each are included; additional markups, inclusions, and exclusions are outlined in Table 78 below and Appendix C.

Table 78: Investment Costs for new Gate

Packer Avenue Gate Conceptual Estimate
Philadelphia Regional Port Authority
Philadelphia, PA

Halcrow
Job No.: DNPAMT
20-Dec-11

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Conventional Full Build Out				**18,572,266**
Fast Ship Automated / Manual Terminal -in-Terminal				**20,763,672**
Fast Ship Integrated Terminal				**21,654,044**

Mark-Ups Included or Specified	
General Conditions	6.0%
Mobilization and Phasing	8.0%
Overhead	10.0%
Profit	10.0%
Design Contingency	10.0%
Construction Contingency	10.0%
Escalation	NIC

Exclusions & Clarifications
Engineering and Design Costs
Permitting and Regulatory Approvals
Environmental Mitigation Requirements
Rezoning Requirements
Land Acquisition
Escalation
Financing or Cost of Money

Source: Halcrow, 2011

8. SUMMARY

The conversion of Philadelphia Regional Port Authority's Packer Avenue Marine Terminal to a 100% container terminal would lead to a major increase in productivity to the Terminal. The incorporation of FastShip to the terminal is fully reasonable and their operations can co-exist very well with the conventional container operations.

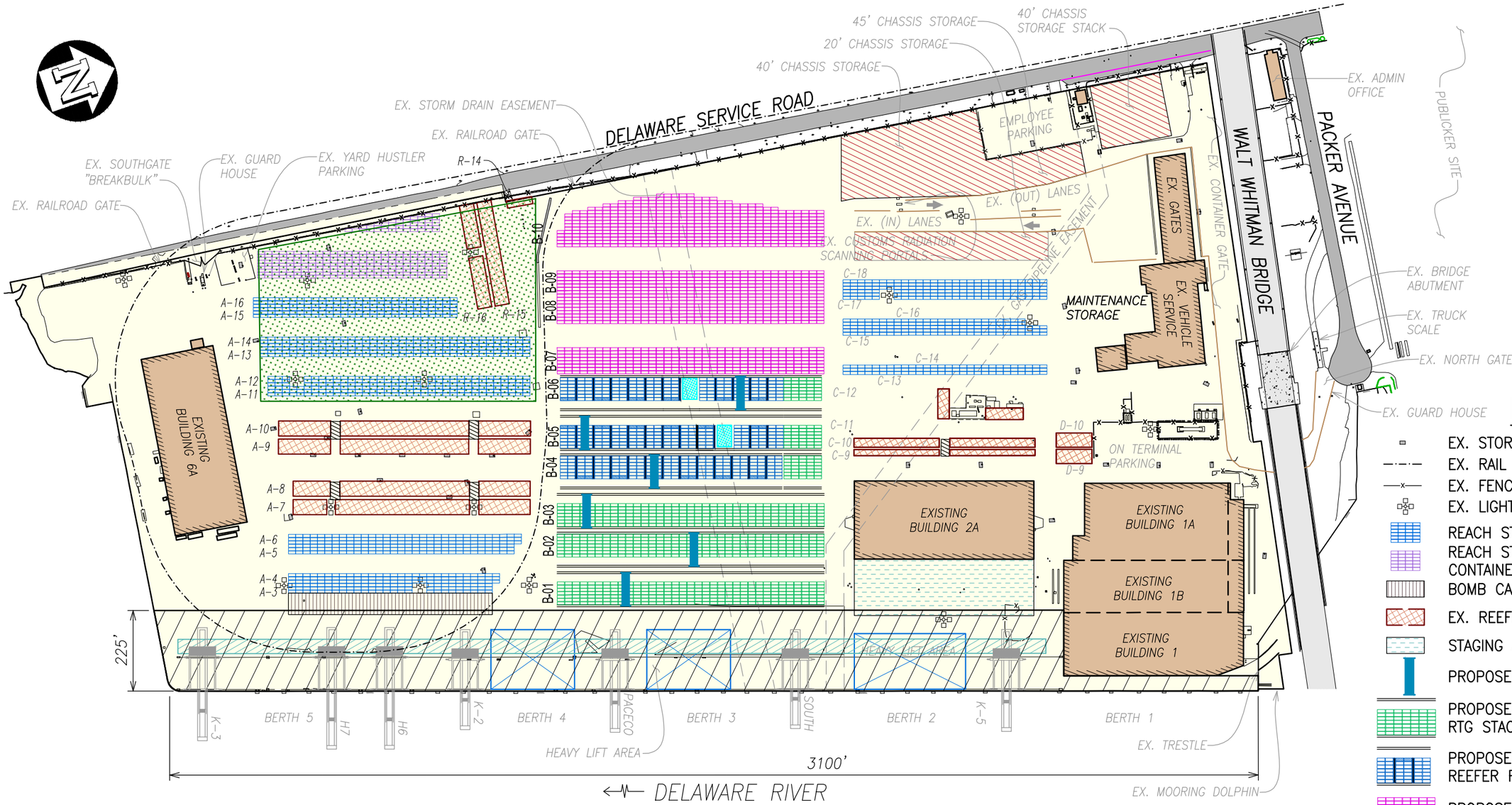
Many improvements will need to be executed and investments for additional resources are needed to meet the increased capacities of the terminal. A transition plan was presented in the report to incorporate the improvements to the terminal while providing minimal disturbances to the existing operations at the terminal. As mentioned in the report, the existing throughput at the terminal is at a level where improvements should be implemented in the very near future to minimize the impacts to the existing operations in the future.

The incorporation of FastShip into the terminal can be implemented in a variety of ways as discussed in the report. In the two Terminal-in-Terminal options the conventional operations is separated in all ways from the FastShip operations and does not allow for any sharing of resources. The Integrated option shares the terminal with the conventional operations.

The depicted investment costs in this report are based on the summary of equipment that is required for each terminal layout in the last volume slice. The equipment costs do not include estimations for reconstruction activities like pavement, creation or demolishing of buildings. Gate improvements are also included. The purpose of the presented amounts is to give an impression about the level of the expected investments and the ability to rank the different layout alternatives according to their price.

APPENDIX A

DRAWINGS



LEGEND

- EX. STORM DRAIN INLET
- EX. RAIL LINES
- EX. FENCE
- EX. LIGHT POLE
- REACH STACKER CONTAINER YARD
- REACH STACKER EMPTY CONTAINER YARD
- BOMB CART STORAGE AREA
- EX. REEFERS
- STAGING AREA
- PROPOSED RTG
- PROPOSED RTG STACK
- PROPOSED REEFER RACK
- PROPOSED EMPTY STORAGE
- PROPOSED SUBSTATIONS
- BERTHING AREA
- CHASSIS AREA STORAGE
- HATCH COVER AREA
- STACKING LIMITATION DUE TO GRADE OR CONDITION
- EXISTING BUILDINGS
- EXISTING CRANE

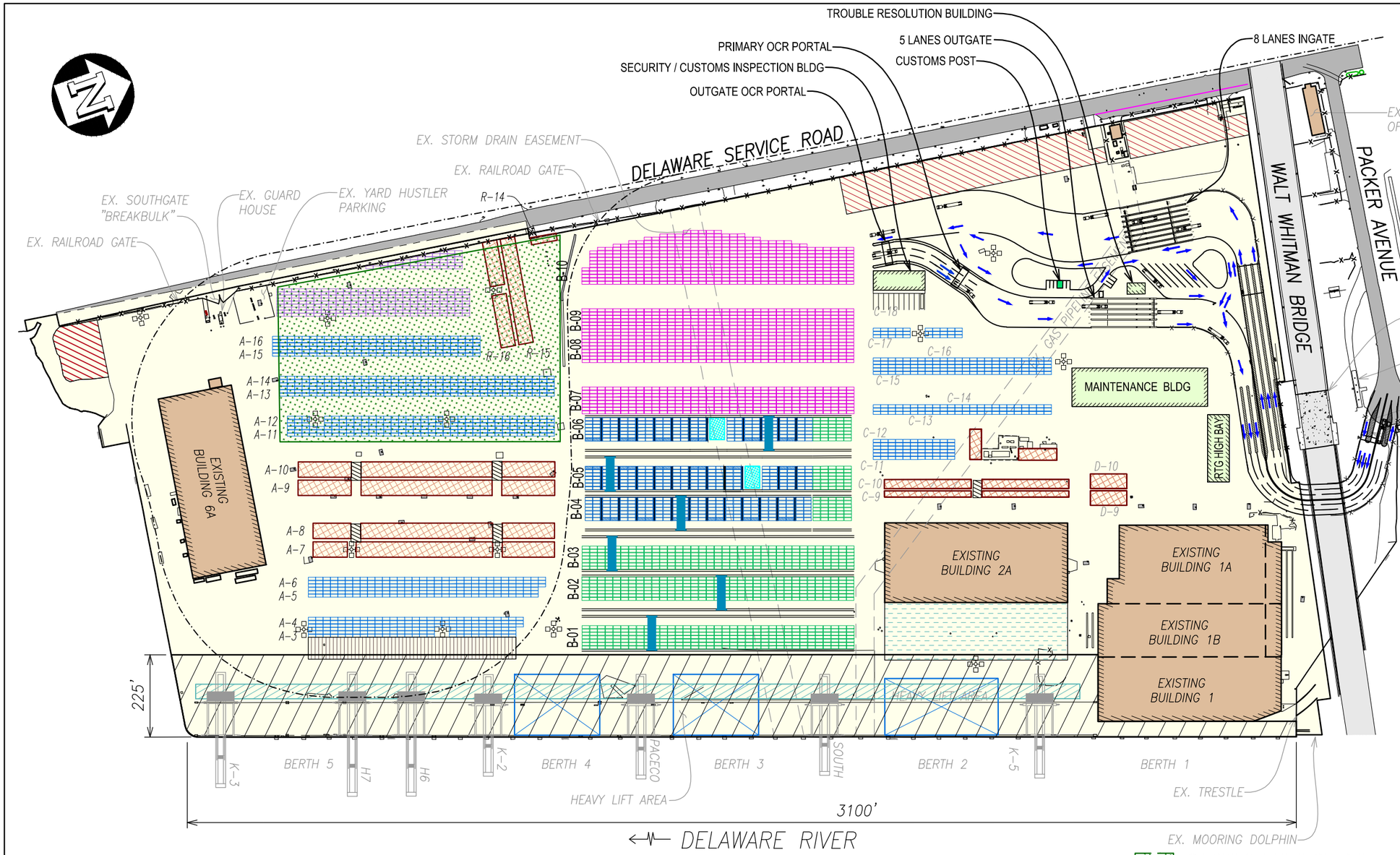
300' 150' 0 150' 300'

