NORTH CAROLINA
MARITIME Strategy

NC Maritime Strategy
Planned Utility Demands for Container Terminal Market Scenarios

Prepared for the
North Carolina Department of Transportation

by

URS
in association with AECOM

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DISCLAIMER

All values provided herein are estimates based on basic conceptual drawings. These estimated values shall not be used to design utility lines or size services.

ACKNOWLEDGEMENTS

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

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

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

EXECUTIVE SUMMARY

As input to the definition of infrastructure needs and opportunities, this *Planned Utility Demands* technical report provides an estimate of the anticipated utility demands of the container terminal market scenarios proposed in the *North Carolina Maritime Strategy*. The estimated utility demands provided are based on demands developed for other container terminal projects sized similarly to the two terminal ranges presented herein (i.e., terminal areas in the 125 – 160-acre range and 350 – 400-acre range) with adjustments made for various yard operational methods.

Anticipated infrastructure required to meet the estimated demands are also provided to the extent that the conceptual layouts allow. Utility infrastructure at existing port facilities, if available, shall be compared to projected required infrastructure. This report is primarily concerned with utilities that cross the terminal boundaries requiring service connections to existing public utility systems.

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1 ELECTRICAL

This section describes the existing electrical service and estimated electrical demands for the conceptual terminal layouts. The estimated values provided are based on demands developed for other container terminal projects sized similarly to the two terminal ranges presented herein (i.e., terminal areas in the 125 – 160-acre range and 350 – 400-acre range) with adjustments made for various yard operational methods. No actual work shall be performed using the estimates provided herein. Further development and refinement of the electrical demands of a selected layout is required as part of a complete planning and design process.

1.1 Methodology

Container terminals impose a large demand on the electrical grid. Medium voltage (1 – 38 kilovolts, kV) loads are placed by dock cranes (DC), and low voltage (<1 kV) loads are placed by refrigerated container (reefer) plugs, high mast pole area lights, pier head power and building power requirements. Additional medium voltage loads may be placed by hybrid rubber-tired gantry (RTG) cranes, automated stacking cranes (ASC, also known as rail-mounted gantry cranes, or RMG), and shore power outlets (SPOs).

Medium or high voltage (>12 kV) electrical service, depending on what is available adjacent to or near the respective site, will be brought onto the terminal. To provide redundancy two (2) service connections should be provided to two (2) separate substations. These substations will then step-down the voltage to low-medium voltage (4.16 – 6.6 kV) for use by dock cranes, electrified gantry cranes, and SPOs. Additional transformers throughout the terminal will step-down incoming voltage to low voltage service (120/208 – 277/480 volts) for use by buildings, reefers, and lights.

1.1.1 Dock Cranes

The electrical load of each dock crane is 1,595 kVA operating at 4.16 kV. A demand factor of 84% is used, which is fairly conservative when applied to the entire wharf. Dock crane electrical loads are developed from the major components comprising the crane as shown in Table 1.

Table 1: Dock Crane Component Electrical Loads

Crane Function	Load (kVA)	Amps @ 4.16 kV (2)
Main Hoist	1,187	165
Trolley	289	40
Boom (1)	289	40
Gantry (1)	423	59
Auxiliaries	263	37
Total	**1,595**	**221**

(1) Non-Concurrent Load. The boom and gantry motors operate non-concurrently from the hoist and trolley (e.g., the boom cannot be raised or lowered while the hoist is in operation). The maximum total load occurs when main hoist and trolley operate simultaneously. Per National Electrical Code (NEC) 610-14(E)(2), total crane motor load is 100% of the largest motor load plus 50% of the second largest motor load. Total crane load is this value plus the auxiliaries. Therefore, Total Load = Main Hoist Load + (50% of Trolley Load) + Auxiliaries Load.

(2) Amperage is lower at higher voltages.

Smaller vessels in the 4,000 to 6,000 TEU classes require three (3) to five (5) cranes to load and unload containers. Larger vessels in the 8,000 to 10,000 TEU range require four (4) to seven (7) cranes. In addition, typical spacing between dock cranes is approximately 300 feet center-to-center to allow for stevedore movement below without interfering traffic at a neighboring crane. These factors as well as vessel lengths and associated gap distances between vessels will be used to determine maximum dock crane counts for a given wharf length. For initial construction, it is reasonable to install fewer than the maximum number of cranes until cargo volumes and/or ship sizes dictate otherwise. However, the electrical demands will be based on maximum crane counts.

1.1.2 Reefers

Each reefer requires an 18 amp plug operating at 480 volts. This equates to an electrical demand of 14.9 kVA. Not all reefer plugs are in use simultaneously, so a demand factor of 60% is applied to calculate the total reefer electrical requirement. To calculate the design number of reefers in a container yard layout based on twenty-foot equivalent grounded slots (TGS), it is assumed that all reefers are grounded, stacked a maximum of two-high without regard to container storage method, and each slot is sized for a forty-foot container (forty-foot equivalent grounded slot, FGS).

1.1.3 Lights

Different types of exterior lights are used throughout a container terminal including high mast light poles (HMP), flood lights, roadway and parking lights, and building-, gate-, and equipment-mounted exterior lights. Building-, gate-, and equipment-mounted exterior lights are included in the electrical load calculations for buildings, gates, and equipment, respectively. To simplify the calculation of the area and roadway lighting electrical loads, only HMPs will be used. Each HMP is assumed to be 120 feet high and have twelve (12) 1000 Watt (W) luminaires. Therefore, each HMP has an electrical demand of 12 kW, or 14.1 kVA at an operating voltage of 480 V. Since all lights are on at night, then the demand factor is 100%.

For the described HMP, ground-level illumination in accordance with code, industry standard, and federal security lighting requirements by both the United States Coast Guard and Homeland Security results in a spacing between HMPs of 400 feet on-center. To prevent unnecessary light pollution and so as to not interfere with the backreach of the dock cranes, HMPs will be placed 200 feet from terminal boundaries and wharf face. The number of HMPs for a given terminal will be calculated using the aforementioned spacing parameters as well as the given terminal's area.

