Container Terminal Planning & Operations

American Association of Port Authorities
Marine Terminal Management Training Program
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GLOBAL REACH. LOCAL RESULTS.

Latest Trends – This and That

- Marine terminal lighting technology
  - Light emitting plasma and other new technology
- Ships and cranes
  - 8-high on deck and its implications
- New terminals in old boundaries
  - Automating the original terminals

Terminal Lighting Technology

- Virtually all terminal lighting is done with high-pressure sodium (HPS) fixtures mounted on high-mast light towers
- These are typically “1000 W” fixtures
- Poles range from 80’ to 150’ in height
- Pole spacing is usually on the order of 3.0 to 3.5 times the pole height, typically 250’ to 400’
- Poles have rosettes of 8 to 12 fixtures per pole
- Maintenance is done by longshore mechanics
- Each pole and foundation costs ~$300,000

Regulatory and Safety Environment

- Lighting of the working areas of marine terminals is governed by 29 CFR 1917.123 (OSHA/NMSA)
- This requires:
  - 5 foot-candles “minimum average” in marine terminal working areas
  - 1 fc minimum
- Engineers limit Maximum / Average to 3:1 or less
- The regulation is silent as to how this is to be measured or established
- Traditionally, this has been done with lighting models prepared by the light fixture vendors

Limitations of HPS

- High power consumption
  - 1280 w x $0.146/kWh = ~$818/fixture/year (California)
- Short replacement cycle
  - 10,000 hours to ballast and fixture replacement (2 yr)
- High light pollution
  - Fixture design relies on glowing housing to spread the light, which causes substantial sky glow
- Poor light quality
  - Light is in the pink-yellow part of the spectrum, not optimized for human night vision

Outer Harbor Marine Terminal, Oakland

175 gross acres of marine terminal
107 high-mast light poles, 8 to 12 luminaires each
1,000 luminaires total
About 1 MW in total power consumption by lights
Massive light pollution from this and other facilities

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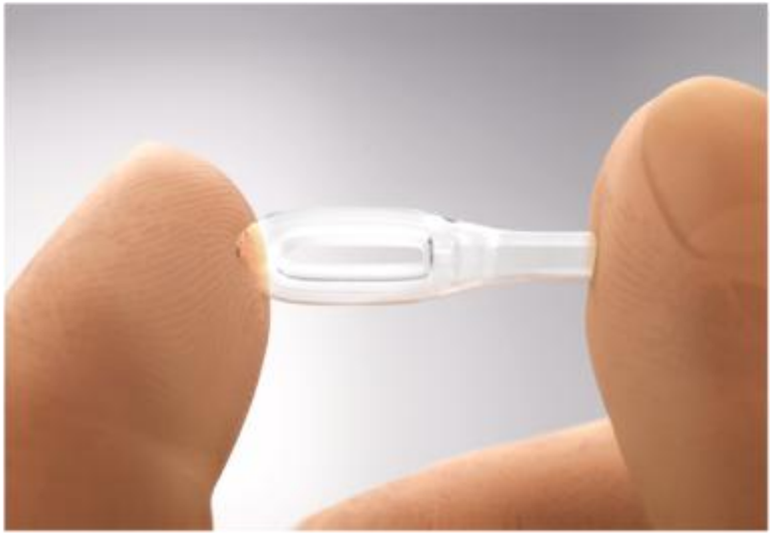
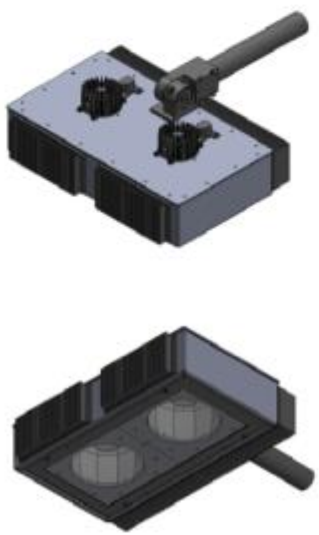
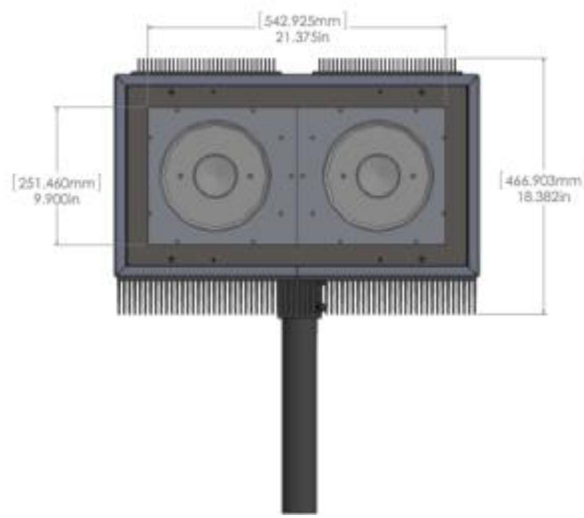
Light Emitting Plasma