MODULE B
EXPORTS - 245 GS (B-01)
IMPORTS - 595 GS
REEFER PLUGS - 964
EMPTIES - 1295 GS

DEC. 15, 2011 V09

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-1 RTG LAYOUT SCTION B MID-PHASE

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE RTG DEV PLAN FB Out.dwg.....Layout: RTG LAY PH I



LEGEND

- EX. STORM DRAIN INLET
- EX. RAIL LINES
- EX. FENCE
- EX. LIGHT POLE
- REACH STACKER CONTAINER YARD
- REACH STACKER EMPTY CONTAINER YARD
- BOMB CART STORAGE AREA
- EX. REEFERS
- STAGING AREA
- PROPOSED RTG
- PROPOSED RTG STACK
- PROPOSED REEFER RACK
- PROPOSED EMPTY STORAGE
- PROPOSED SUBSTATIONS
- BERTHING AREA
- CHASSIS AREA STORAGE
- HATCH COVER AREA
- STACKING LIMITATION DUE TO GRADE OR CONDITION
- EXISTING BUILDINGS
- EXISTING CRANE

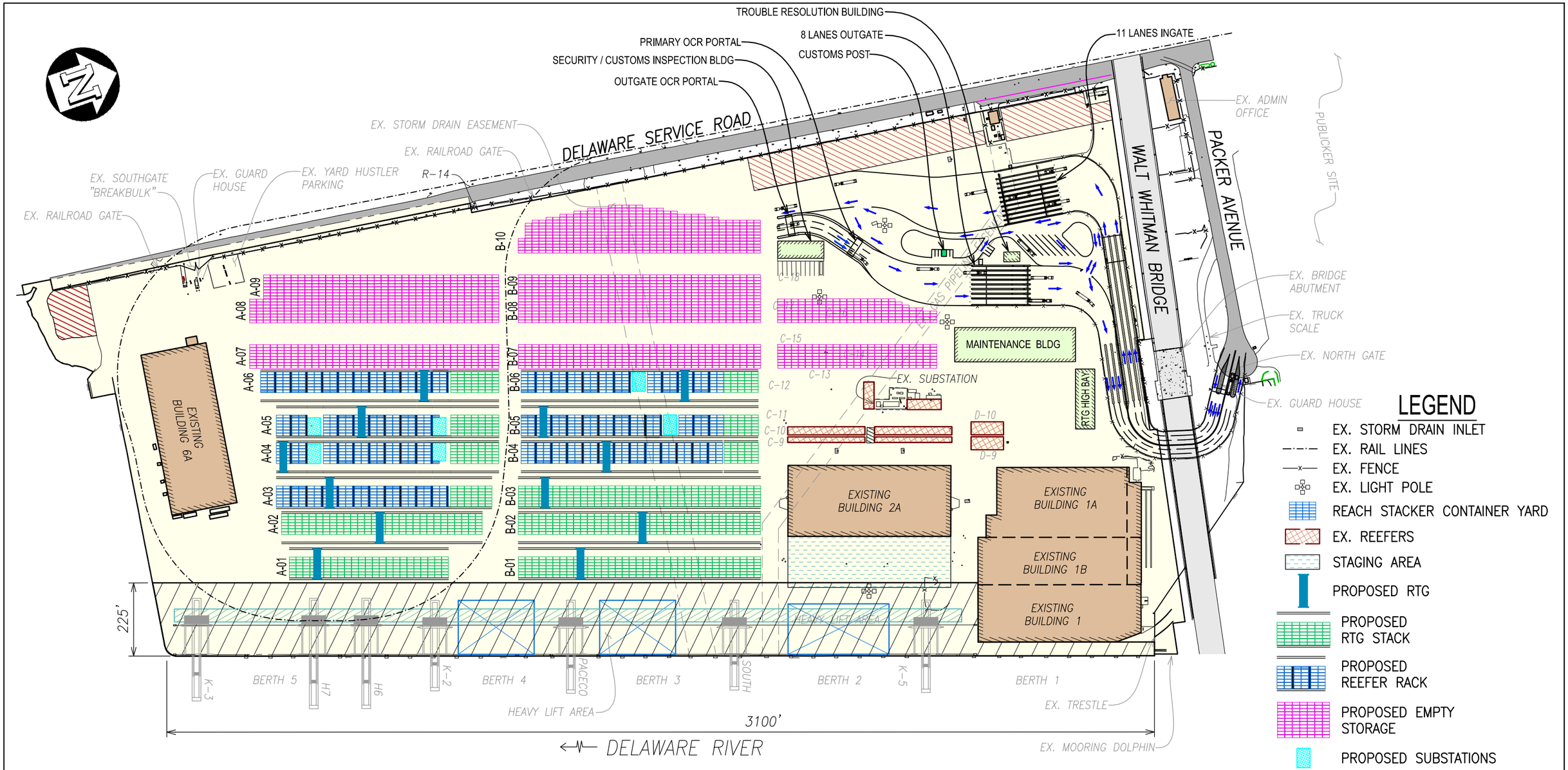
300' 150' 0 150' 300'

MODULE B
EXPORTS - 245 GS (B-01)
IMPORTS - 595 GS
REEFER PLUGS - 964
EMPTIES - 1295 GS

DEC. 15, 2011 V09

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-1a RTG LAYOUT SCTION B FINAL-PHASE

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE RTG DEV PLAN FB Out.dwg.....Layout: RTG LAY PH I (2)



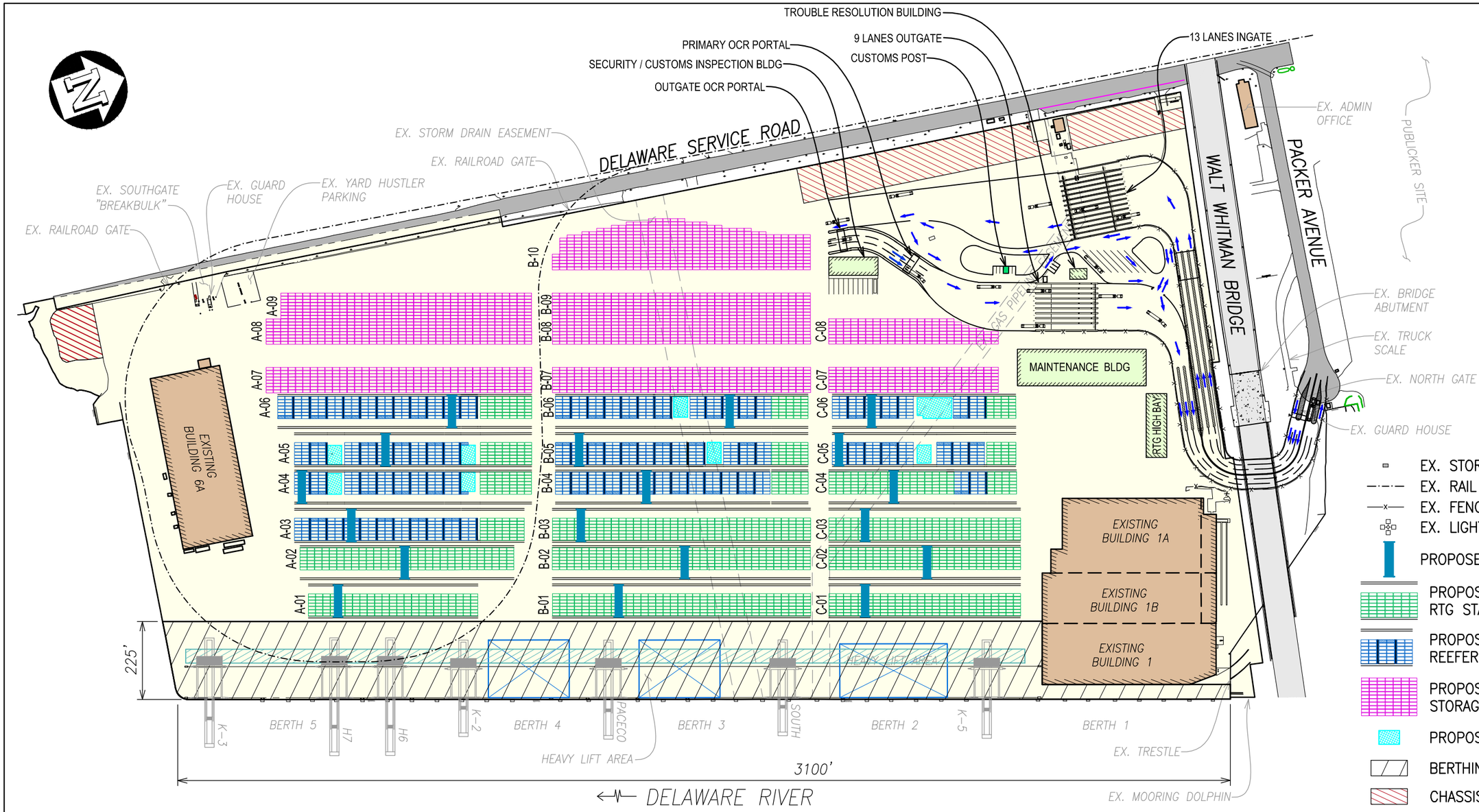
MODULE A
EXPORTS - 161 GS (A-01)
IMPORTS - 392 GS
REEFER PLUGS - 1096
EMPTIES - 848 GS

MODULE B
EXPORTS - 245 GS (B-01)
IMPORTS - 595 GS
REEFER PLUGS - 964
EMPTIES - 1295 GS

DEC. 15, 2011 V09

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-2 RTG LAYOUT SECTION B+A

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE RTG DEV PLAN FB Out.dwg.....Layout: RTG LAY PH II



300' 150' 0 150' 300'