1.1.4 Buildings

The electrical requirements for buildings and gates vary from terminal to terminal depending on terminal capacity and throughput as well as on the chosen stevedoring method such as use of ASCs instead of RTGs and/or reach stacker (RS) and whether a terminal is operated by the port authority or by a private terminal operator or shipping line. The major buildings in a terminal include maintenance and repair facilities for stevedoring vehicles and container yard equipment, a reefer wash facility, gates, a truckers'/drivers' services building, an administration building and an operations building. It is assumed that the buildings for Sites 3 and 5 will be smaller since there is less throughput; and therefore, fewer workers. Sites 4 and 6, with the exception of the automated terminal option, will likely have larger buildings to meet the higher throughput; and

thereby, place a higher demand of the terminal electrical system. Based on these assumptions, current building sizes, proposed building floor areas provided in the conceptual terminal layouts, and recent building construction at comparable facilities, the anticipated building floor areas are provided in Table 2. Buildings are given a demand factor of 100% for the purposes of this report.

Table 2: Estimated Building Square Footages

Building	Site 5 - RS	Site 5 - RTG	Site 3 - RTG	Site 6 - RTG	Site 6 - ASC	Site 4 - RTG
Administration	7,300	7,300	7,300	16,000	16,000	12,500
Gate Security & Drivers' Services	600	600	600	1,200	1,200	1,000
Longshoremen's Restrooms	1,260	1,340	1,330	2,600	1,400	2,000
Maintenance & Repair (inc. Roadability)	26,700	39,300	39,300	60,000	40,000	50,000
Operations (Marine, Rail, & Yard)	2,890	2,890	4,550	9,000	9,000	7,500

1.1.5 Pier-Head Power

Pier-head power consists of 50 amp service outlets operating at 480 volts. These service outlets are available every 250 feet along the wharf face. Pier-head power has an estimated demand factor of 40%.

1.1.6 ASCs and Hybrid RTGs

Automated stacking cranes (ASCs) and hybrid rubber-tired gantry cranes (RTGs) have electrical loads of 550 kVA each and operate at 4.16 kV. An estimated demand factor of 60% is used.

1.1.7 Shore Power Outlets

Although shore power outlets (SPOs) are not part of this terminal analysis, it may be valuable to see the electrical demands of these systems if their addition under future conditions is so desired. Several SPOs are typically spaced all along the wharf face to allow for different berthing patterns and vessel connection configurations. The spacing is similar to pier-head power service. However, a vessel only uses one (1) SPO when berthed. Therefore, the number of SPOs used in the electrical demand calculations under each scenario is determined by the number of berths. Shore power outlets have an electrical demand of 7,500 kVA at an operating voltage of 6.6 kV. Since a ship will be powered the entire time it is at berth, then the estimated demand factor for SPOs is 100%.

1.2 Site 5 – Reach Stacker Alternative

The total estimated electrical demand for the reach stacker alternative of Site 5 as proposed is 15,973 kVA. Table 3 provides a breakdown of this estimated electrical demand. Existing electrical service voltage is shown in the GIS as 480 volts, which is insufficient. SPOs are not included for this lower throughput alternative.

Table 3: Site 5 – Reach Stacker Alternative Estimated Electrical Demand

Item	Est. Build-Out Count	Unit Demand (kVA)	Est. Demand Factor	Est. Electrical Demand (kVA)
Dock Crane	6	1,595	84%	8,039
Reefers	534	14.9	60%	4,774
Lighting (HMP)	35	14.1	100%	494
Buildings	1	2,500	100%	2,500
Pier-Head Power	10	41.6	40%	166
Total	**n/a**	**n/a**	**n/a**	**15,973**

1.3 Site 5 – RTG Alternative

The total estimated electrical demand for the RTG alternative of Site 5 as proposed is 20,675 kVA. If SPOs are desired, they will add an additional demand of 15,000 kVA for an estimated total demand of 35,675 kVA. Table 4 provides a breakdown of this estimated electrical demand. Existing electrical service is shown in the GIS as 480 volts, which is insufficient.

Table 4: Site 5 – RTG Alternative Estimated Electrical Demand

Item	Est. Build-Out Count	Unit Demand (kVA)	Est. Demand Factor	Est. Electrical Demand (kVA)
Dock Crane	9	1,595	84%	12,058
Reefers	588	14.9	60%	5,257
Lighting (HMP)	35	14.1	100%	494
Buildings	1	2,730	100%	2,730
Pier-Head Power	10	41.6	40%	166
Total	**n/a**	**n/a**	**n/a**	**20,675**
SPOs	2	7,500	100%	15,000
Total w/ SPOs	**n/a**	**n/a**	**n/a**	**35,675**

1.4 Site 3 – Radio Island

The total estimated electrical demand for Site 3 as proposed is 19,201 kVA. If SPOs are desired, they will add an additional demand of 15,000 kVA for an estimated total demand of 34,201 kVA. Table 5 provides a breakdown of this estimated electrical demand. Per the GIS database, electrical service crosses the site, but no voltage is provided.

Table 5: Site 3 – Radio Island Alternative Estimated Electrical Demand

Item	Est. Build-Out Count	Unit Demand (kVA)	Est. Demand Factor	Est. Electrical Demand (kVA)
Dock Crane	9	1,595	84%	12,058
Reefers	384	14.9	60%	3,433
Lighting (HMP)	35	14.1	100%	494
Buildings	1	3,050	100%	3,050
Pier-Head Power	10	41.6	40%	166
Total	**n/a**	**n/a**	**n/a**	**19,201**
SPOs	2	7,500	100%	15,000
Total w/ SPOs	**n/a**	**n/a**	**n/a**	**34,201**

1.5 Site 6 – Standard RTG Alternative

The total estimated electrical demand for the standard RTG alternative of Site 6 as proposed is 33,656 kVA. If SPOs are desired, they will add an additional demand of 22,500 kVA for an estimated total demand of 56,156 kVA. Table 6 provides a breakdown of this estimated electrical demand.