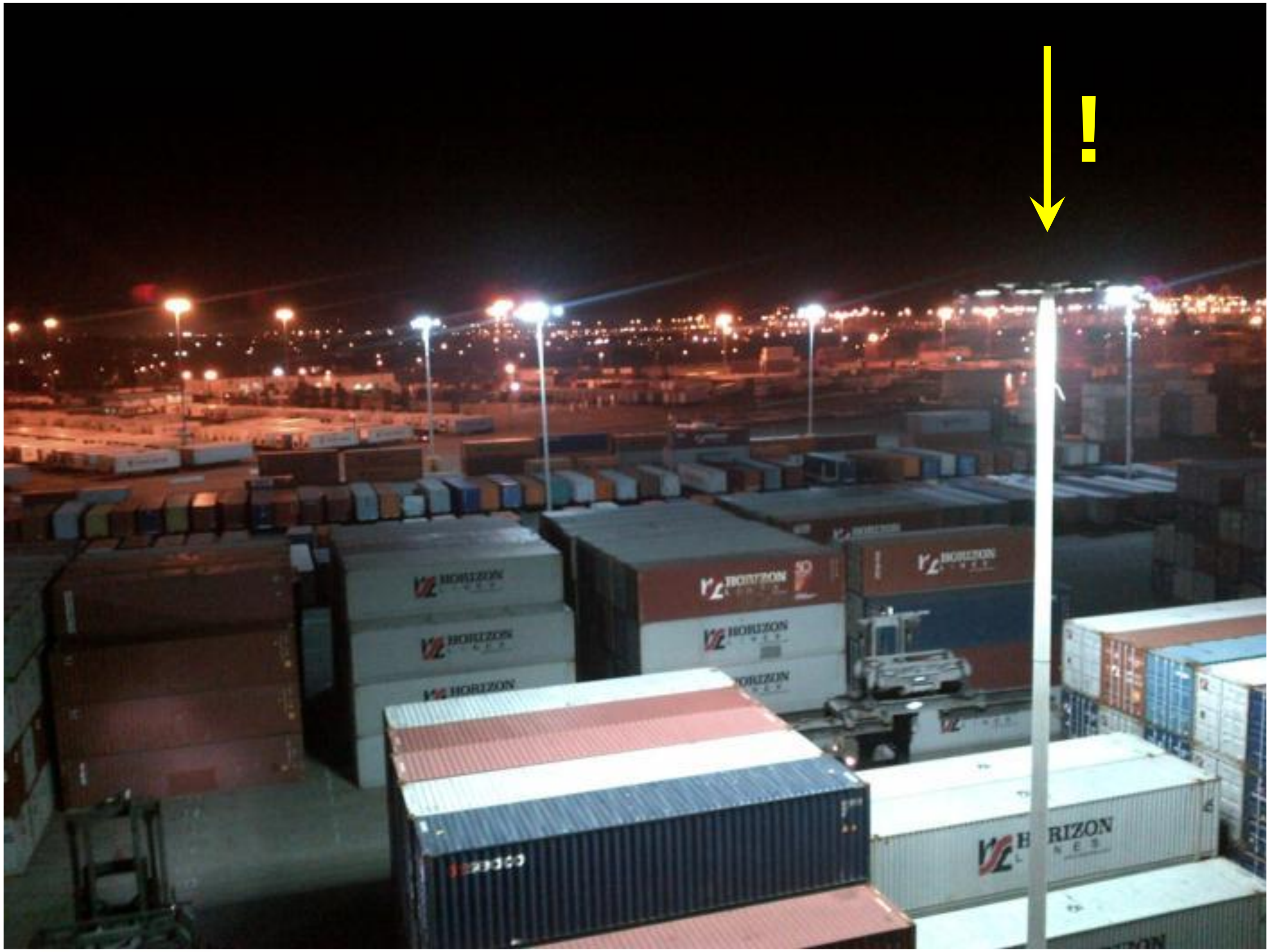




LEP Test Installation at OHMT

LEPs vs. HPS at OHMT

At Luminaire Height



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LEP Numeric Results vs. OSHA Requirements

- OSHA Minimum Average:
  ≥ 5 fc required, 5.1 achieved
- OSHA Minimum:
  ≥1 fc required, 1.3 achieved
- Uniformity:
  ≤3:1 required, 2.1 achieved
- With new LEP lamps,
  <u>OSHA requirements are met</u>
- Color is substantially improved

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Summary

- LEP effectiveness established
- Payback for new: 1.5 years
- Payback for replacement: 3.2 years
- Substantially improved visibility
- Substantially improved uniformity, spread
- Substantially reduced light pollution
- Substantially improved control
- Substantially reduced maintenance
- Energy consumption reduced >50%
- All on the current light pole system

Alternatives to LEP and HPS

Light-Emitting Diode

- Each emitter is small, 100s of emitters per fixture
- Very pointable
- Very sensitive to heat, so large heat sinks required
- Result is a heavy head, about 95 lbs, to achieve current lumens/fixture
- Capital cost the same as LEP
- Energy savings a bit more than LEP

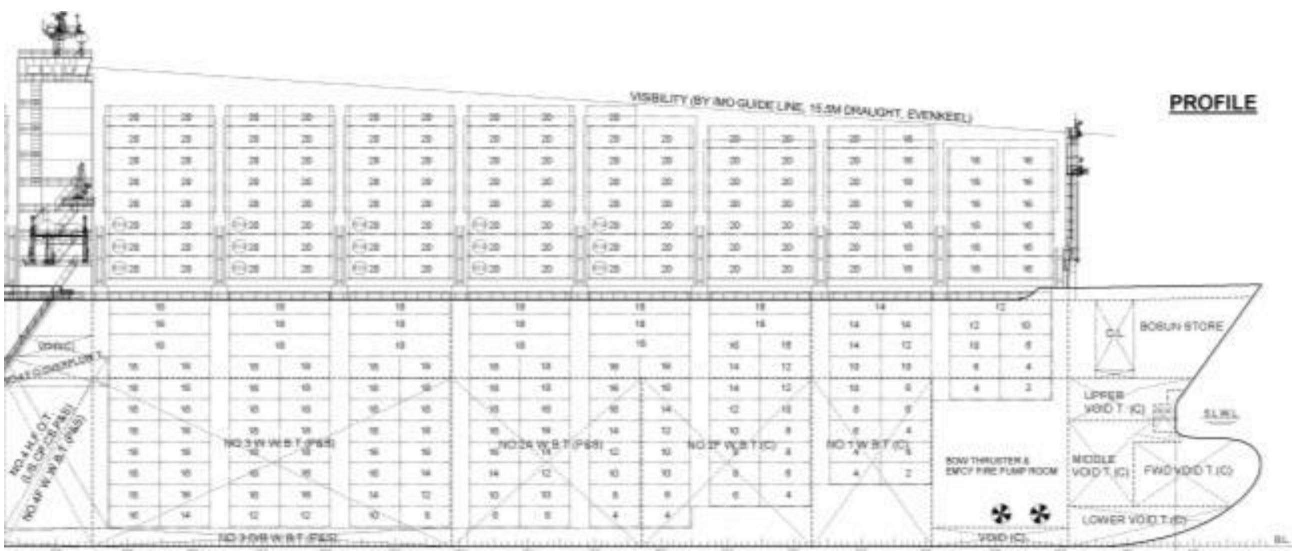
Metal Halide

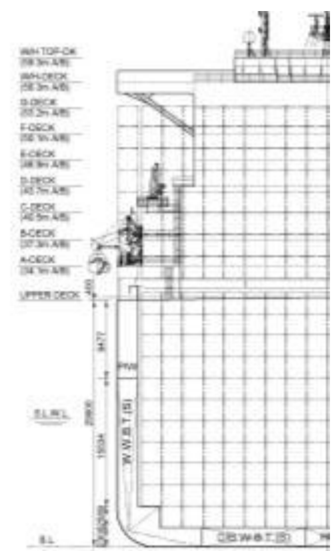
- Each emitter is large, and can produce a lot of light
- Mirrors can direct as needed
- Not a lot of energy savings
- Not a lot of capital savings
- A good option if you are stuck with very long pole spacing and need more light