MODULE A
EXPORTS - 161 GS (A-01)
IMPORTS - 392 GS
REEFER PLUGS - 1096
EMPTIES - 848 GS

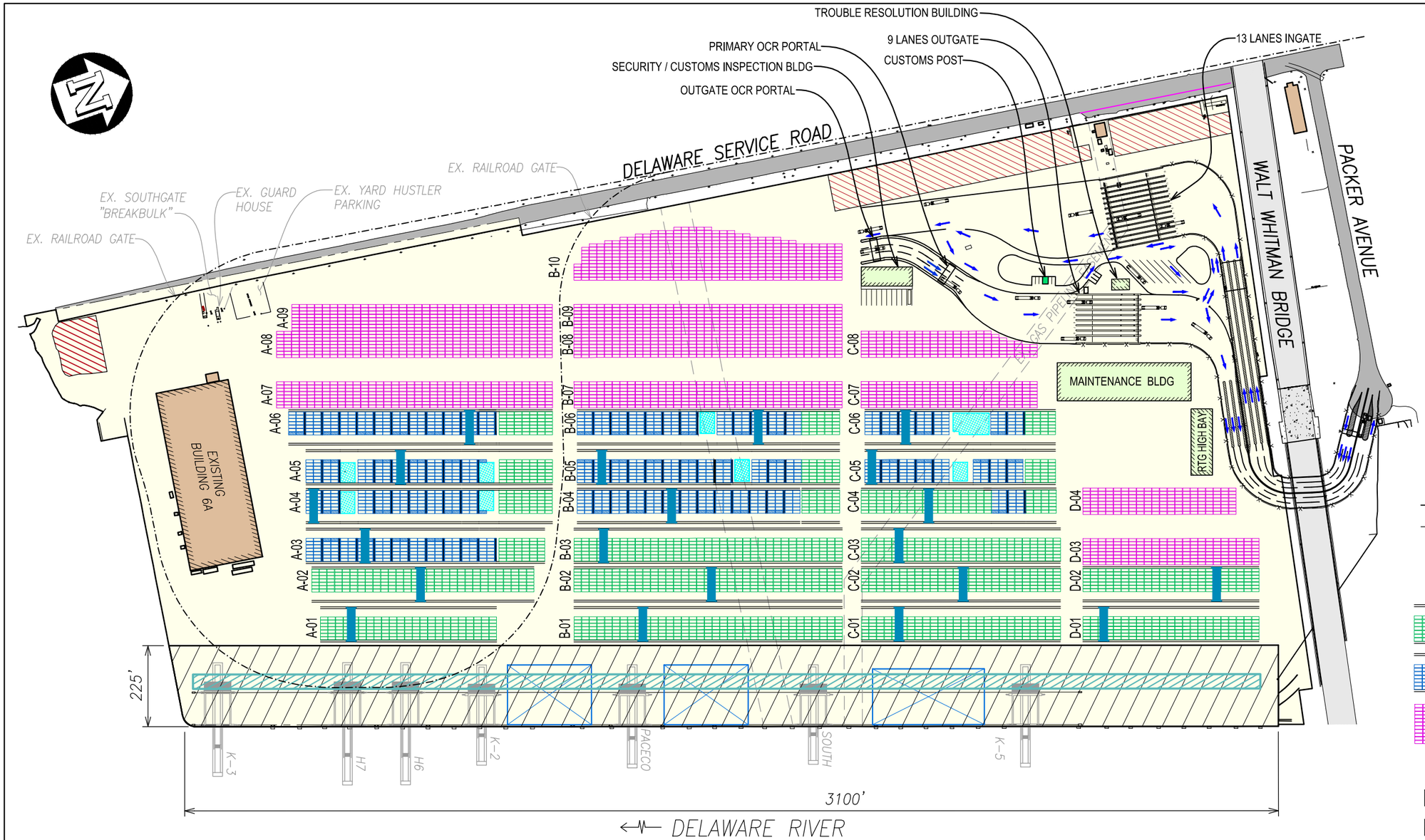
MODULE B
EXPORTS - 245 GS (B-01)
IMPORTS - 595 GS
REEFER PLUGS - 964
EMPTIES - 1295 GS

MODULE C
EXPORTS - 182 GS(C-01)
IMPORTS - 567 GS
REEFER PLUGS - 352
EMPTIES - 416

DEC. 15, 2011 V09

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-3 RTG LAYOUT SECTION B+A+C

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE RTG DEV PLAN FB Out.dwg.....Layout: RTG LAY PH III



LEGEND

- EX. STORM DRAIN INLET
- EX. RAIL LINES
- EX. FENCE
- EX. LIGHT POLE
- PROPOSED RTG
- PROPOSED RTG STACK
- PROPOSED REEFER RACK
- PROPOSED EMPTY STORAGE
- PROPOSED SUBSTATIONS
- BERTHING AREA
- CHASSIS AREA STORAGE
- HATCH COVER AREA
- EXISTING BUILDINGS
- EXISTING CRANE

300' 150' 0 150' 300'

MODULE A
EXPORTS - 161 GS (A-01)
IMPORTS - 392 GS
REEFER PLUGS - 1096
EMPTIES - 848 GS

MODULE B
EXPORTS - 245 GS (B-01)
IMPORTS - 595 GS
REEFER PLUGS - 964
EMPTIES - 1295 GS

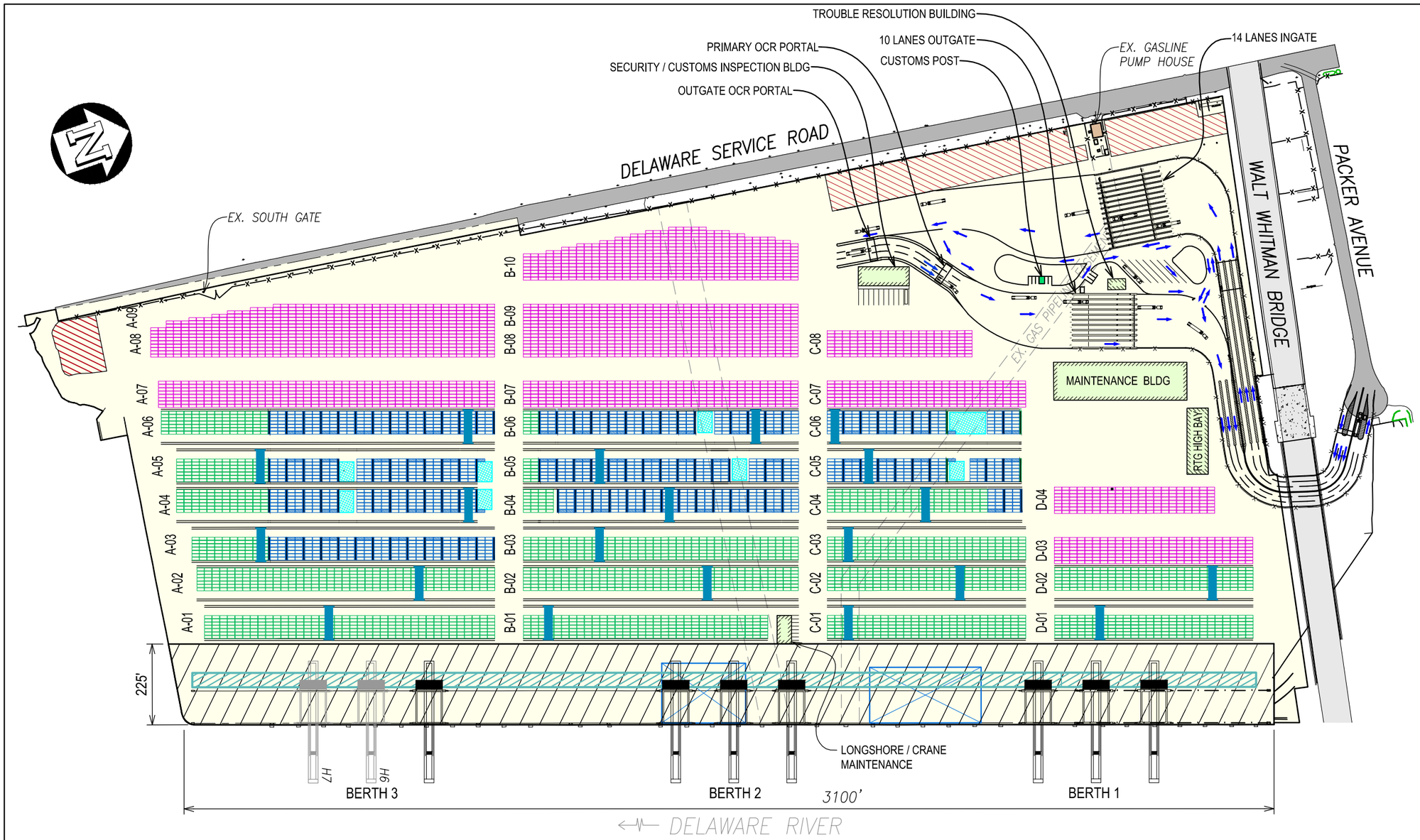
MODULE C
EXPORTS - 182 GS(C-01)
IMPORTS - 567 GS
REEFER PLUGS - 352
EMPTIES - 416

MODULE D
EXPORTS - 161 GS(D-01)
IMPORTS - 161 GS
EMPTIES - 344

DEC. 15, 2011 V09

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-4 RTG LAYOUT SECTION B+A+C+D

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE RTG DEV PLAN FB Out.dwg.....Layout: RTG LAY PH IV



LEGEND

- PROPOSED RTG STACK
- PROPOSED REEFER RACK
- PROPOSED EMPTY STORAGE
- PROPOSED SUBSTATIONS
- BERTHING AREA
- PARKING AREA
- HATCH COVER AREA
- PROPOSED BUILDINGS
- EXISTING TANKS TO BE RELOCATED
- TYPICAL GATES
- PROPOSED RTG
- EXISTING CRANE
- PROPOSED CRANE

300' 150' 0 150' 300'