Table 6: Site 6 – Standard RTG Alternative Estimated Electrical Demand

Item	Est. Build-Out Count	Unit Demand (kVA)	Est. Demand Factor	Est. Electrical Demand (kVA)
Dock Crane	13	1,595	84%	17,417
Reefers	1,208	14.9	60%	10,800
Lighting (HMP)	90	14.1	100%	1,269
Buildings	1	3,920	100%	3,920
Pier-Head Power	15	41.6	40%	250
Total	**n/a**	**n/a**	**n/a**	**33,656**
SPOs	3	7,500	100%	22,500
Total w/ SPOs	**n/a**	**n/a**	**n/a**	**56,156**

The number of dock cranes is based on anticipated vessel sizes servicing these berths as well as the wharf length. Thirteen (13) dock cranes would be an optimal build-out number for this wharf length. The number of reefers is based on the ratio of reefer TGS to total TGS for the Site 5 – RTG Alternative. Therefore, 7.4% of 16,320 TGS is 1,208 TGS (604 FGS) for reefers. At two-high stacking 1,208 reefer outlets are proposed. The container yard is conceptual in nature. Based on typical operations of one (1) RTG per module, or row, and the proposed container yard area, which appears to have 36 rows, then the estimated build-out number of diesel-powered RTGs is 36.

1.6 Site 6 – Hybrid RTG Alternative

The total estimated electrical demand for the hybrid RTG alternative of Site 6 as proposed is 45,409 kVA. If SPOs are desired, they will add an additional demand of 22,500 kVA for an estimated total demand of 67,909 kVA. Table 7 provides a breakdown of this estimated electrical demand.

Table 7: Site 6 – Hybrid RTG Alternative Estimated Electrical Demand

Item	Build-Out Count	Unit Demand (kVA)	Demand Factor	Electrical Demand (kVA)
Dock Crane	13	1,595	84%	17,417
Reefers	1,208	14.9	60%	10,800
Lighting (HMP)	81	14.1	100%	1,142
Buildings	1	3,920	100%	3,920
Pier-Head Power	15	41.6	40%	250
Hybrid RTG	36	550	60%	11,880
Total	**n/a**	**n/a**	**n/a**	**45,409**
SPOs	3	7,500	100%	22,500
Total w/ SPOs	**n/a**	**n/a**	**n/a**	**67,909**

The number of dock cranes is based on anticipated vessel sizes servicing these berths as well as the wharf length. Thirteen (13) dock cranes would be an optimal build-out number for this wharf length. The number of reefers is based on the ratio of reefer TGS to total TGS for the Site 5 – RTG Alternative. Therefore, 7.4% of 16,320 TGS is 1,208 TGS (604 FGS) for reefers. At two-high stacking 1,208 reefer outlets are proposed. The container yard is conceptual in nature. Based on typical operations of one (1) RTG per module, or row, and the proposed container yard area, which appears to have 36 rows, then the estimated build-out number of hybrid RTGs is 36.

1.7 Site 6 – ASC Alternative

The total estimated electrical demand for the ASC alternative of Site 6 as proposed is 59,992 kVA. If SPOs are desired, they will add an additional demand of 22,500 kVA for an estimated total demand of 82,492 kVA. Table 8 provides a breakdown of this estimated electrical demand.

Table 8: Site 6 – ASC Alternative Estimated Electrical Demand

Item	Est. Build-Out Count	Unit Demand (kVA)	Est. Demand Factor	Est. Electrical Demand (kVA)
Dock Crane	16	1,595	84%	21,437
Reefers	1,420	14.9	60%	12,698
Lighting (HMP)	70	14.1	100%	987
Buildings	1	3,500	100%	3,500
Pier-Head Power	15	41.6	40%	250
ASCs	64	550	60%	21,120
Total	**n/a**	**n/a**	**n/a**	**59,992**
SPOs	3	7,500	100%	22,500
Total w/ SPOs	**n/a**	**n/a**	**n/a**	**82,492**

The number of dock cranes is based on the number of ASC modules. There are typically two (2) ASC modules, or columns, per dock crane. Since there are 32 ASC modules, then 16 dock cranes would be the optimal number. There are also 2 ASCs per module, one working the waterside and one working the landside of the module, for a total of 64 ASCs. The number of reefers is based on the ratio of reefers TGS to total TGS for the Site 5 – RTG Alternative. Therefore, 7.4% of 19,200 TGS is 1,420 TGS (710 FGS) for reefers.

Since ASC operations are automated within the container storage area, less lighting is required since no persons are allowed to enter during operations for safety reasons. Only a few HMPs are required within the container storage area for security, so the estimated number of HMPs is reduced by 20.

1.8 Site 4 – Standard RTG Alternative

The total estimated electrical demand for the standard RTG alternative of Site 4 as proposed is 23,942 kVA. If SPOs are desired, they will add an additional demand of 15,000 kVA for an estimated total demand of 38,942 kVA. Table 9 provides a breakdown of this estimated electrical demand.

Table 9: Site 4 – Standard RTG Alternative Estimated Electrical Demand

Item	Build-Out Count	Unit Demand (kVA)	Demand Factor	Electrical Demand (kVA)
Dock Crane	9	1,595	84%	12,058
Reefers	796	14.9	60%	7,116
Lighting (HMP)	81	14.1	100%	1,142
Buildings	1	3,460	100%	3,460
Pier-Head Power	10	41.6	40%	166
Total	**n/a**	**n/a**	**n/a**	**23,942**
SPOs	2	7,500	100%	15,000
Total w/ SPOs	**n/a**	**n/a**	**n/a**	**38,942**

The number of dock cranes is based on anticipated vessel sizes servicing these berths as well as the wharf length. Nine (9) dock cranes would be an optimal build-out number for this wharf length. The number of reefers is based on the ratio of reefer TGS to total TGS for the Site 5 – RTG Alternative. Therefore, 7.4% of 10,760 TGS is 796 TGS (398 FGS) for reefers. The container yard is conceptual in nature. Based on typical operations of one (1) RTG per module, or row, and the proposed container yard area, which appears to have 24 rows, then the estimated build-out number of diesel-powered RTGs is 24.