Ships and Cranes

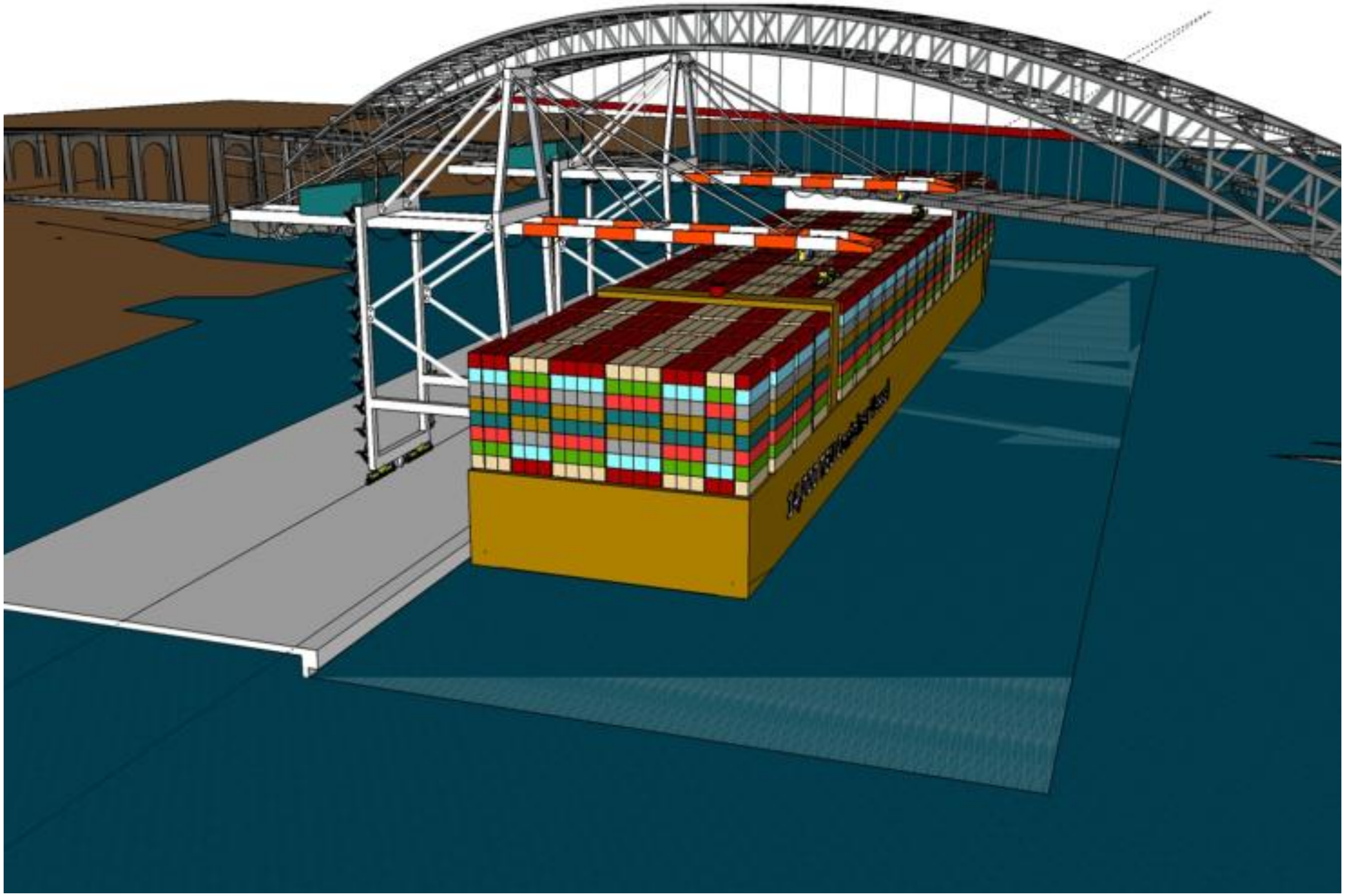
- Shipping lines have long predicted ships of 20 to 24 container stacks across on deck
  - Beam up to 200 ft or 61 m
- No one really predicted that ships would get a lot taller, up to 8-high on deck

The New Monsters





A Bit of Perspective



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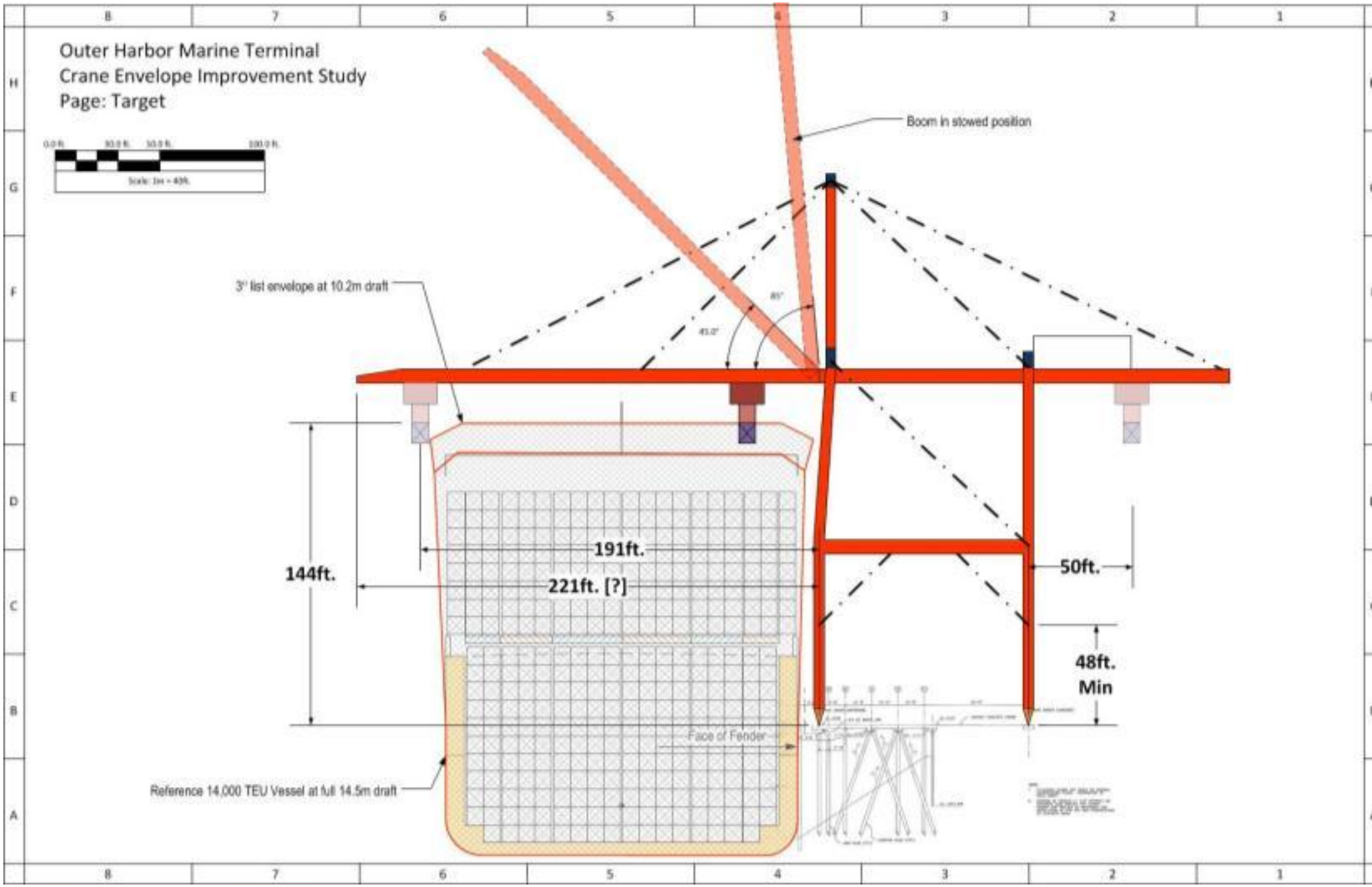
Dock Gantry Cranes – Target Envelope



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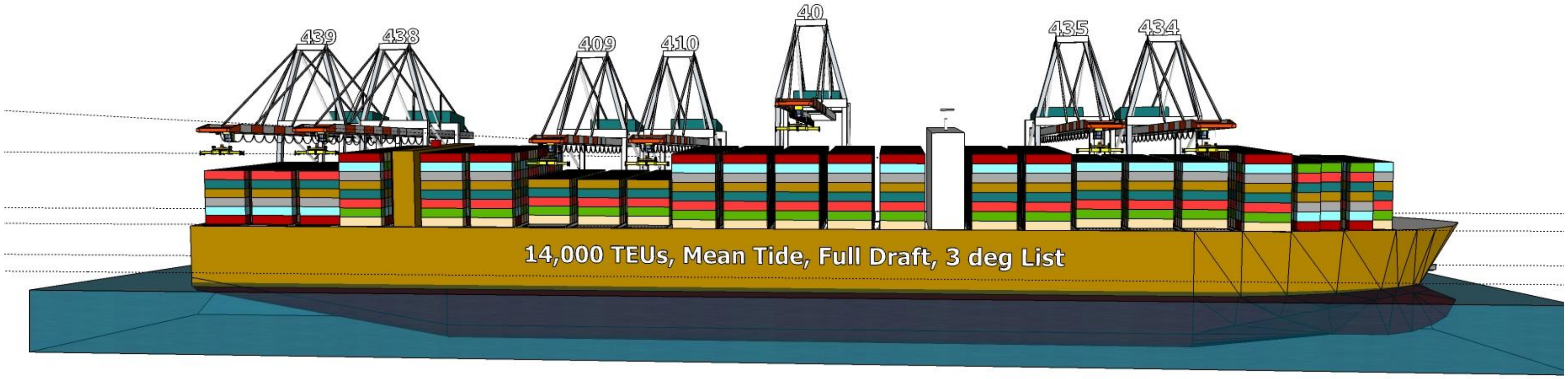
Outer Harbor Crane Array