MODULE A
EXPORTS - 266 GS (A-01)
IMPORTS - 581 GS
REEFER PLUGS = 1304
EMPTIES - 1016 GS

MODULE B
EXPORTS - 224 GS (B-01)
IMPORTS - 560 GS
REEFER PLUGS - 1092
EMPTIES - 1322 GS

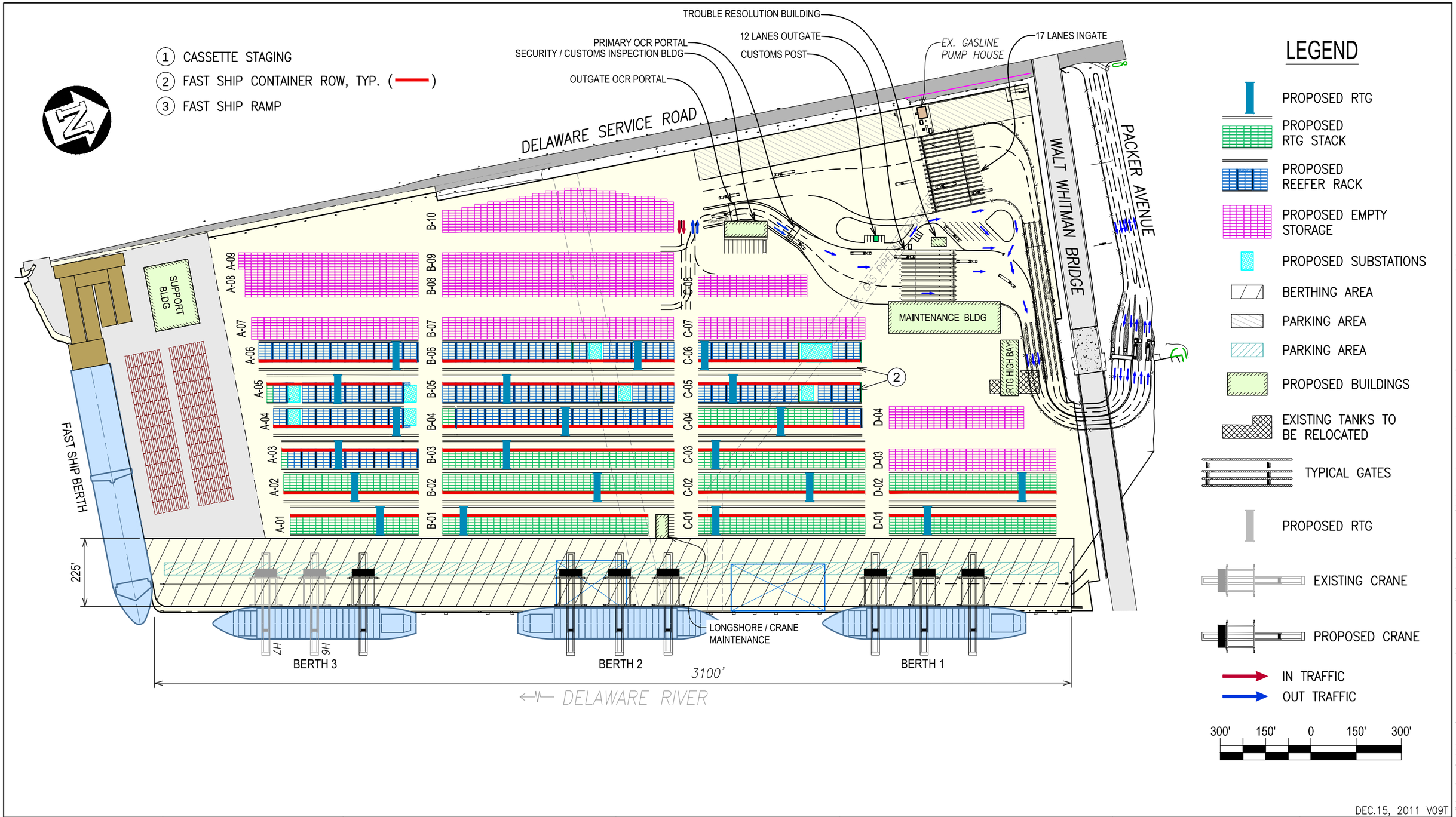
MODULE C
EXPORTS - 182 GS(C-01)
IMPORTS - 511 GS
REEFER PLUGS - 548
EMPTIES - 384

MODULE D
EXPORTS - 182 GS(D-01)
IMPORTS - 182 GS
EMPTIES - 376

DEC. 15, 2011 V09

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-5 RTG FULL BUILDOUT

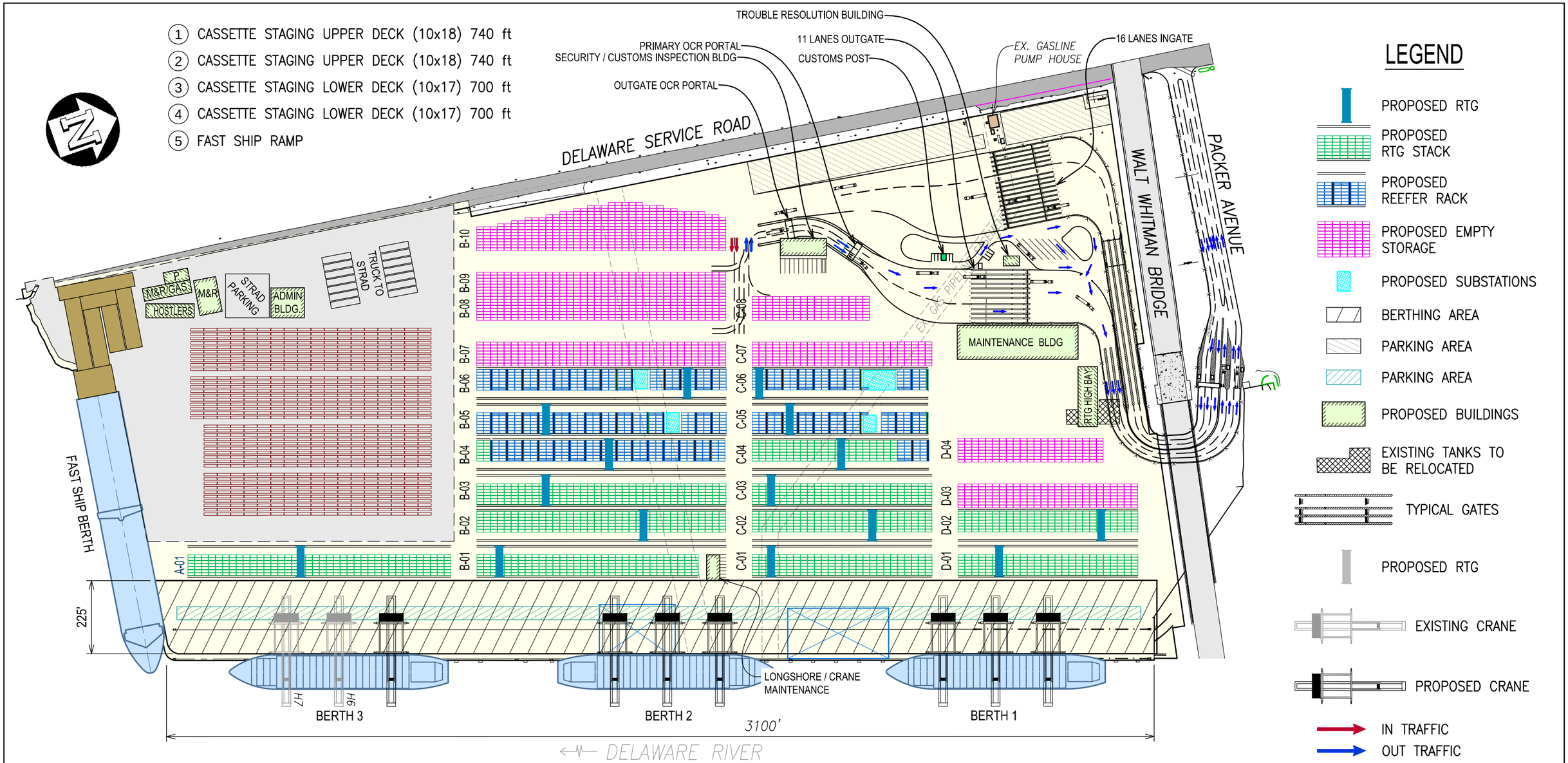
CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE RTG DEV PLAN FB Out.dwg.....Layout: RTG Layout FULL BO



DEC.15, 2011 V09T

PACKER AVE. MARINE TERMINAL **OPERATIONAL ANALYSIS REPORT** DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	**FIG. A-6** FAST SHIP MANUAL INTEGRATED TERMINAL

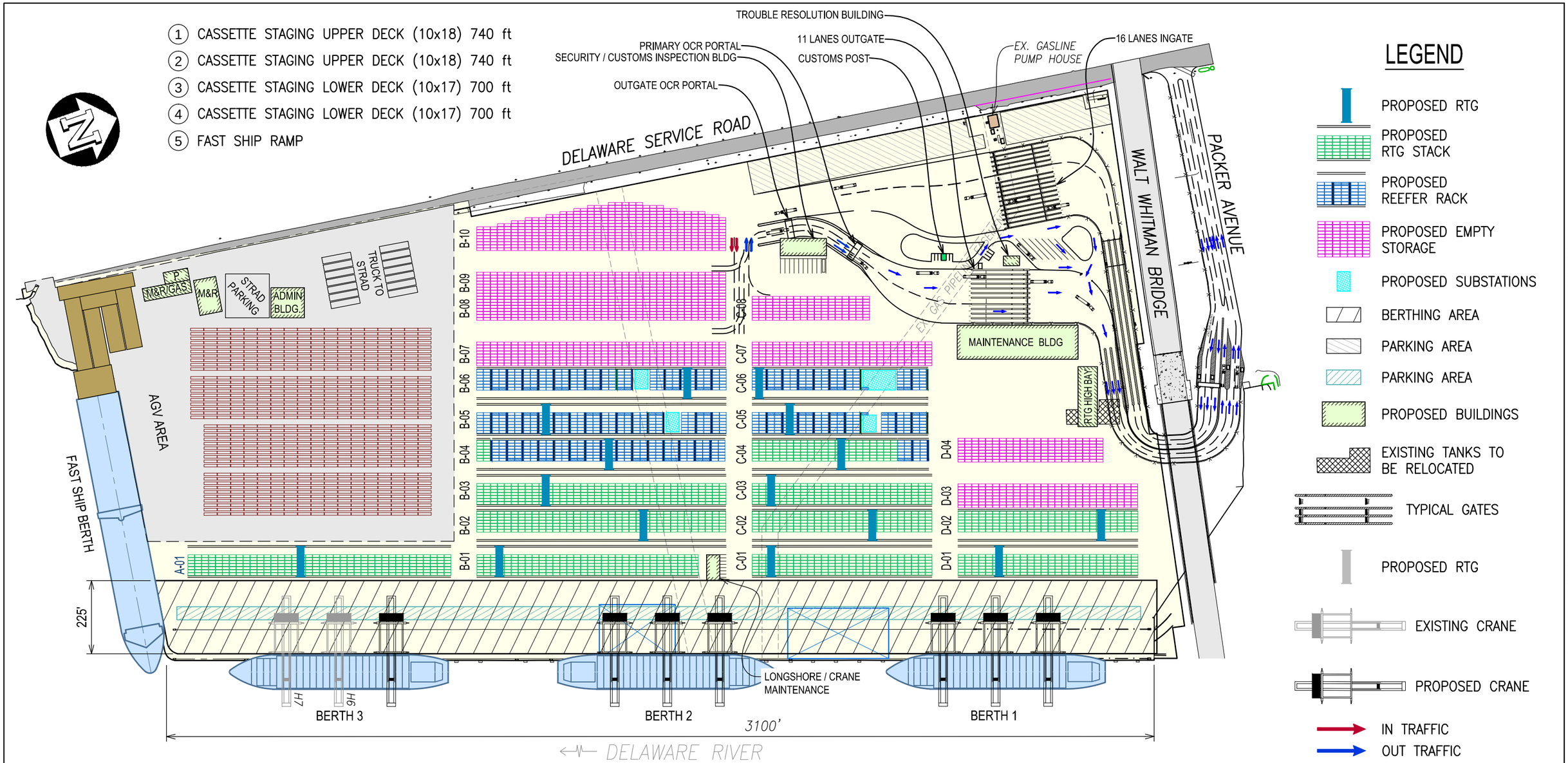
CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE-FASTSHIP-LAY.dwg.....Layout: FAST SHIP MIT