1.9 Site 4 – Hybrid RTG Alternative

The total estimated electrical demand for the hybrid RTG alternative of Site 4 as proposed is 31,862 kVA. If SPOs are desired, they will add an additional demand of 15,000 kVA for an estimated total demand of 46,862 kVA. Table 10 provides a breakdown of this estimated electrical demand.

Table 10: Site 4 – Hybrid RTG Alternative Estimated Electrical Demand

Item	Build-Out Count	Unit Demand (kVA)	Demand Factor	Electrical Demand (kVA)
Dock Crane	9	1,595	84%	12,058
Reefers	796	14.9	60%	7,116
Lighting (HMP)	81	14.1	100%	1,142
Buildings	1	3,460	100%	3,460
Pier-Head Power	10	41.6	40%	166
Hybrid RTG	24	550	60%	7,920
Total	**n/a**	**n/a**	**n/a**	**31,862**
SPOs	2	7,500	100%	15,000
Total w/ SPOs	**n/a**	**n/a**	**n/a**	**46,862**

The number of dock cranes is based on anticipated vessel sizes servicing these berths as well as the wharf length. Nine (9) dock cranes would be an optimal build-out number for this wharf length. The number of reefers is based on the ratio of reefer TGS to total TGS for the Site 5 – RTG Alternative. Therefore, 7.4% of 10,760 TGS is 796 TGS (398 FGS) for reefers. The container yard is conceptual in nature. Based on typical operations of one (1) RTG per module, or row, and the proposed container yard area, which appears to have 24 rows, then the estimated build-out number of hybrid RTGs is 24.

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2 WATER

This section describes the existing water service and estimated water demands for the conceptual terminal layouts. The estimated values provided are based on fixture unit counts developed for other similarly sized container terminal projects. No actual work shall be performed using the estimates provided herein. Further development and refinement of the water demands of a selected layout is required as part of a complete planning and design process.

2.1 Methodology

2.1.1 Domestic Water

Domestic water usage at a container terminal includes flow to buildings to service restrooms, kitchens and/or break rooms, and utility closets. Buildings include but are not limited to administration, operations, maintenance and repair facility offices, gate security, drivers'/ truckers' services, and longshoremen's restrooms. Additional flow is required for the equipment shops at the maintenance and repair facilities and the reefer wash facility as well as at roadability services.

There are different methods for estimating domestic water demand. The preferred method, which is the method published in the North Carolina Plumbing Code, is to count fixture units. Each type of plumbing fixture such as a lavatory or water closet (i.e., toilet stall) is assigned a fixture unit. The total fixture units for a given structure, or in some cases a given floor, is converted to a maximum probable flow. This flow is used to size pipes and meters. The number of plumbing fixtures is a function of the building capacity which is a function of the anticipated number of employees and other occupants. Since the number of employees and other occupants is unknown at this time, sources such as facilities at similar sized container terminals and employee counts at other container terminals are used to estimate required fixture counts and henceforth, domestic water flow. The building floor areas are provided in Table 2, herein before. In addition, flush valve (flushometer) type urinals and water closets are assumed. Due to its high usage, an additional reefer wash hose bibb flow from 40 gpm (for the smaller terminal layouts) up to 120 gpm (for the larger terminal layouts) will be added to building and equipment shop domestic water flows.

2.1.2 Ship Water

Most modern container ships have on-board desalination plants, and they produce potable water while at sea. Therefore, few vessels request shore water connections though it is available. When container ships do take on shore water, it is typically in the range of 100 to 500 gallons per ship during the entire time at berth. Therefore, since ship water is a rare occurrence and only a minimal amount is taken when a connection is used, then ship water will be discounted in this report.

2.1.3 Fire Water

Fire protection requirements for container terminals are set by National Fire Protection Association Standard 307 (NFPA 307), the North Carolina Fire Code (NCFC), and the authority

having jurisdiction (AHJ). The North Carolina Fire Code provides fire water flow requirements for buildings within the terminals but not for the container yard. No fire water flow requirements are provided in NFPA 307 nor the standards of the AHJs for container yards either. AHJs at other container terminals throughout the United States vary in their approach to fire flow requirements. These requirements depend on whether the facility is an existing terminal or a greenfield site, the type of the yard storage (i.e., reach stacker, RTG, or ASC), and risk management. Two of the more conservative fire flow protection schemes include sizing pipes and equipment based on flow from either:

a) the furthest four (4) hydrants at a rate of 1,000 gpm each for a total fire water flow of 4,000 gpm with a residual pressure of 20 pressure per square inch (psi) at the most remote outlet (note: residual pressure requirement per NCFC), or
b) the furthest three (3) hydrants at a rate of 1,500 gpm each for a total fire water flow of 4,500 gpm with a residual pressure of 20 psi at the most remote outlet.

A less conservative but still widely used and accepted method is to size pipes and equipment to handle fire water flow at the two (2) furthest hydrants flowing at a rate of 1,500 gpm each for a total fire water flow of 3,000 gpm with a residual pressure of 20 psi at the most remote outlet. Since NFPA 307 defers to the AHJ, then the fire department responsible for the preferred container terminal site will have to specify the fire flow requirements acceptable to them. Please note that all fire flows are in addition to the estimated peak hour domestic water flow. It is assumed that all buildings within the terminal shall be Type IIA or better as described in the NCFC. Based on proposed and assumed building areas provided in Table 2, all buildings would require fire flows less than 4,500 gpm per Appendix B of the NCFC. Therefore, for the purposes of this report, a fire flow value of 4,500 gpm will be used. In addition, the following two items are assumed: 1) the AJH allows for combined fire and domestic water systems within the terminal except for building standpipe and fire sprinkler systems and 2) building standpipe and fire sprinkler systems are pressurized using a fire pump to meet NFPA 13 and 14 and NCFC fire flow and residual pressure requirements.