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Outer Harbor X434/X435, Mean Tide, 3^{o} list

Potential Crane Modifications

- To be fully capable:
  - Raise X438/X439 by 34’, extend by 24’
  - Raise X434/X435 by 32’, extend by 17’
- Issues:
  - Mechanical capabilities - ropes, drums, drives
  - Productivity - drives, motors, speeds, duty cycles
  - Frame structural strength - boom, frame seismic
  - Wharf structural strength - rail girders
  - Wharf tie-downs and stowage pins
  - Power supply and demand – terminal and wharf
  - Cranes may need to be shuffled

Choices

- There are only three possible responses to bigger ships
- 1. Do nothing
  - Keep going with what you have
  - Forego new freight and revenue from big ships
- 2. Modify existing cranes, if possible
  - Raise and extend
  - $1.0M to $2.0M per crane, 30 to 60 days of downtime
- 3. Build new cranes
  - $11.0M to $12.5M per crane, depending on location

New Terminals in Old Boundaries

- We are being asked to consider the application of new automation technologies in old terminals
- Automation likes nice, rectangular shapes
- Most automation to date has been deployed on new sites, which can be made rectangular
- Existing sites are what they are – changing shapes is difficult
- We must work with what we have, and adapt technologies to suit

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Greenfield Rectangles are:

- Flexible
- Efficient
- Productive
- Capacious
- Easy to lay out
- Easy to design
- Easy to build
- Lack pesky constraints
- …and exceedingly rare

Not Everything is a Greenfield Rectangle

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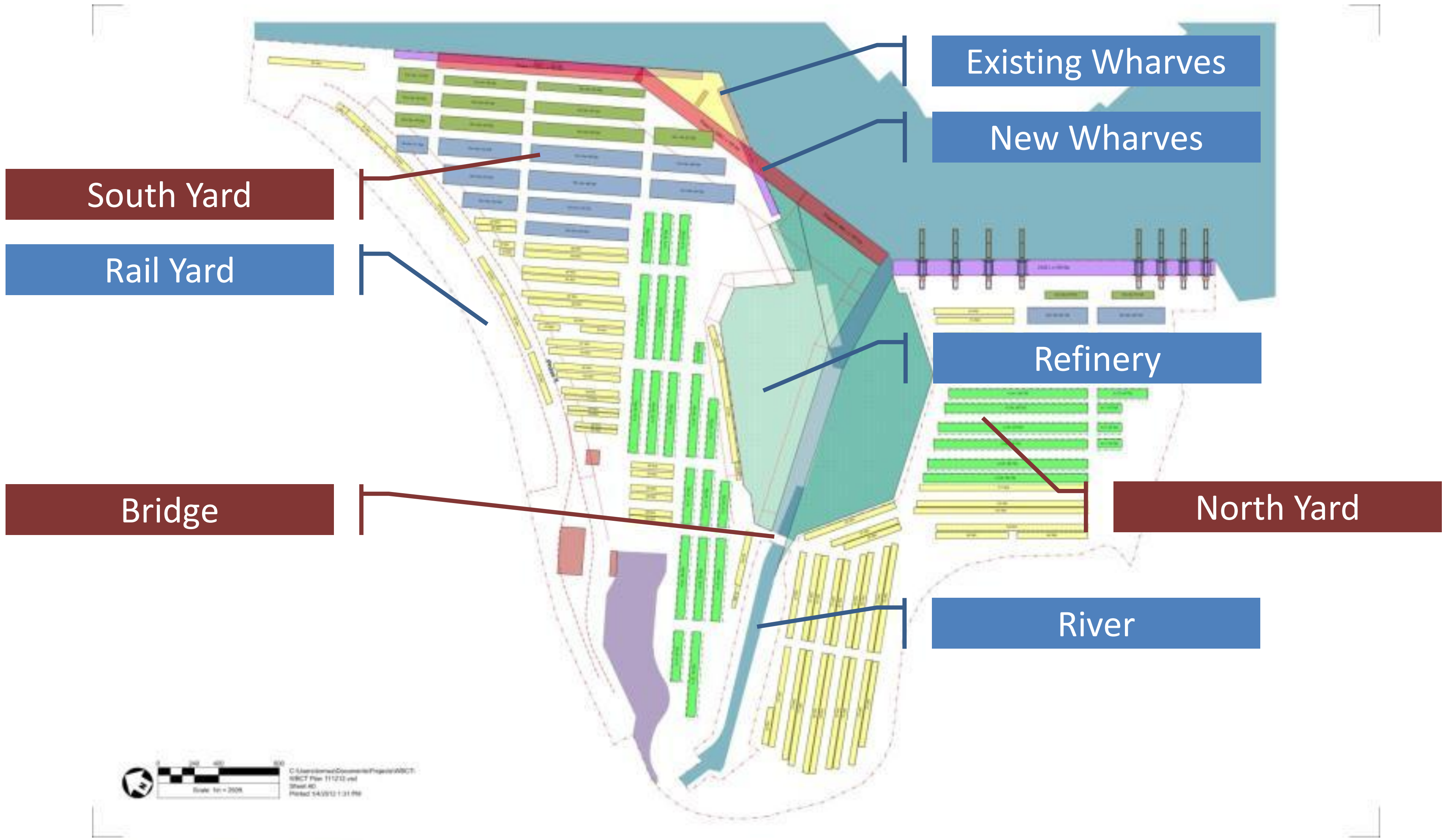
A Case in Point: West Basin Container Terminal