DEC.15, 2011 V09T

PACKER AVE. MARINE TERMINAL **OPERATIONAL ANALYSIS REPORT** DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	**FIG. A-7** FAST SHIP MANUAL TERMINAL IN TERMINAL

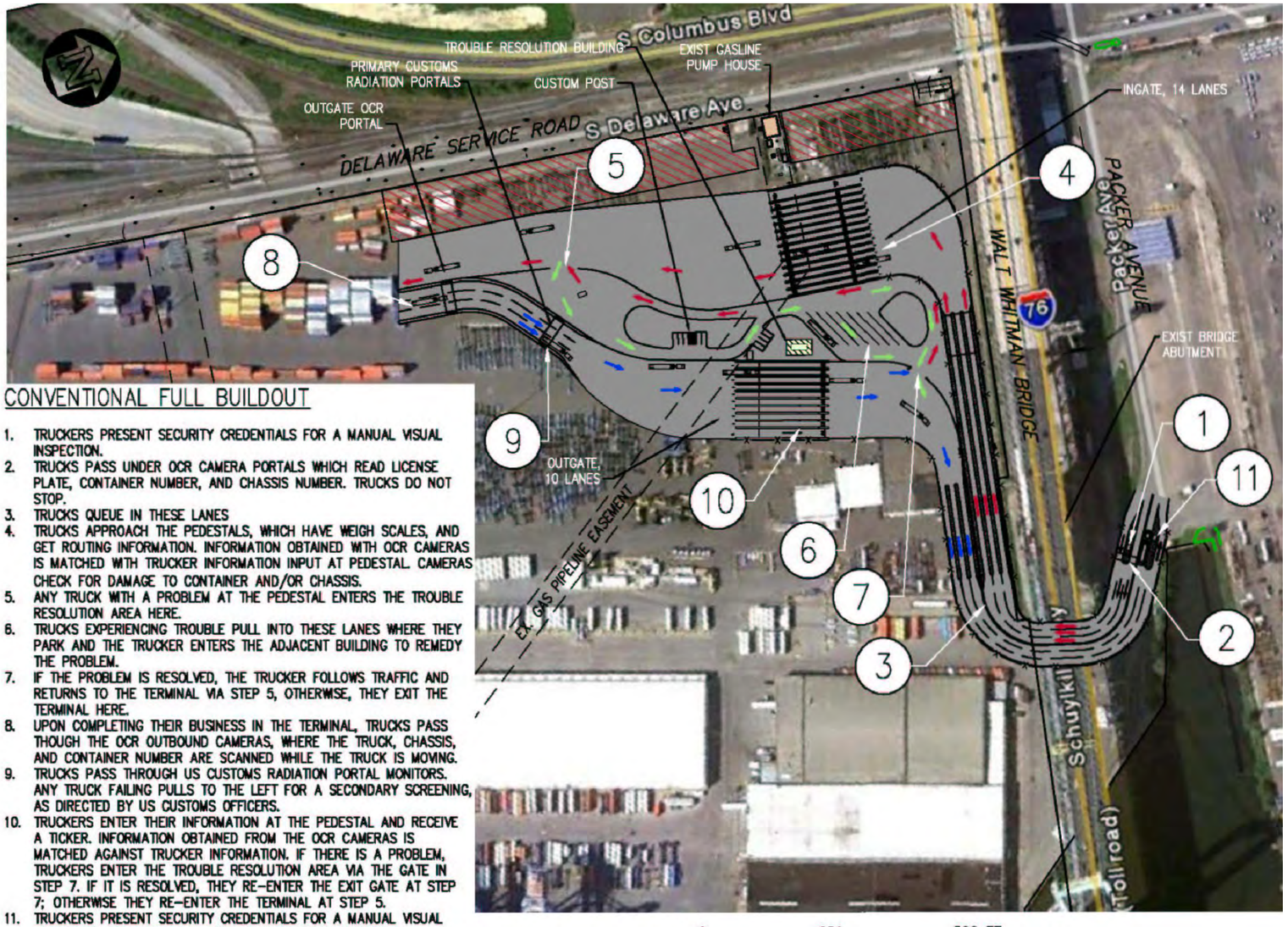
CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE-FASTSHIP-LAY.dwg.....Layout: FAST SHIP MTnT



DEC.15, 2011 V09T

PACKER AVE. MARINE TERMINAL **OPERATIONAL ANALYSIS REPORT** DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY **FIG. A-8** FAST SHIP AUTOMATED TERMINAL IN TERMINAL

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE-FASTSHIP-LAY.dwg.....Layout: FAST SHIP ATnT