NFPA 307 does discuss fire hydrant spacing which is set to no further than 300 feet apart between hydrants. Hydrants are typically placed adjacent to high mast light poles so that the hydrant location is easily identified, to provide added protection (drivers are less likely to hit a high mast light pole than a low set hydrant), and to minimize lost container slots. Since high mast light pole spacing is typically 400 feet, many AHJs grant waivers to NFPA 307 to allow hydrants to also be spaced 400 feet apart.

Additional NFPA standards including standards 10, 13, 14, and 20 as well as occupancy classifications and loads as defined in the North Carolina Building Code will have to be consulted as part of any design process. Depending on use, occupancy classifications within a container terminal may include Business, Factory and Industrial, High Hazard, and Storage. The classifications shall be determined in consultation with local building and fire authorities. This report only focuses on anticipated fire flow requirements and potential fire pump requirements.

2.2 Site 5 – Reach Stacker Alternative

Site 5 is located on the existing container terminal at the Port of Wilmington. The reach stacker alternative does not propose a reefer wash facility. This alternative also calls for the existing maintenance and repair building, operations building, and longshoremen's restroom to remain; however, estimated fixture counts are used for these structures since renovations may be incorporated as part of other terminal upgrades due to unknown future employee needs. The projected range of maximum probable domestic water flows is 103 to 109 gpm (129 to 145 gpm) as shown in Table 11.

Table 11: Site 5 – Reach Stacker Alternative Maximum Probable Domestic Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	65	80
Gate Security & Drivers' Services	25	35
Longshoremen's Restrooms	45	55
Maintenance & Repair (inc. Roadability)	160	200
Operations (Marine, Rail, & Yard)	125	150
Total Fixture Units	**420**	**520**
Maximum Probable DW Flow (gpm)	103 (129) (1)	109 (145) (1)
Reefer Wash (gpm)	n/a	n/a
Total DW Flow (gpm)	**103 (129) (1)**	**109 (145) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Adding a fire flow of 4,500 gpm would increase the potable water range to 4,603 to 4,609 gpm (4,629 to 4,645 gpm). Fire hydrant pressure tests should be conducted on existing hydrants to determine if a fire pump capable of 4,700 gpm will be necessary to maintain the required residual pressure. If a fire pump is required, than a jockey pump capable of maintaining proper line pressure during initial fire pump start-up will also be necessary. This fire pump package is in addition to any fire pumps necessary to maintain proper line pressure in the buildings' standpipe and fire sprinkler systems.

Based on an estimated maximum day plus fire flow of 4,700 gpm, a minimum 8-inch looped waterline would be required. The GIS information shows a 6-inch water line traversing the existing site. The current waterline is insufficient. Building supply lines will likely be 2 inches in diameter, but both building supply and property service lines will need to be sized as part of a planning and design process.

2.3 Site 5 – RTG Alternative

Site 5 is located on the existing container terminal at the Port of Wilmington. The RTG alternative proposes to replace the existing maintenance and repair facility, the longshoremen's restroom, and the administration building. A reefer wash facility will be added as well. The existing operations building will remain, but it may be renovated as part of other terminal upgrades. The projected range of maximum probable domestic water flows is 148 to 173 gpm (181 to 215 gpm) as shown in Table 12.

Table 12: Site 5 – RTG Alternative Maximum Probable Domestic Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	65	80
Gate Security & Drivers' Services	25	35
Longshoremen's Restrooms	50	65
Maintenance & Repair (inc. Roadability)	230	270
Operations (Marine, Rail, & Yard)	125	150
Total Fixture Units	**495**	**600**
Maximum Probable DW Flow (gpm)	108 (141) (1)	113 (155) (1)
Reefer Wash (gpm)	40	60
Total DW Flow (gpm)	**148 (181) (1)**	**173 (215) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Adding a fire flow of 4,500 gpm would increase the potable water range to 4,648 to 4,673 gpm (4,681 to 4,715 gpm). Fire hydrant pressure tests should be conducted on existing hydrants to determine if a fire pump capable of 4,700 gpm will be necessary to maintain the required residual pressure. If a fire pump is required, than a jockey pump capable of maintaining proper line pressure during initial fire pump start-up will also be necessary. This fire pump package is in addition to any fire pumps necessary to maintain proper line pressure in the buildings' standpipe and fire sprinkler systems.

Based on an estimated maximum day plus fire flow of 4,700 gpm, a minimum 8-inch looped waterline would be required. The GIS information shows a 6-inch water line traversing the proposed site. The current waterline is insufficient. Building supply lines will likely be 2 inches in diameter, but both building supply and property service lines will need to be sized as part of a planning and design process.

2.4 Site 3 – Radio Island

The projected range of maximum probable domestic water flows for the greenfield Site 3 is 179 to 194 gpm (215 to 240 gpm) as shown in Table 13.

Adding a fire flow of 4,500 gpm would increase the potable water range to 4,679 to 4,694 gpm (4,715 to 4,740 gpm). Pressure tests should be conducted at the nearest fire hydrants to determine if a fire pump capable of 4,800 gpm will be necessary to maintain the required residual pressure. If a fire pump is required, than a jockey pump capable of maintaining proper line pressure during initial fire pump start-up will also be necessary. This fire pump package is in addition to any fire pumps necessary to maintain proper line pressure in the buildings' standpipe and fire sprinkler systems.

Table 13: Site 3 Maximum Probable Domestic Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	65	80
Gate Security & Drivers' Services	25	35
Longshoremen's Restrooms	50	65
Maintenance & Repair (inc. Roadability)	230	270
Operations (Marine, Rail, & Yard)	150	175
Total Fixture Units	**520**	**625**
Maximum Probable DW Flow (gpm)	109 (145) (1)	114 (160) (1)
Reefer Wash (gpm)	70	80
Total DW Flow (gpm)	**179 (215) (1)**	**194 (240) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Based on an estimated maximum day plus fire flow of 4,800 gpm, a minimum 8-inch looped waterline would be required. The GIS information shows a 4-inch water line traversing the proposed site. The current waterline is insufficient. Building supply lines will likely be 2 inches in diameter, but both building supply and property service lines will need to be sized as part of a planning and design process.