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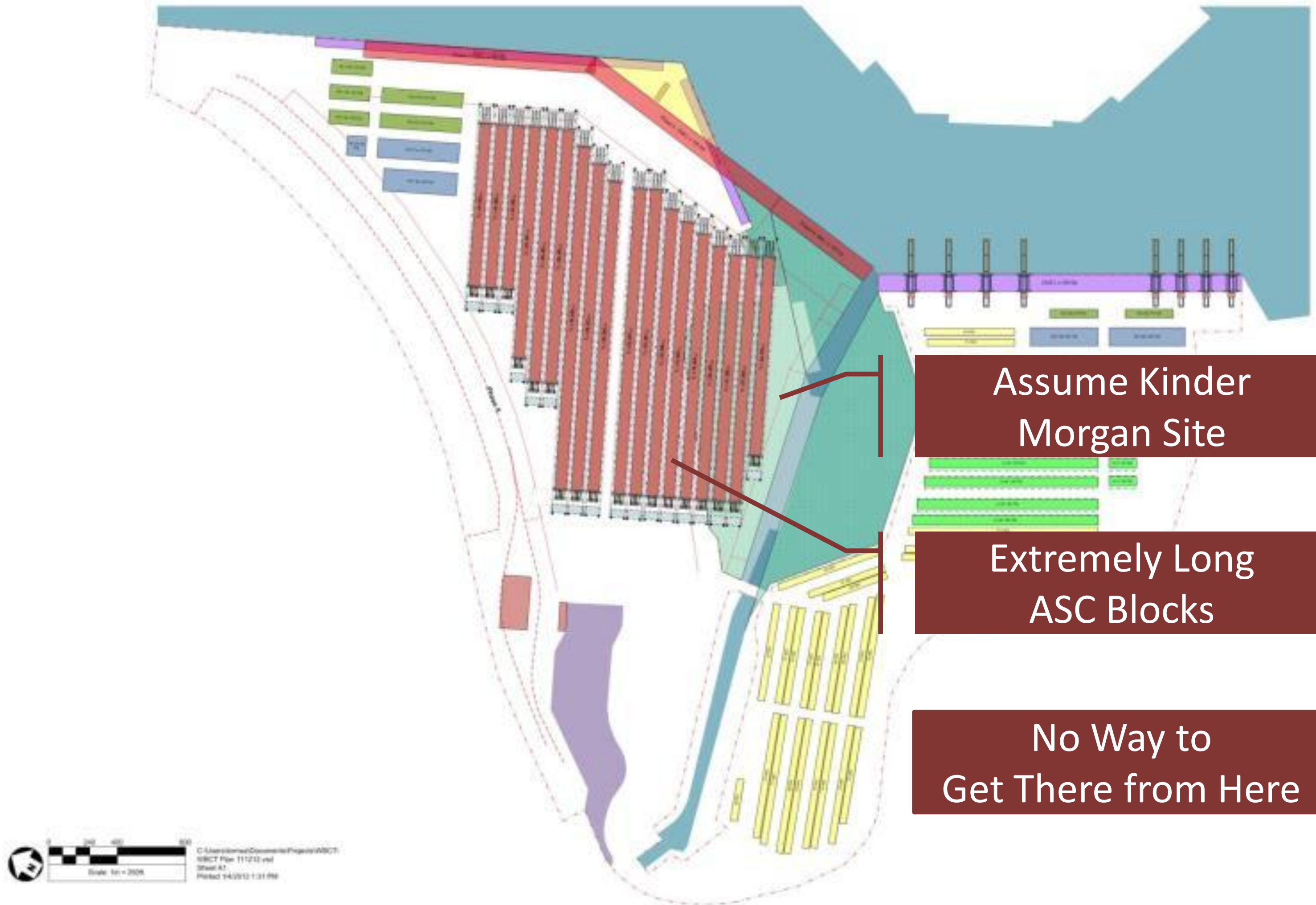
Challenges

- No rectangles, anywhere
- Port is rebuilding the wharves to ease navigation and increase crane gauge from 50’ to 100’
- Uncertain future access to refinery area
- Split terminal

- And a desire to convert this to a high-performance automated facility for very large container ships

Imposing Rectangular Thinking

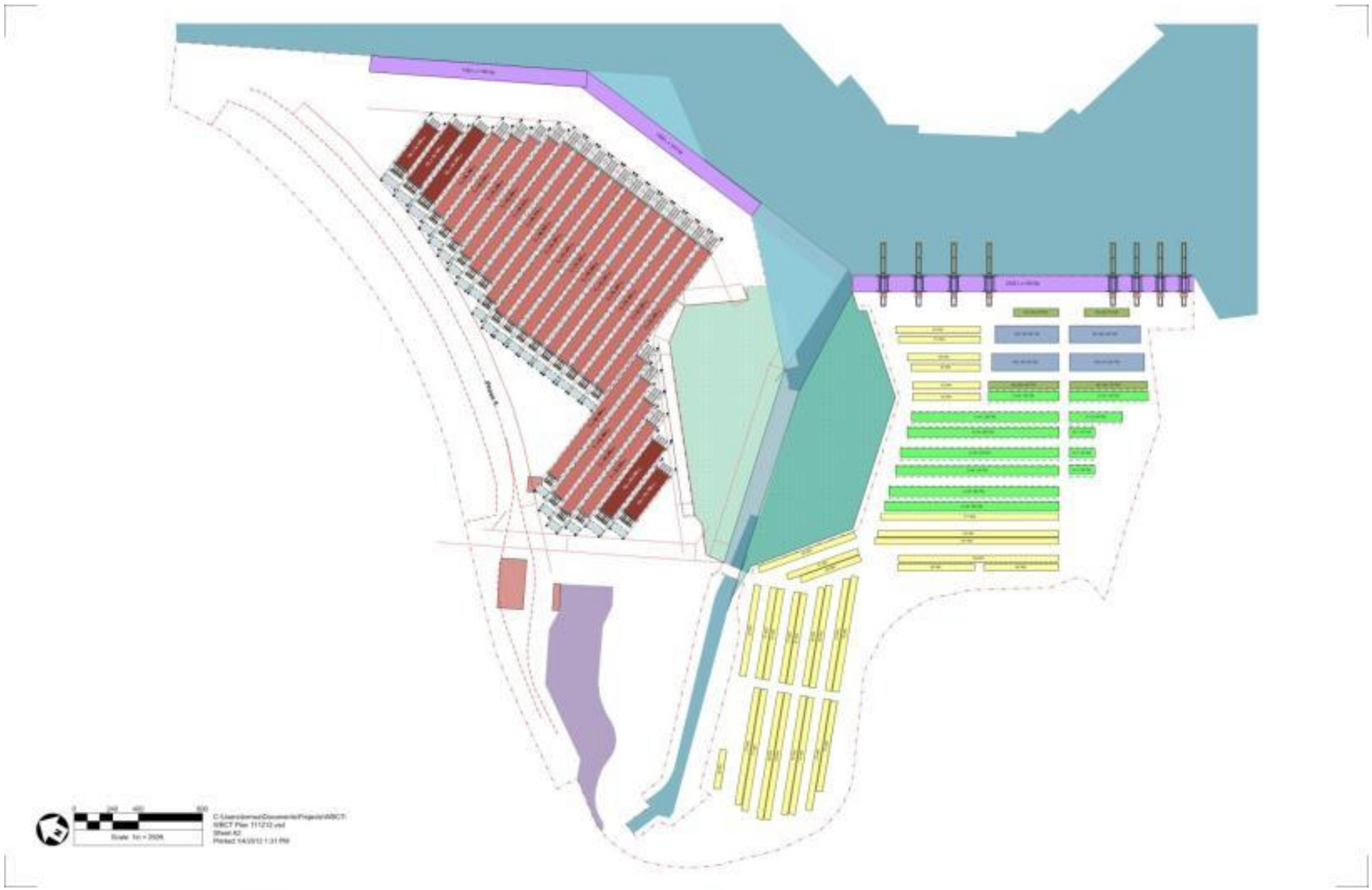


Assume Kinder Morgan Site

Extremely Long ASC Blocks

No Way to Get There from Here

Perpendicular to Berth 122?