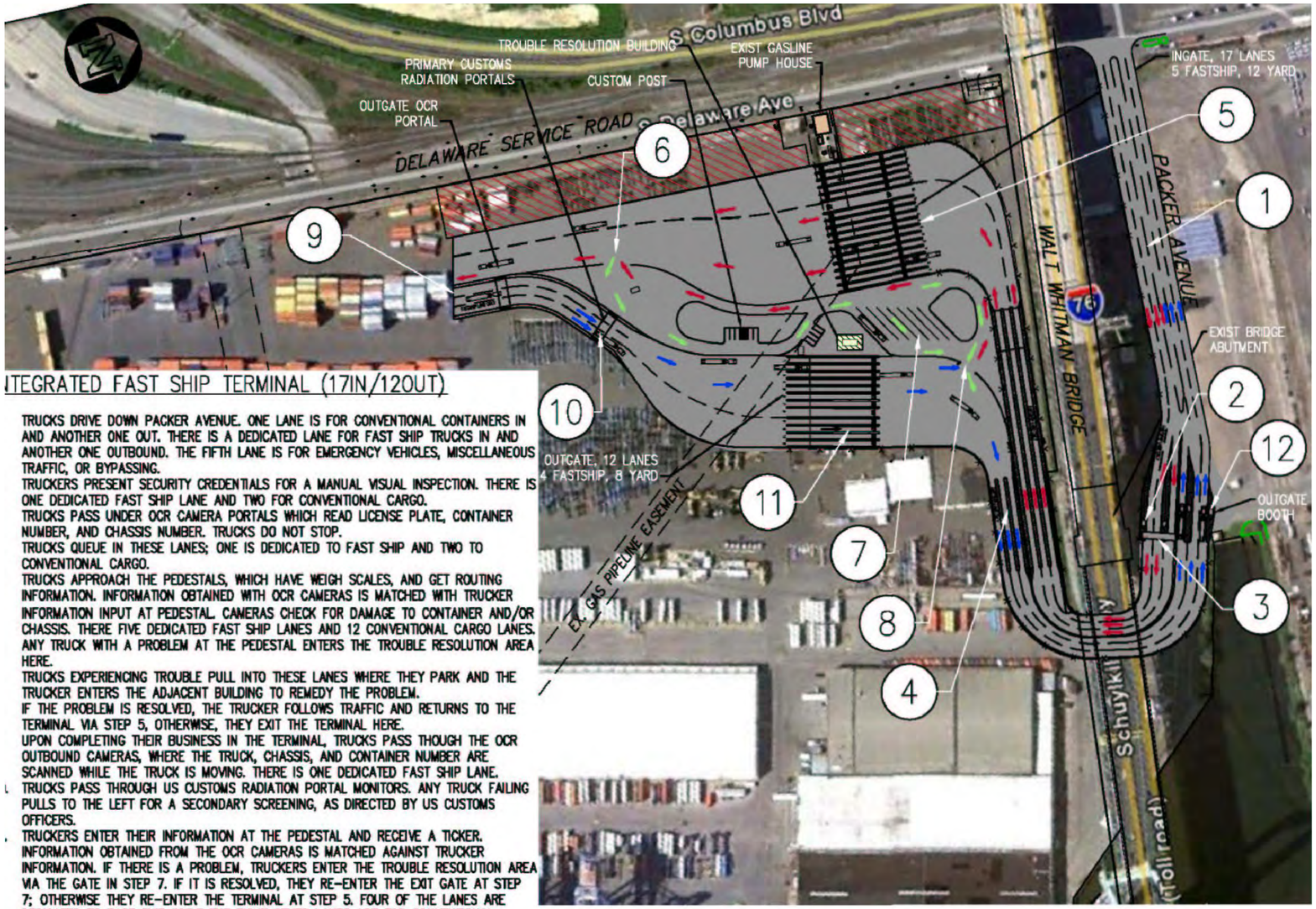
CONVENTIONAL FULL BUILDOUT

1. TRUCKERS PRESENT SECURITY CREDENTIALS FOR A MANUAL VISUAL INSPECTION.
2. TRUCKS PASS UNDER OCR CAMERA PORTALS WHICH READ LICENSE PLATE, CONTAINER NUMBER, AND CHASSIS NUMBER. TRUCKS DO NOT STOP.
3. TRUCKS QUEUE IN THESE LANES
4. TRUCKS APPROACH THE PEDESTALS, WHICH HAVE WEIGH SCALES, AND GET ROUTING INFORMATION. INFORMATION OBTAINED WITH OCR CAMERAS IS MATCHED WITH TRUCKER INFORMATION INPUT AT PEDESTAL. CAMERAS CHECK FOR DAMAGE TO CONTAINER AND/OR CHASSIS.
5. ANY TRUCK WITH A PROBLEM AT THE PEDESTAL ENTERS THE TROUBLE RESOLUTION AREA HERE.
6. TRUCKS EXPERIENCING TROUBLE PULL INTO THESE LANES WHERE THEY PARK AND THE TRUCKER ENTERS THE ADJACENT BUILDING TO REMEDY THE PROBLEM.
7. IF THE PROBLEM IS RESOLVED, THE TRUCKER FOLLOWS TRAFFIC AND RETURNS TO THE TERMINAL VIA STEP 5, OTHERWISE, THEY EXIT THE TERMINAL HERE.
8. UPON COMPLETING THEIR BUSINESS IN THE TERMINAL, TRUCKS PASS THOUGH THE OCR OUTBOUND CAMERAS, WHERE THE TRUCK, CHASSIS, AND CONTAINER NUMBER ARE SCANNED WHILE THE TRUCK IS MOVING.
9. TRUCKS PASS THROUGH US CUSTOMS RADIATION PORTAL MONITORS. ANY TRUCK FAILING PULLS TO THE LEFT FOR A SECONDARY SCREENING, AS DIRECTED BY US CUSTOMS OFFICERS.
10. TRUCKERS ENTER THEIR INFORMATION AT THE PEDESTAL AND RECEIVE A TICKER. INFORMATION OBTAINED FROM THE OCR CAMERAS IS MATCHED AGAINST TRUCKER INFORMATION. IF THERE IS A PROBLEM, TRUCKERS ENTER THE TROUBLE RESOLUTION AREA VIA THE GATE IN STEP 7. IF IT IS RESOLVED, THEY RE-ENTER THE EXIT GATE AT STEP 7; OTHERWISE THEY RE-ENTER THE TERMINAL AT STEP 5.
11. TRUCKERS PRESENT SECURITY CREDENTIALS FOR A MANUAL VISUAL INSPECTION AND EXIT THE TERMINAL ONTO PACKER AVENUE.

0 250 500 FT.
1"=250'

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-9 T-n-T FAST SHIP TERMINAL GATE

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE GATES.dwg.....Layout: CONV-FB



INTEGRATED FAST SHIP TERMINAL (17IN/12OUT)

TRUCKS DRIVE DOWN PACKER AVENUE. ONE LANE IS FOR CONVENTIONAL CONTAINERS IN AND ANOTHER ONE OUT. THERE IS A DEDICATED LANE FOR FAST SHIP TRUCKS IN AND ANOTHER ONE OUTBOUND. THE FIFTH LANE IS FOR EMERGENCY VEHICLES, MISCELLANEOUS TRAFFIC, OR BYPASSING.

TRUCKERS PRESENT SECURITY CREDENTIALS FOR A MANUAL VISUAL INSPECTION. THERE IS ONE DEDICATED FAST SHIP LANE AND TWO FOR CONVENTIONAL CARGO.

TRUCKS PASS UNDER OCR CAMERA PORTALS WHICH READ LICENSE PLATE, CONTAINER NUMBER, AND CHASSIS NUMBER. TRUCKS DO NOT STOP.

TRUCKS QUEUE IN THESE LANES; ONE IS DEDICATED TO FAST SHIP AND TWO TO CONVENTIONAL CARGO.

TRUCKS APPROACH THE PEDESTALS, WHICH HAVE WEIGH SCALES, AND GET ROUTING INFORMATION. INFORMATION OBTAINED WITH OCR CAMERAS IS MATCHED WITH TRUCKER INFORMATION INPUT AT PEDESTAL. CAMERAS CHECK FOR DAMAGE TO CONTAINER AND/OR CHASSIS. THERE FIVE DEDICATED FAST SHIP LANES AND 12 CONVENTIONAL CARGO LANES. ANY TRUCK WITH A PROBLEM AT THE PEDESTAL ENTERS THE TROUBLE RESOLUTION AREA HERE.

TRUCKS EXPERIENCING TROUBLE PULL INTO THESE LANES WHERE THEY PARK AND THE TRUCKER ENTERS THE ADJACENT BUILDING TO REMEDY THE PROBLEM.

IF THE PROBLEM IS RESOLVED, THE TRUCKER FOLLOWS TRAFFIC AND RETURNS TO THE TERMINAL VIA STEP 5, OTHERWISE, THEY EXIT THE TERMINAL HERE.

UPON COMPLETING THEIR BUSINESS IN THE TERMINAL, TRUCKS PASS THOUGH THE OCR OUTBOUND CAMERAS, WHERE THE TRUCK, CHASSIS, AND CONTAINER NUMBER ARE SCANNED WHILE THE TRUCK IS MOVING. THERE IS ONE DEDICATED FAST SHIP LANE.

TRUCKS PASS THROUGH US CUSTOMS RADIATION PORTAL MONITORS. ANY TRUCK FAILING PULLS TO THE LEFT FOR A SECONDARY SCREENING, AS DIRECTED BY US CUSTOMS OFFICERS.

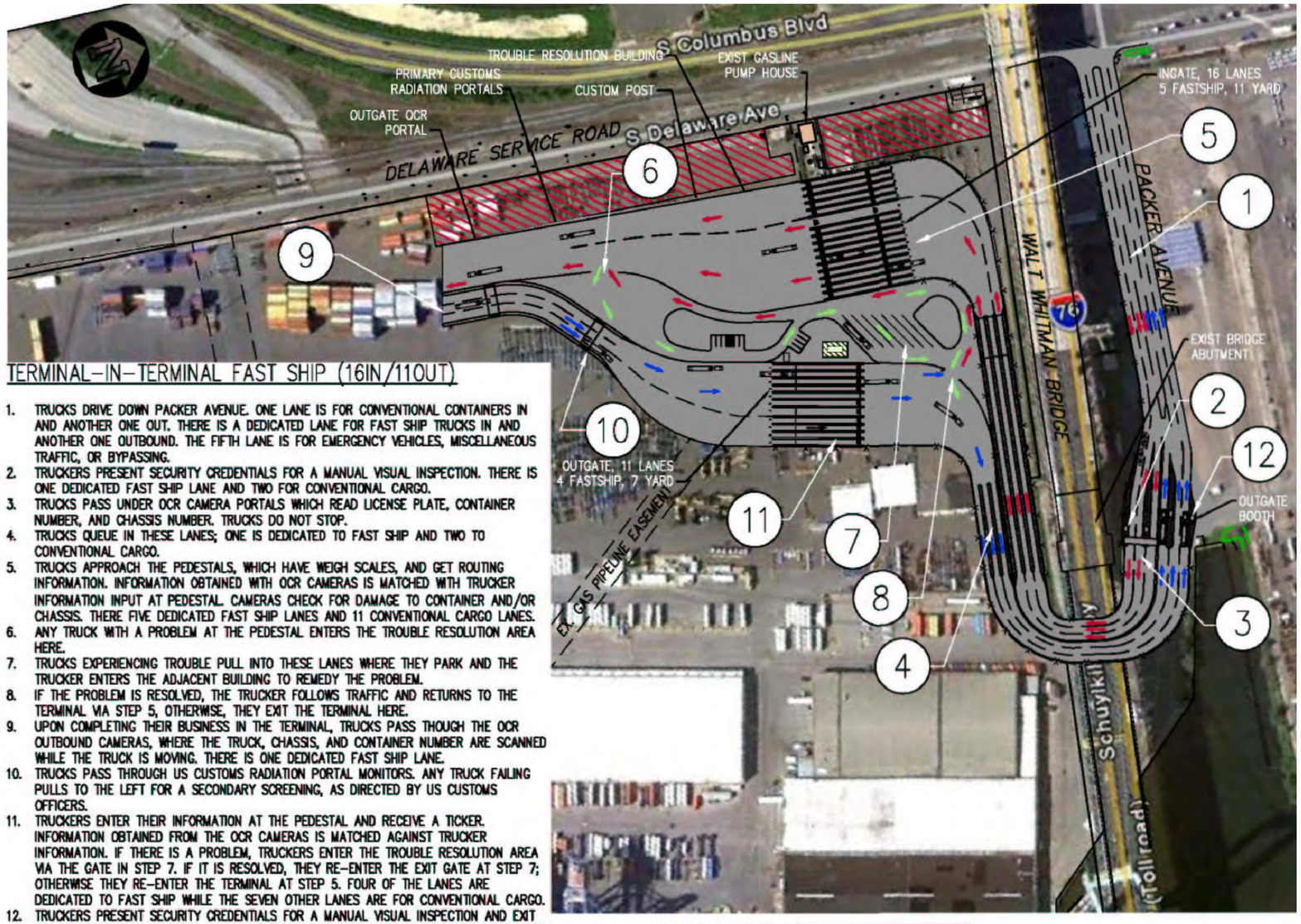
TRUCKERS ENTER THEIR INFORMATION AT THE PEDESTAL AND RECEIVE A TICKER. INFORMATION OBTAINED FROM THE OCR CAMERAS IS MATCHED AGAINST TRUCKER INFORMATION. IF THERE IS A PROBLEM, TRUCKERS ENTER THE TROUBLE RESOLUTION AREA VIA THE GATE IN STEP 7. IF IT IS RESOLVED, THEY RE-ENTER THE EXIT GATE AT STEP 7; OTHERWISE THEY RE-ENTER THE TERMINAL AT STEP 5. FOUR OF THE LANES ARE DEDICATED TO FAST SHIP WHILE THE EIGHT OTHER LANES ARE FOR CONVENTIONAL CARGO.

TRUCKERS PRESENT SECURITY CREDENTIALS FOR A MANUAL VISUAL INSPECTION AND EXIT THE TERMINAL ONTO PACKER AVENUE. THERE IS ONE DEDICATED FAST SHIP LANE AND TWO CONVENTIONAL CARGO LANES.

1"=200' 0 200 400 FT.