2.5 Site 6 – Standard and Hybrid RTG Alternatives

The projected range of maximum probable domestic water flows for the standard and hybrid RTG alternatives for Site 6 is 213 to 254 gpm (289 to 339 gpm) as shown in

Table 14.

Adding a fire flow of 4,500 gpm would increase the potable water range to 4,713 to 4,754 gpm (4,789 to 4,839 gpm). Pressure tests should be conducted at the nearest fire hydrants to determine if a fire pump capable of 4,900 gpm will be necessary to maintain the required residual pressure. If a fire pump is required, than a jockey pump capable of maintaining proper line pressure during initial fire pump start-up will also be necessary. This fire pump package is in addition to any fire pumps necessary to maintain proper line pressure in the buildings' standpipe and fire sprinkler systems.

Based on an estimated maximum day plus fire flow of 4,900 gpm, a minimum 8-inch looped waterline would be required. Building supply lines will likely be 2 inches in diameter, but both building supply and property service lines will need to be sized as part of a planning and design process.

Table 14: Site 6 – Standard & Hybrid RTG Alternatives Maximum Probable Domestic Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	150	180
Gate Security & Drivers' Services	45	60
Longshoremen's Restrooms	95	120
Maintenance & Repair (inc. Roadability)	380	420
Operations (Marine, Rail, & Yard)	250	300
Total Fixture Units	**920**	**1,080**
Maximum Probable DW Flow (gpm)	123 (199) (1)	134 (219) (1)
Reefer Wash (gpm)	90	120
Total DW Flow (gpm)	**213 (289) (1)**	**254 (339) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

2.6 Site 6 – ASC Alternative

The projected range of maximum probable domestic water flows for the ASC alternative for Site 6 is 208 to 242 gpm (263 to 313 gpm) as shown in Table 15. The estimated fixture units for the longshoremen's restrooms and the maintenance and repair facility are much smaller than a terminal of similar size because the automated facility requires fewer longshoremen especially within the yard and utilizes fewer stevedoring and service vehicles. Also, since the ASCs are rail-mounted, they are repaired in-situ rather than at a maintenance facility.

Adding a fire flow of 4,500 gpm would increase the potable water range to 4,708 to 4,742 gpm (4,763 to 4,813 gpm). Pressure tests should be conducted at the nearest fire hydrants to determine if a fire pump capable of 4,900 gpm will be necessary to maintain the required residual pressure. If a fire pump is required, than a jockey pump capable of maintaining proper line pressure during initial fire pump start-up will also be necessary. This fire pump package is in addition to any fire pumps necessary to maintain proper line pressure in the buildings' standpipe and fire sprinkler systems.

Table 15: Site 6 – ASC Alternative Maximum Probable Domestic Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	150	180
Gate Security & Drivers' Services	45	60
Longshoremen's Restrooms	50	65
Maintenance & Repair (inc. Roadability)	230	270
Operations (Marine, Rail, & Yard)	250	300
Total Fixture Units	**725**	**875**
Maximum Probable DW Flow (gpm)	118 (173) (1)	122 (193) (1)
Reefer Wash (gpm)	90	120
Total DW Flow (gpm)	**208 (263) (1)**	**242 (313) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Based on an estimated maximum day plus fire flow of 4,900 gpm, a minimum 8-inch looped waterline would be required. Building supply lines will likely be 2 inches in diameter, but both building supply and property service lines will need to be sized as part of a planning and design process.

2.7 Site 4 – Standard and Hybrid RTG Alternatives

The projected range of maximum probable domestic water flows for Site 4 is 198 to 232 gpm (254 to 301 gpm) as shown in Table 16.

Table 16: Site 4 Maximum Probable Domestic Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	110	140
Gate Security & Drivers' Services	40	55
Longshoremen's Restrooms	80	100
Maintenance & Repair (inc. Roadability)	300	340
Operations (Marine, Rail, & Yard)	200	230
Total Fixture Units	**730**	**865**
Maximum Probable DW Flow (gpm)	118 (174) (1)	122 (191) (1)
Reefer Wash (gpm)	80	110
Total DW Flow (gpm)	**198 (254) (1)**	**232 (301) (1)**

(2) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Adding a fire flow of 4,500 gpm would increase the potable water range to 4,698 to 4,732 gpm (4,754 to 4,801 gpm). Pressure tests should be conducted at the nearest fire hydrants to determine if a fire pump capable of 4,800 gpm will be necessary to maintain the required residual pressure. If a fire pump is required, than a jockey pump capable of maintaining proper line pressure during initial fire pump start-up will also be necessary. This fire pump package is in addition to any fire pumps necessary to maintain proper line pressure in the buildings' standpipe and fire sprinkler systems.

Based on an estimated maximum day plus fire flow of 4,800 gpm, a minimum 8-inch looped waterline would be required. Building supply lines will likely be 2 inches in diameter, but both building supply and property service lines will need to be sized as part of a planning and design process.

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3 WASTE WATER

This section describes the existing waste water service and estimated waste water flow generation for the conceptual terminal layouts. The estimated values provided are based on fixture unit counts developed for other similarly sized container terminal projects. No actual work shall be performed using the estimates provided herein. Further development and refinement of the waste water flow generation of a selected layout is required as part of a complete planning and design process.

3.1 Methodology

Waste water generation at a container terminal includes flow from restrooms, kitchens and/or break rooms, and utility closets in buildings. Buildings include but are not limited to administration, operations, maintenance and repair facility offices, gate security, drivers'/ truckers' services, and longshoremen's restrooms. Additional flow is generated from the equipment shops at the maintenance and repair facilities and the reefer wash facility as well as from roadability services. These waste water flows may contain industrial soaps and hydrocarbons; and therefore, need to be pretreated using clarifiers or other primary treatment systems before being discharged into the sanitary sewer system.