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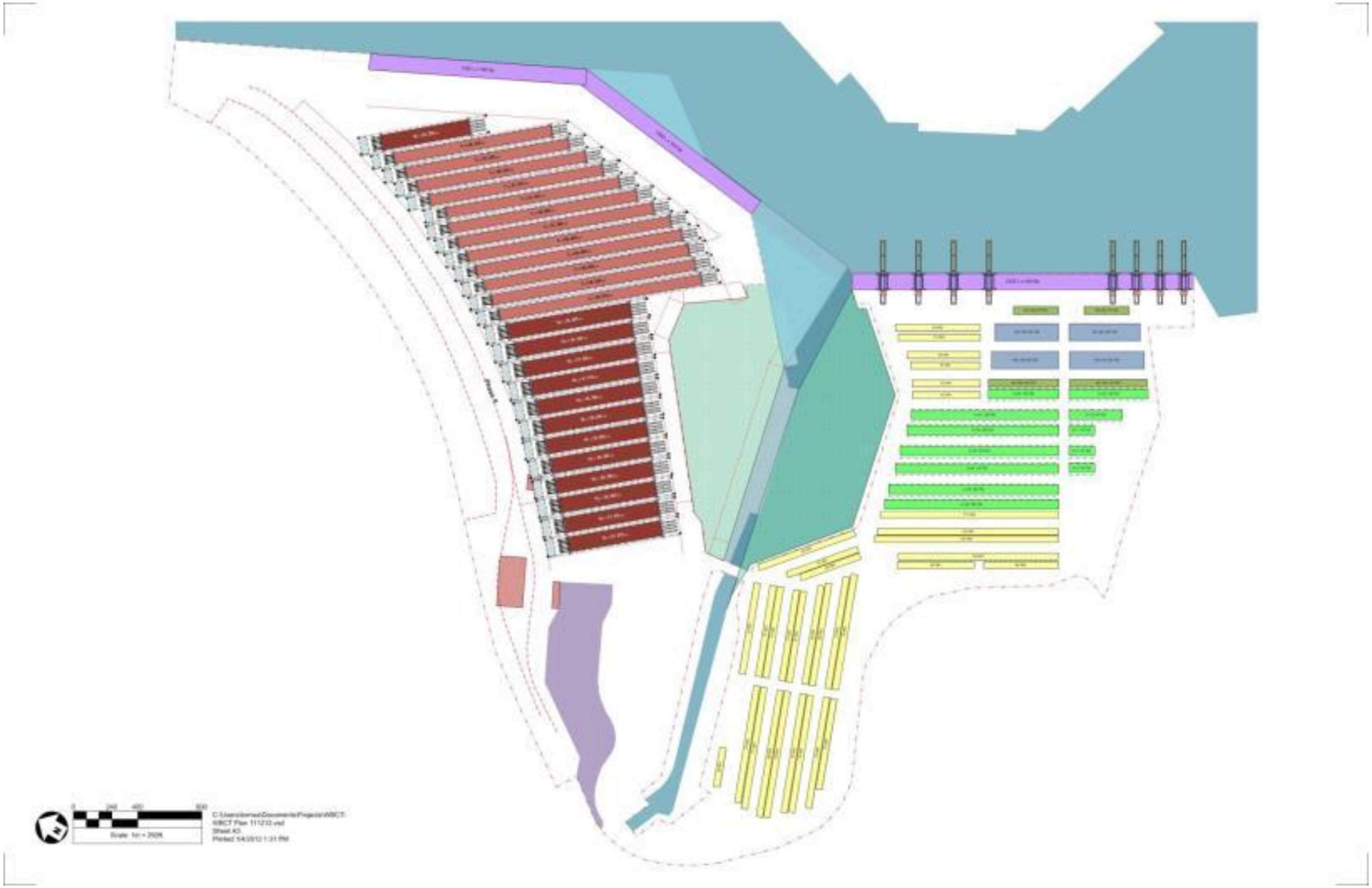
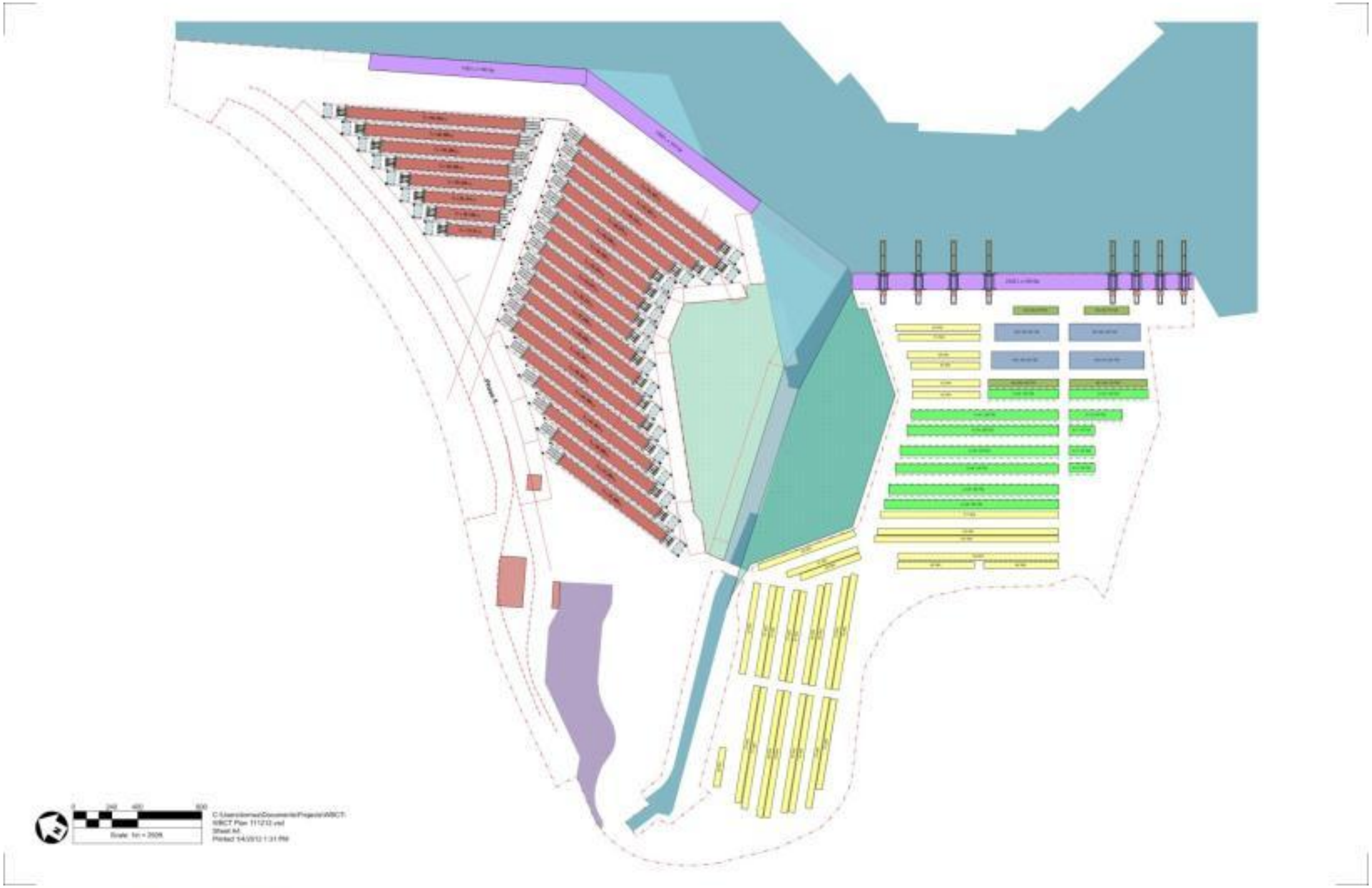
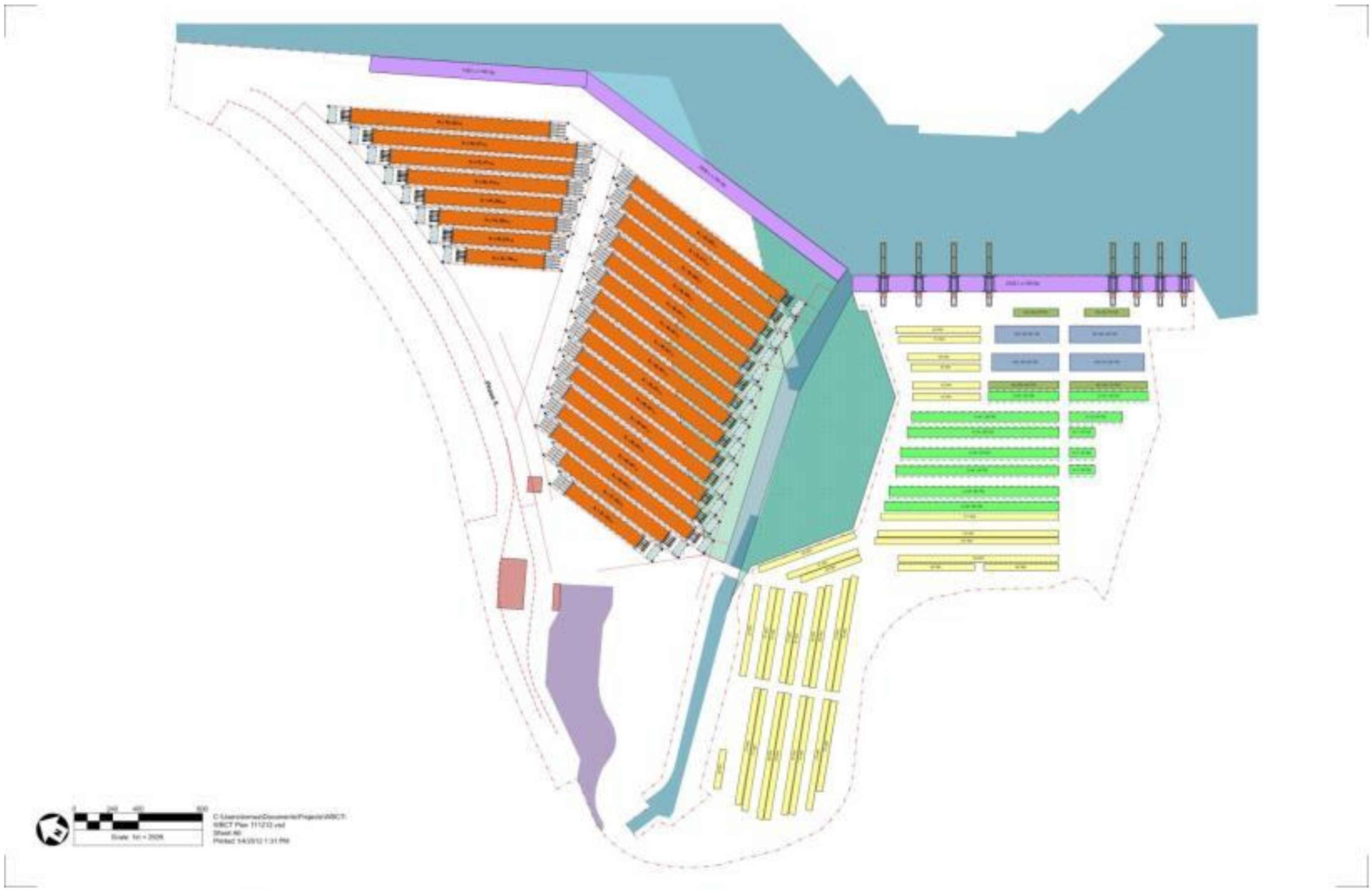
Perpendicular to KM Boundary?