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-10 INTEGRATED FAST SHIP TERMINAL GATE

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE GATES.dwg.....Layout: INT FS



TERMINAL-IN-TERMINAL FAST SHIP (16IN/11OUT)

1. TRUCKS DRIVE DOWN PACKER AVENUE. ONE LANE IS FOR CONVENTIONAL CONTAINERS IN AND ANOTHER ONE OUT. THERE IS A DEDICATED LANE FOR FAST SHIP TRUCKS IN AND ANOTHER ONE OUTBOUND. THE FIFTH LANE IS FOR EMERGENCY VEHICLES, MISCELLANEOUS TRAFFIC, OR BYPASSING.
2. TRUCKERS PRESENT SECURITY CREDENTIALS FOR A MANUAL VISUAL INSPECTION. THERE IS ONE DEDICATED FAST SHIP LANE AND TWO FOR CONVENTIONAL CARGO.
3. TRUCKS PASS UNDER OCR CAMERA PORTALS WHICH READ LICENSE PLATE, CONTAINER NUMBER, AND CHASSIS NUMBER. TRUCKS DO NOT STOP.
4. TRUCKS QUEUE IN THESE LANES; ONE IS DEDICATED TO FAST SHIP AND TWO TO CONVENTIONAL CARGO.
5. TRUCKS APPROACH THE PEDESTALS, WHICH HAVE WEIGH SCALES, AND GET ROUTING INFORMATION. INFORMATION OBTAINED WITH OCR CAMERAS IS MATCHED WITH TRUCKER INFORMATION INPUT AT PEDESTAL. CAMERAS CHECK FOR DAMAGE TO CONTAINER AND/OR CHASSIS. THERE FIVE DEDICATED FAST SHIP LANES AND 11 CONVENTIONAL CARGO LANES.
6. ANY TRUCK WITH A PROBLEM AT THE PEDESTAL ENTERS THE TROUBLE RESOLUTION AREA HERE.
7. TRUCKS EXPERIENCING TROUBLE PULL INTO THESE LANES WHERE THEY PARK AND THE TRUCKER ENTERS THE ADJACENT BUILDING TO REMEDY THE PROBLEM.
8. IF THE PROBLEM IS RESOLVED, THE TRUCKER FOLLOWS TRAFFIC AND RETURNS TO THE TERMINAL VIA STEP 5, OTHERWISE, THEY EXIT THE TERMINAL HERE.
9. UPON COMPLETING THEIR BUSINESS IN THE TERMINAL, TRUCKS PASS THOUGH THE OCR OUTBOUND CAMERAS, WHERE THE TRUCK, CHASSIS, AND CONTAINER NUMBER ARE SCANNED WHILE THE TRUCK IS MOVING. THERE IS ONE DEDICATED FAST SHIP LANE.
10. TRUCKS PASS THROUGH US CUSTOMS RADIATION PORTAL MONITORS. ANY TRUCK FAILING PULLS TO THE LEFT FOR A SECONDARY SCREENING, AS DIRECTED BY US CUSTOMS OFFICERS.
11. TRUCKERS ENTER THEIR INFORMATION AT THE PEDESTAL AND RECEIVE A TICKER. INFORMATION OBTAINED FROM THE OCR CAMERAS IS MATCHED AGAINST TRUCKER INFORMATION. IF THERE IS A PROBLEM, TRUCKERS ENTER THE TROUBLE RESOLUTION AREA VIA THE GATE IN STEP 7. IF IT IS RESOLVED, THEY RE-ENTER THE EXIT GATE AT STEP 7; OTHERWISE THEY RE-ENTER THE TERMINAL AT STEP 5. FOUR OF THE LANES ARE DEDICATED TO FAST SHIP WHILE THE SEVEN OTHER LANES ARE FOR CONVENTIONAL CARGO.
12. TRUCKERS PRESENT SECURITY CREDENTIALS FOR A MANUAL VISUAL INSPECTION AND EXIT THE TERMINAL ONTO PACKER AVENUE. THERE IS ONE DEDICATED FAST SHIP LANE AND TWO CONVENTIONAL CARGO LANES.

PACKER AVE. MARINE TERMINAL OPERATIONAL ANALYSIS REPORT DECEMBER, 2011	URBAN ENGINEERS, INC. MARINE ENGINEERING SERVICES DIVISION 530 WALNUT STREET, 14TH FLOOR PHILADELPHIA, PA. 19106-3685 PHONE (215) 922-8080 FAX (215) 922-8082	HPC HAMBURG PORT CONSULTING GmbH 21129 HAMBURG, GERMANY TEL +49 (0) 40 74008-132	TEC INC. 619 SEVERN AVE., SUITE 202 ANNAPOLIS, MD 21403 TEL (410) 990-0299 FAX (410) 990-0455	Halcrow 22 CORTLANDT STREET NEW YORK, NY 10007 TEL (212) 608-3990 FAX (212) 566-5059	PHILADELPHIA REGIONAL PORT AUTHORITY	FIG. A-11 T-n-T FAST SHIP TERMINAL GATE

CADD FILE: X:\Annapolis\Projects\9603 Packer Ave Automation Master Plan\DWGs\CURRENT\9603-PACAVE GATES.dwg.....Layout: T-n-T FS

APPENDIX B

LIST OF ABBREVIATION

List of Abbreviations

AGV	Automated Guided Vehicle
aTnT	Automated Termini In Terminal
CFS	Container Freight Station
DGPS	Differential Global Position Satellite
DOD	Department of Defense
DSR	Delaware Avenue Service Road
GPS	Global Positioning Satellite
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
MARAD	Maritime Administration
M&R	Maintenance and Repair
mInT	Manual Integrated Terminal
MT	Empty Containers
mTnT	Manual Terminal in Terminal
OCR	Optical Character Recognition
OOG	Out of Gauge
OOG	Over Height or Over Weight
PAMT	Packer Avenue Marine Terminal
PRPA	Philadelphia Regional Port Authority
RPM	Radiation Portal Monitors
RTG	Rubber Tired Gantry Crane
SC	SCdle Carrier
TIR	“Transports Internationaux Routiers” or "International Road Transports"
TEU	Twenty Foot Equivalent Unit

APPENDIX C

GATE COST BREAKDOWN

Packer Avenue Gate Conceptual Estimate
Philadelphia Regional Port Authority
Philadelphia, PA

Job No.: DNPAMT
20-Dec-11

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Conventional Full Build Out				**18,572,266**
Removals	***1***	***ls***	***1,061,640***	**1,061,640**
Remove Existing Pavements at Work Area	***51,250***	***sq yd***	***17***	**896,670**
Pavement Removal	51,250	sq yd	6	298,890
Material Disposal	34,166.67	cu yd	17	597,780
Excavations as Required for New Infrastructure	***1,898***	***cu yd***	***41***	**77,490**
Excavation	1,898.15	cu yd	23	44,280
Material Disposal	1,898.15	cu yd	17	33,210
Existing Gate and Miscellaneous Site Removals	***1***	***ls***	***87,480***	**87,480**
Existing Gate and Miscellaneous Site Removals	1.00	ls	87,480	87,480
Site Work	***1***	***ls***	***5,466,042***	**5,466,042**
New Pavement Road System / Curbing - Complete	***51,250***	***sq yd***	***41***	**2,092,230**
New Pavement Road System / Curbing - Complete	51,250.00	sq yd	41	2,092,230
New Drainage Systems	***1***	***ls***	***233,280***	**233,280**
New Drainage Systems	1.00	ls	233,280	233,280
Security Fencing	***3,250***	***ft***	***292***	**947,700**
Security Fencing	3,250.00	ft	292	947,700
Road Lane and Parking Stripping	***1***	***ls***	***34,992***	**34,992**
Road Lane and Parking Stripping	1.00	ls	34,992	34,992
Traffic Signage	***1***	***ls***	***29,160***	**29,160**
Traffic Signage	1.00	ls	29,160	29,160
Traffic Control and Safety Protection Systems	***1***	***ls***	***87,480***	**87,480**
Traffic Control and Safety Protection Systems	1.00	ls	87,480	87,480

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Electrical Utilities & Ductbanks	***1***	***ls***	***583,200***	**583,200**
Electrical Utilities & Ductbanks	1.00	ls	583,200	583,200
Communication Ductbanks	***1***	***ls***	***583,200***	**583,200**
Communication Ductbanks	1.00	ls	583,200	583,200
Area Lighting	***1***	***ls***	***874,800***	**874,800**
Area Lighting	1.00	ls	874,800	874,800
Operations and Security Infrastructure	***1***	***ls***	***6,157,426***	**6,157,426**
Inbound Access Security Booth	***1***	***unit***	***23,328***	**23,328**
Inbound Access Security Booth	1.00	unit	23,328	23,328
Inbound OCR Camera Portals	***3***	***lane***	***104,976***	**314,928**
Inbound OCR Camera Portals	3.00	lane	17,496	52,488
OCR Camera Units and Supporting Infrastructure	15.00	unit	17,496	262,440
Inbound Control Gate	***14***	***sets***	***200,371***	**2,805,192**
Control Gate Building - 14 Lanes	14.00	sets	17,496	244,944
Weigh Scales	14.00	unit	58,320	816,480
Data Collection Pedestals	14.00	unit	11,664	163,296
Access Control Gate	14.00	unit	8,748	122,472
Camera Bridge	1.00	ls	233,280	233,280
Camera Units	70.00	units	11,664	816,480
Data Cabling	1.00	ls	408,240	408,240
Trouble Resolution Building	***1,250***	***sq ft***	***175***	**218,700**
Trouble Resolution Building	1,250.00	sq ft	175	218,700
Outbound OCR Camera Portals	***3***	***lane***	***104,976***	**314,928**
Outbound OCR Camera Portals	3.00	lane	17,496	52,488
OCR Camera Units and Supporting Infrastructure	15.00	unit	17,496	262,440
Radiation Portal Monitors	***3***	***unit***	***291,600***	**874,800**
Radiation Portal Monitors	3.00	unit	291,600	874,800

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Outbound Control Gate	***10***	***sets***	***160,380***	**1,603,800**
Control Gate Building - 14 Lanes	10.00	sets	17,496	174,960
Data Collection Pedestals	10.00	unit	11,664	116,640
Access Control Gate	10.00	unit	8,748	87,480
Camera Bridge	1.00	ls	233,280	233,280
Camera Units	50.00	units	11,664	583,200
Data Cabling	1.00	ls	408,240	408,240
Outbound Access Security Booth - Upgrade	***1***	***unit***	***1,750***	**1,750**
Outbound Access Security Booth - Upgrade	1.00	unit	1,750	1,750
		Sub-Total		**12,685,108**
		Overhead	10.0%	1,268,511
		Profit	10.0%	1,395,362
		Design Contingency	10.0%	1,534,898
		Construction Contingency	10.0%	1,688,388
		Conventional Full Build Out		**18,572,266**