There are different methods for estimating waste water flow. The preferred method, which is the method published in the North Carolina Plumbing Code, is to count fixture units. Each type of plumbing fixture such as a lavatory or water closet (i.e., toilet stall) is assigned a fixture unit. The total fixture units for a given structure, or in some cases a given floor, is converted to a maximum probable flow. This flow is used to size pipes and clarifiers, where required. The number of plumbing fixtures is a function of the building capacity which is a function of the anticipated number of employees and other occupants. Since the number of employees and other occupants is unknown at this time, sources such as facilities at similar sized container terminals and employee counts at other container terminals are used to estimate required fixture counts and henceforth, waste water flow. The building floor areas are provided in Table 2, above. In addition, flush valve (flushometer) type urinals and water closets are assumed.

Since a container terminal is a primarily paved facility with little or no irrigation needs, return-to-sewer (rts) ratios are fairly high on the order of 90 to 97% of domestic water flows. Due to its high usage, an additional rts flow from the reefer wash is estimated as 100% of the water demand from the hose bibb of 40 gpm (for the smaller terminal layouts) up to 120 gpm (for the larger terminal layouts). As part of a comprehensive design, inflow and infiltration (I/I) should be included in sizing the sewer pipes. Since available I/I factors are only known for the Wilmington area on an acreage and/or per capita basis, I/I was omitted from the calculations in this report. Due to the nature of container terminals, I/I should be applied per lineal foot-diameter of pipe basis once that length of pipe is determined.

3.2 Site 5 – Reach Stacker Alternative

Site 5 is located on the existing container terminal at the Port of Wilmington. The reach stacker alternative does not propose a reefer wash facility. This alternative also calls for the existing maintenance and repair building, operations building, and longshoremen's restroom to remain;

however, estimated fixture counts are used for these structures since renovations may be incorporated as part of other terminal upgrades due to unknown future employee needs. The projected range of maximum probable waste water flows is 98 to 104 gpm (116 to 130 gpm) as shown in Table 17. This represents a return-to-sewer ratio of 0.95 (0.90), which is a reasonable rts ratio for light industrial facilities.

Table 17: Site 5 – Reach Stacker Alternative Maximum Probable Waste Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	45	60
Gate Security & Drivers' Services	20	30
Longshoremen's Restrooms	40	50
Maintenance & Repair (inc. Roadability)	140	180
Operations (Marine, Rail, & Yard)	95	115
Total Fixture Units	**340**	**435**
Maximum Probable WW Flow (gpm)	98 (116) (1)	104 (130) (1)
Reefer Wash (gpm)	n/a	n/a
Total WW Flow (gpm)	**98 (116) (1)**	**104 (130) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Based on Table 710.1 (1) of the North Carolina Plumbing Code, a minimum 5-inch pipe with a 2% (1/4 inch in 1 foot) slope would be required. The GIS information shows an existing 6-inch sewer line within 200 feet of the proposed site. Modeling will be required to determine if the existing sewer line has spare capacity to accommodate the estimated flow without exceeding the design depth-to-diameter (d/D) ratio. Building drains will likely be 3 to 4 inches in diameter depending on code allowance, but both building drains and trunk lines will need to be sized as part of a planning and design process.

3.3 Site 5 – RTG Alternative

Site 5 is located on the existing container terminal at the Port of Wilmington. The RTG alternative proposes to replace the existing maintenance and repair facility, the longshoremen's restroom, and the administration building. A reefer wash facility will be added as well. The existing operations building will remain, but it may be renovated as part of other terminal upgrades. The projected range of maximum probable waste water flows is 142 to 168 gpm (167 to 203 gpm) as shown in Table 18. This represents a return-to-sewer ratio of 0.96 (0.93), which is a reasonable rts ratio for light industrial facilities.

Table 18: Site 5 – RTG Alternative Maximum Probable Waste Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	45	60
Gate Security & Drivers' Services	20	30
Longshoremen's Restrooms	45	60
Maintenance & Repair (inc. Roadability)	205	240
Operations (Marine, Rail, & Yard)	95	115
Total Fixture Units	**410**	**505**
Maximum Probable DW Flow (gpm)	102 (127) (1)	108 (143) (1)
Reefer Wash (gpm)	40	60
Total DW Flow (gpm)	**142 (167) (1)**	**168 (203) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Based on Table 710.1 (1) of the North Carolina Plumbing Code, a minimum 6-inch pipe with a 2% (1/4 inch in 1 foot) slope would be required. The GIS information shows an existing 6-inch sewer line within 200 feet of the proposed site. Modeling will be required to determine if the existing sewer line has spare capacity to accommodate the estimated flow without exceeding the design depth-to-diameter (d/D) ratio. Building drains will likely be 3 to 4 inches in diameter depending on code allowance, but both building drains and trunk lines will need to be sized as part of a planning and design process.

3.4 Site 3 – Radio Island

The projected range of maximum probable waste water flows for Site 3 is 173 to 189 gpm (200 to 225 gpm) as shown in Table 19. This represents a return-to-sewer ratio of 0.97 (0.93), which is a reasonable rts ratio for light industrial facilities.

Table 19: Site 3 Maximum Probable Waste Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	45	60
Gate Security & Drivers' Services	20	30
Longshoremen's Restrooms	45	60
Maintenance & Repair (inc. Roadability)	205	240
Operations (Marine, Rail, & Yard)	115	135
Total Fixture Units	**430**	**525**
Maximum Probable DW Flow (gpm)	103 (130) (1)	109 (145) (1)
Reefer Wash (gpm)	70	80
Total DW Flow (gpm)	**173 (200) (1)**	**189 (225) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Based on Table 710.1 (1) of the North Carolina Plumbing Code, a minimum 6-inch pipe with a 2% (1/4 inch in 1 foot) slope would be required. The GIS information shows a sewer line traversing the proposed site, but no size is given. Further investigation is required to determine

the capacity and adequacy of the existing line. Building drains will likely be 3 to 4 inches in diameter depending on code allowance, but both building drains and trunk lines will need to be sized as part of a planning and design process.