Parallel to Both Berths?



Rebalanced with KM?



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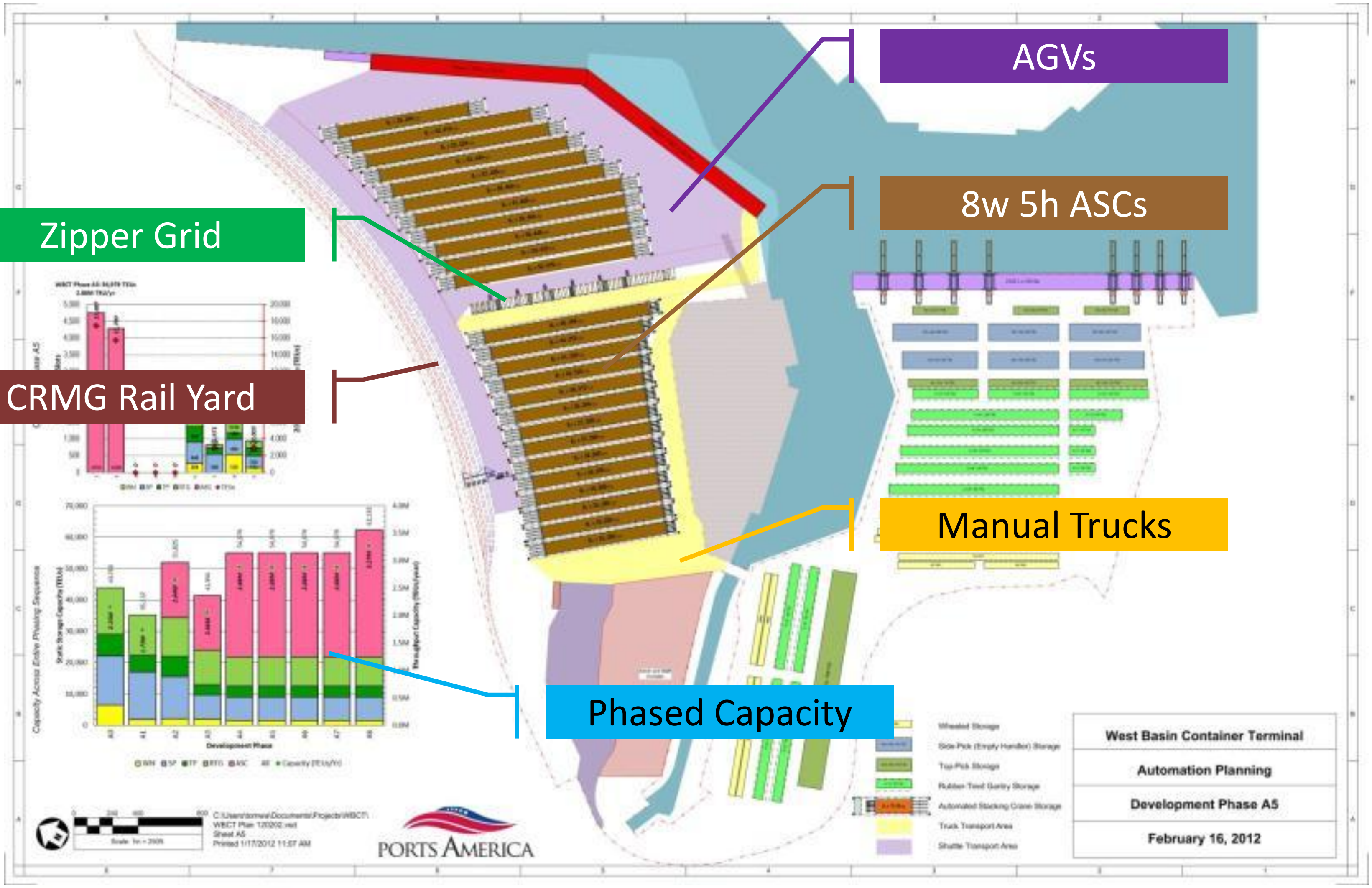
What's a Planner to ***<u>Do</u>***?