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Fast Ship Automated / Manual Terminal -in-Terminal				**20,763,672**
Removals	***1***	***ls***	***1,475,430***	**1,475,430**
Remove Existing Pavements at Work Area	***54,028***	***sq yd***	***24***	**1,296,810**
Terminal Pavement Removal	54,027.78	sq yd	6	315,090
Material Disposal	49,861.11	cu yd	17	872,370
Packer Ave Removals	6,250.00	sq yd	6	36,450
Material Disposal	4,166.67	cu yd	17	72,900
Excavations as Required for New Infrastructure	***2,233***	***cu yd***	***41***	**91,140**
Excavation	2,232.51	cu yd	23	52,080
Material Disposal	2,232.51	cu yd	17	39,060
Existing Gate and Miscellaneous Site Removals	***1***	***ls***	***87,480***	**87,480**
Existing Gate and Miscellaneous Site Removals	1.00	ls	87,480	87,480
Site Work	***1***	***ls***	***5,980,392***	**5,980,392**
New Pavement Road System / Curbing - Complete	***54,028***	***sq yd***	***46***	**2,460,780**
New Terminal Pavement Road System / Curbing - Complete	54,027.78	sq yd	41	2,205,630
New Packer Avenue Pavement Road System / Curbing - Complete	6,250.00	sq yd	41	255,150
New Drainage Systems	***1***	***ls***	***233,280***	**233,280**
New Drainage Systems	1.00	ls	233,280	233,280
Security Fencing	***3,250***	***ft***	***292***	**947,700**
Security Fencing	3,250.00	ft	292	947,700
Road Lane and Parking Stripping	***1***	***ls***	***34,992***	**34,992**
Road Lane and Parking Stripping	1.00	ls	34,992	34,992
Traffic Signage	***1***	***ls***	***40,824***	**40,824**
Traffic Signage	1.00	ls	40,824	40,824
Traffic Control and Safety Protection Systems	***1***	***ls***	***104,976***	**104,976**
Traffic Control and Safety Protection Systems	1.00	ls	104,976	104,976

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Electrical Utilities & Ductbanks	***1***	***ls***	***583,200***	**583,200**
Electrical Utilities & Ductbanks	1.00	ls	583,200	583,200
Communication Ductbanks	***1***	***ls***	***583,200***	**583,200**
Communication Ductbanks	1.00	ls	583,200	583,200
Area Lighting	***1***	***ls***	***991,440***	**991,440**
Area Lighting	1.00	ls	991,440	991,440
Operations and Security Infrastructure	***1***	***ls***	***6,726,046***	**6,726,046**
Inbound Access Security Booth	***2***	***unit***	***23,328***	**46,656**
Inbound Access Security Booth	2.00	unit	23,328	46,656
Inbound OCR Camera Portals	***3***	***lane***	***104,976***	**314,928**
Inbound OCR Camera Portals	3.00	lane	17,496	52,488
OCR Camera Units and Supporting Infrastructure	15.00	unit	17,496	262,440
Inbound Control Gate	***16***	***sets***	***198,288***	**3,172,608**
Control Gate Building - 14 Lanes	16.00	sets	17,496	279,936
Weigh Scales	16.00	unit	58,320	933,120
Data Collection Pedestals	16.00	unit	11,664	186,624
Access Control Gate	16.00	unit	8,748	139,968
Camera Bridge	1.00	ls	233,280	233,280
Camera Units	80.00	units	11,664	933,120
Data Cabling	1.00	ls	466,560	466,560
Trouble Resolution Building	***1,250***	***sq ft***	***175***	**218,700**
Trouble Resolution Building	1,250.00	sq ft	175	218,700
Outbound OCR Camera Portals	***3***	***lane***	***104,976***	**314,928**
Outbound OCR Camera Portals	3.00	lane	17,496	52,488
OCR Camera Units and Supporting Infrastructure	15.00	unit	17,496	262,440
Radiation Portal Monitors	***3***	***unit***	***291,600***	**874,800**
Radiation Portal Monitors	3.00	unit	291,600	874,800

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Outbound Control Gate	***11***	***sets***	***159,850***	**1,758,348**
Control Gate Building - 14 Lanes	11.00	sets	17,496	192,456
Data Collection Pedestals	11.00	unit	11,664	128,304
Access Control Gate	11.00	unit	8,748	96,228
Camera Bridge	1.00	ls	233,280	233,280
Camera Units	55.00	units	11,664	641,520
Data Cabling	1.00	ls	466,560	466,560
Outbound Access Security Booths	***1***	***unit***	***25,078***	**25,078**
Outbound Access Security Booth - Upgrade	1.00	unit	1,750	1,750
Outbound Access Security Booth - New	1.00	unit	23,328	23,328
		Sub-Total		**14,181,868**
		Overhead	10.0%	1,418,187
		Profit	10.0%	1,560,005
		Design Contingency	10.0%	1,716,006
		Construction Contingency	10.0%	1,887,607
		Fast Ship Automated / Manual Terminal -in-Terminal		**20,763,672**

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Fast Ship Integrated Terminal				**21,654,044**
Removals	***1***	***ls***	***1,544,430***	**1,544,430**
Remove Existing Pavements at Work Area	***56,806***	***sq yd***	***24***	**1,361,610**
Pavement Removal	56,805.56	sq yd	6	331,290
Material Disposal	52,638.89	cu yd	17	920,970
Packer Ave Removals	6,250.00	sq yd	6	36,450
Material Disposal	4,166.67	cu yd	17	72,900
Excavations as Required for New Infrastructure	***2,335***	***cu yd***	***41***	**95,340**
Excavation	2,335.39	cu yd	23	54,480
Material Disposal	2,335.39	cu yd	17	40,860
Existing Gate and Miscellaneous Site Removals	***1***	***ls***	***87,480***	**87,480**
Existing Gate and Miscellaneous Site Removals	1.00	ls	87,480	87,480
Site Work	***1***	***ls***	***6,152,112***	**6,152,112**
New Pavement Road System / Curbing - Complete	***56,806***	***sq yd***	***45***	**2,574,180**
New Pavement Road System / Curbing - Complete	56,805.56	sq yd	41	2,319,030
New Packer Avenue Pavement Road System / Curbing - Complete	6,250.00	sq yd	41	255,150
New Drainage Systems	***1***	***ls***	***233,280***	**233,280**
New Drainage Systems	1.00	ls	233,280	233,280
Security Fencing	***3,250***	***ft***	***292***	**947,700**
Security Fencing	3,250.00	ft	292	947,700
Road Lane and Parking Stripping	***1***	***ls***	***34,992***	**34,992**
Road Lane and Parking Stripping	1.00	ls	34,992	34,992
Traffic Signage	***1***	***ls***	***40,824***	**40,824**
Traffic Signage	1.00	ls	40,824	40,824
Traffic Control and Safety Protection Systems	***1***	***ls***	***104,976***	**104,976**
Traffic Control and Safety Protection Systems	1.00	ls	104,976	104,976

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Electrical Utilities & Ductbanks	***1***	***ls***	***583,200***	**583,200**
Electrical Utilities & Ductbanks	1.00	ls	583,200	583,200
Communication Ductbanks	***1***	***ls***	***583,200***	**583,200**
Communication Ductbanks	1.00	ls	583,200	583,200
Area Lighting	***1***	***ls***	***1,049,760***	**1,049,760**
Area Lighting	1.00	ls	1,049,760	1,049,760
Operations and Security Infrastructure	***1***	***ls***	***7,093,462***	**7,093,462**
Inbound Access Security Booth	***2***	***unit***	***23,328***	**46,656**
Inbound Access Security Booth	2.00	unit	23,328	46,656
Inbound OCR Camera Portals	***3***	***lane***	***104,976***	**314,928**
Inbound OCR Camera Portals	3.00	lane	17,496	52,488
OCR Camera Units and Supporting Infrastructure	15.00	unit	17,496	262,440
Inbound Control Gate	***17***	***sets***	***199,146***	**3,385,476**
Control Gate Building - 14 Lanes	17.00	sets	17,496	297,432
Weigh Scales	17.00	unit	58,320	991,440
Data Collection Pedestals	17.00	unit	11,664	198,288
Access Control Gate	17.00	unit	8,748	148,716
Camera Bridge	1.00	ls	233,280	233,280
Camera Units	85.00	units	11,664	991,440
Data Cabling	1.00	ls	524,880	524,880
Trouble Resolution Building	***1,250***	***sq ft***	***175***	**218,700**
Trouble Resolution Building	1,250.00	sq ft	175	218,700
Outbound OCR Camera Portals	***3***	***lane***	***104,976***	**314,928**
Outbound OCR Camera Portals	3.00	lane	17,496	52,488
OCR Camera Units and Supporting Infrastructure	15.00	unit	17,496	262,440
Radiation Portal Monitors	***3***	***unit***	***291,600***	**874,800**
Radiation Portal Monitors	3.00	unit	291,600	874,800

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost
Outbound Control Gate	***12***	***sets***	***159,408***	**1,912,896**
Control Gate Building - 14 Lanes	12.00	sets	17,496	209,952
Data Collection Pedestals	12.00	unit	11,664	139,968
Access Control Gate	12.00	unit	8,748	104,976
Camera Bridge	1.00	ls	233,280	233,280
Camera Units	60.00	units	11,664	699,840
Data Cabling	1.00	ls	524,880	524,880
Outbound Access Security Booth - Upgrade	***1***	***unit***	***25,078***	**25,078**
Outbound Access Security Booth - Upgrade	1.00	unit	1,750	1,750
Outbound Access Security Booth - New	1.00	unit	23,328	23,328
		Sub-Total		**14,790,004**
		Overhead	10.0%	1,479,000
		Profit	10.0%	1,626,900
		Design Contingency	10.0%	1,789,590
		Construction Contingency	10.0%	1,968,549
		Fast Ship Integrated Terminal		**21,654,044**

Cost Estimate - 30% Design

ITEM DESCRIPTION	Quantity	Unit	Unit Cost	Total Cost

Mark-Ups Included or Specified		**Exclusions & Clarifications**
General Conditions	6.0%	Engineering and Design Costs
Mobilization and Phasing	8.0%	Permitting and Regulatory Approvals
Overhead	10.0%	Environmental Mitigation Requirements
Profit	10.0%	Rezoning Requirements
Design Contingency	10.0%	Land Acquisition
Construction Contingency	10.0%	Escalation
Escalation	NIC	Financing or Cost of Money