3.5 Site 6 – Standard and Hybrid RTG Alternatives

The projected range of maximum probable waste water flows for the standard and hybrid RTG alternatives for Site 6 is 209 to 243 gpm (269 to 315 gpm) as shown in Table 20. This represents a return-to-sewer ratio of 0.97 (0.93), which is a reasonable rts ratio for light industrial facilities.

Table 20: Site 6 – Standard & Hybrid RTG Alternatives Maximum Probable Waste Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	115	135
Gate Security & Drivers' Services	35	50
Longshoremen's Restrooms	85	105
Maintenance & Repair (inc. Roadability)	340	375
Operations (Marine, Rail, & Yard)	190	225
Total Fixture Units	**765**	**890**
Maximum Probable DW Flow (gpm)	119 (179) (1)	123 (195) (1)
Reefer Wash (gpm)	90	120
Total DW Flow (gpm)	**209 (269) (1)**	**243 (315) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Based on Table 710.1 (1) of the North Carolina Plumbing Code, a minimum 8-inch pipe with a 2% (1/4 inch in 1 foot) slope would be required. Building drains will likely be 3 to 4 inches in diameter depending on code allowance, but both building drains and trunk lines will need to be sized as part of a planning and design process. There is no information regarding sewer lines within the property or crossing the proposed terminal boundary.

3.6 Site 6 – ASC Alternative

The projected range of maximum probable waste water flows for the ASC alternative for Site 6 is 203 to 237 gpm (244 to 291 gpm) as shown in Table 21. This represents a return-to-sewer ratio of 0.98 (0.93), which is a somewhat high, but still reasonable rts ratio for light industrial facilities.

Based on Table 710.1 (1) of the North Carolina Plumbing Code, a minimum 6-inch pipe with a 2% (1/4 inch in 1 foot) slope would be required. Building drains will likely be 3 to 4 inches in diameter depending on code allowance, but both building drains and trunk lines will need to be sized as part of a planning and design process. There is no information regarding sewer lines within the property or crossing the proposed terminal boundary.

Table 21: Site 6 – ASC Alternative Maximum Probable Waste Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	115	135
Gate Security & Drivers' Services	35	50
Longshoremen's Restrooms	45	60
Maintenance & Repair (inc. Roadability)	205	240
Operations (Marine, Rail, & Yard)	190	225
Total Fixture Units	**590**	**710**
Maximum Probable DW Flow (gpm)	113 (154) (1)	117 (171) (1)
Reefer Wash (gpm)	90	120
Total DW Flow (gpm)	**203 (244) (1)**	**237 (291) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

3.7 Site 4 – Standard and Hybrid RTG Alternatives

The projected range of maximum probable waste water flows for Site 4 is 193 to 227 gpm (237 to 283 gpm) as shown in Table 22. This represents a return-to-sewer ratio of 0.98 (0.94), which is a somewhat high, but still reasonable rts ratio for light industrial facilities.

Table 22: Site 4 Maximum Probable Waste Water Flows

Source	Estimated Min. Fixture Units	Estimated Max. Fixture Units
Administration	85	105
Gate Security & Drivers' Services	35	50
Longshoremen's Restrooms	70	90
Maintenance & Repair (inc. Roadability)	270	305
Operations (Marine, Rail, & Yard)	150	175
Total Fixture Units	**610**	**725**
Maximum Probable DW Flow (gpm)	113 (157) (1)	117 (173) (1)
Reefer Wash (gpm)	80	110
Total DW Flow (gpm)	**193 (237) (1)**	**227 (283) (1)**

(1) Maximum Probable Flow determined from Table C13.18 in the article "Plumbing Piping Systems" (Frankel, Michael. "Plumbing Piping Systems" in Piping Handbook, 7th ed. New York: McGraw-Hill, 2000. (Values in parentheses determined from Table 3-6 of American Society of Plumbing Engineers Data Book, 1988.)

Based on Table 710.1 (1) of the North Carolina Plumbing Code, a minimum 6-inch pipe with a 2% (1/4 inch in 1 foot) slope would be required. Building drains will likely be 3 to 4 inches in diameter depending on code allowance, but both building drains and trunk lines will need to be sized as part of a planning and design process. There is no information regarding sewer lines within the property or crossing the proposed terminal boundary.

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4 OTHER UTILITIES

4.1 Gas

Natural gas is needed for the production of hot water in the buildings. Only Site 5 within the Port of Wilmington has gas service. No gas lines are present at the other proposed sites.

4.2 Storm Water

Storm water needs to be mitigated in accordance with North Carolina Department of Environment and Natural Resources regulations as well as local storm water management manuals and standards. The storm water manuals and regulations require that there be no net increase in storm water runoff between the pre-development condition and the developed condition. This requires installation of retention ponds and other Best Management Practices (BMPs) to allow for the net increase in runoff to filter into the soil as it naturally would have under pre-development conditions. Other BMPs designed to capture this flow include vegetated swales, pervious pavements, and engineered wetlands. Furthermore, BMPs also need to be designed that detain the first flush of a design storm event for a given period of time, since the first flush runoff tends to contain the highest concentration of pollutants. The detention period should be designed to allow for a determined percent reduction in defined pollutants.

Storm water flow and volume are a function of peak rainfall intensity for a design storm event and runoff coefficient of the site. Peak rainfall intensity is a function of the time of concentration. The runoff coefficient is based on how impervious the finish surface is. For example, solid concrete has a higher runoff coefficient and therefore generates more runoff than pervious concrete, gravel, or sandy soil. The time of concentration is based on the most hydrologically remote point within a drainage basin.

Due to the multitude of variables inherent in calculating storm water runoff flows and volumes, no calculations were performed as part of this report. Given the size of the conceptual terminal layouts, it is also likely that the proposed developments would be granted variances reducing the amount of flow and volume that need to be retained and/or detained. In addition, all runoff are assumed to be contained within the terminals and eventually discharged to adjacent rivers and/or sounds. Therefore, no interface with storm water utility systems outside of the terminal boundaries should be required.

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