- There is no obvious "best" solution that perfectly balances:
  - Capacity
  - Productivity
  - Efficiency
  - Phaseability
  - Flexibility to use or not use Kinder Morgan
  - Accessibility from North Yard to rail yard
- Something unorthodox is required…

An Unorthodox Solution



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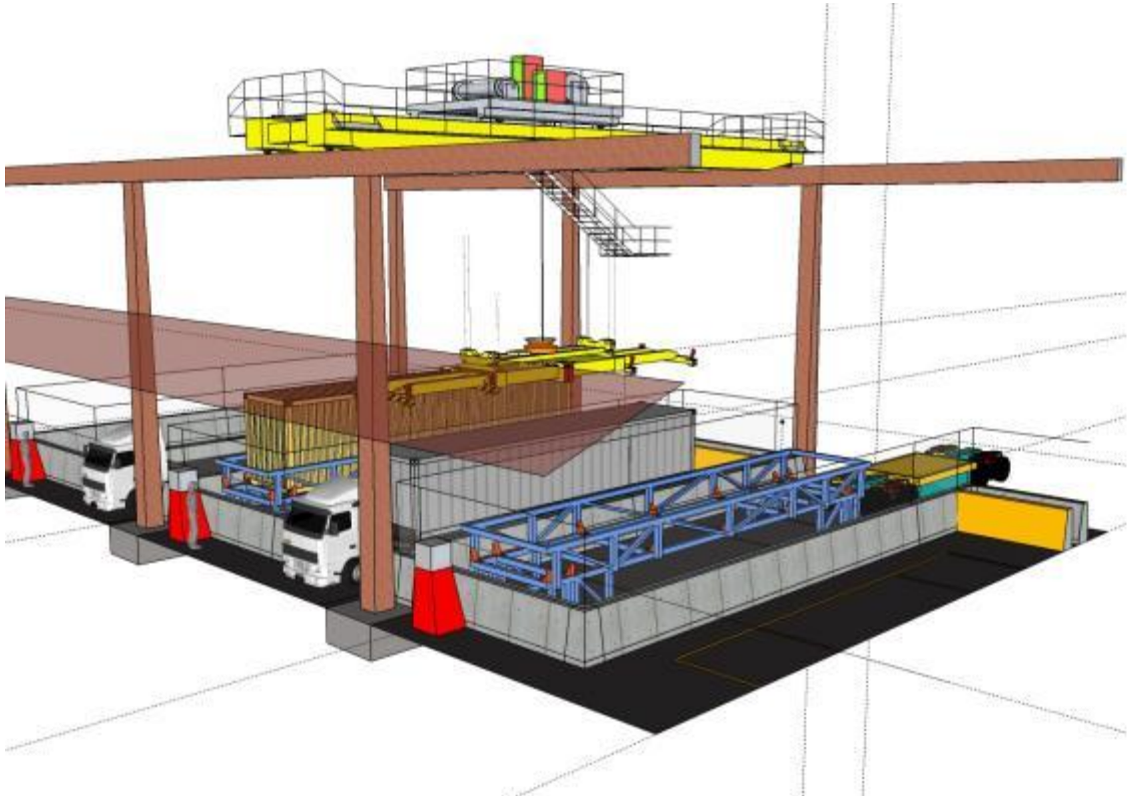
Zipper Grid



- Zipper Grid concept allows yard/truck interface in a very compact space
- Overhead bridge crane, very similar to an ASC trolley, shuffles boxes across the wall: 1 OHBC per six pairs of slots

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But will it work?

- Detailed simulation analysis
  - Equipment counts, Productivity
  - Inter-yard transfer performance
  - Congestion relief
  - Resource allocation paradigms
- Detailed phased financial model
  - Equipment
  - Manning
  - Management Labor
  - Capital and Operating Costs, Revenue Phasing
- …Yes!

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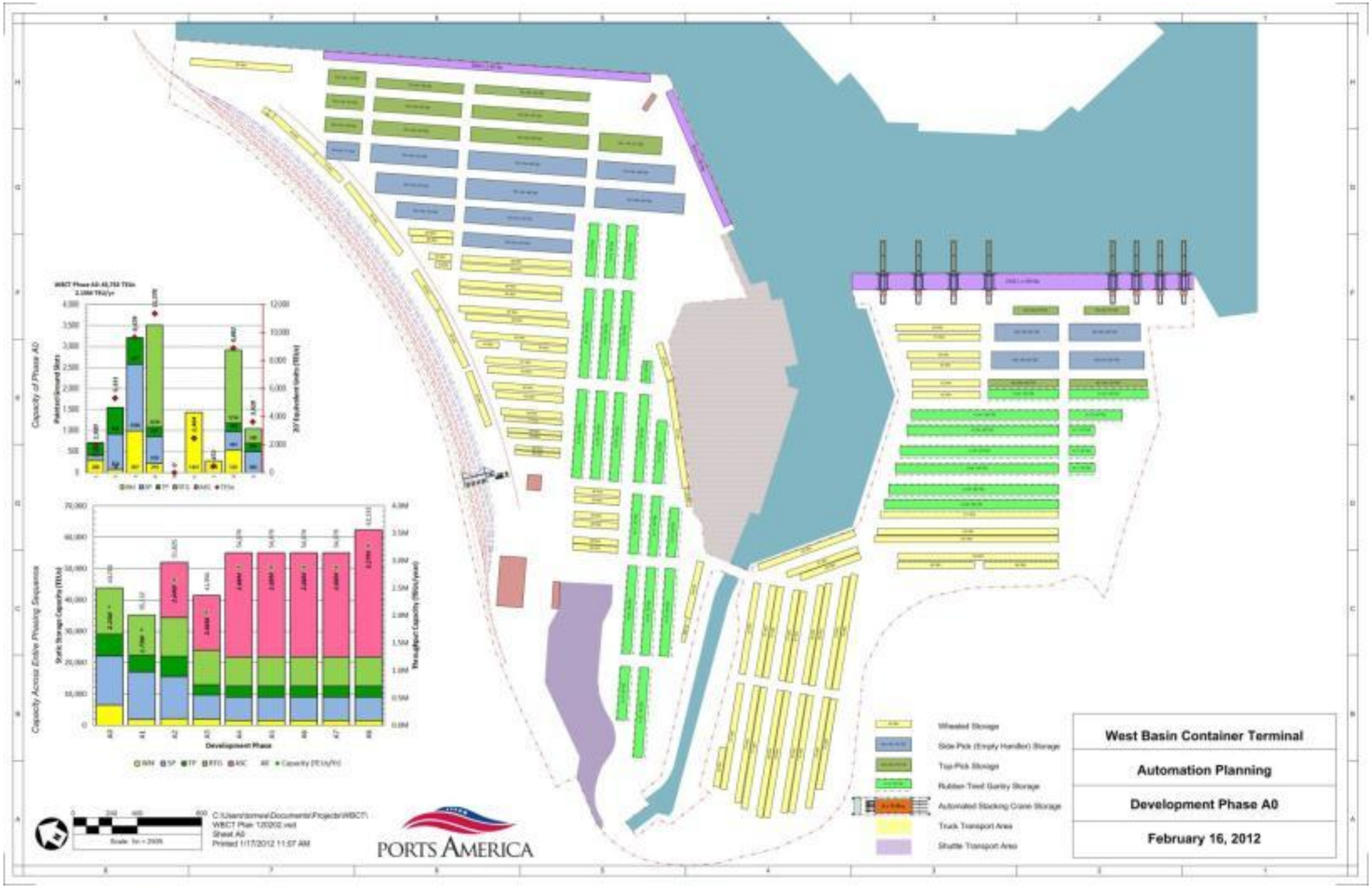
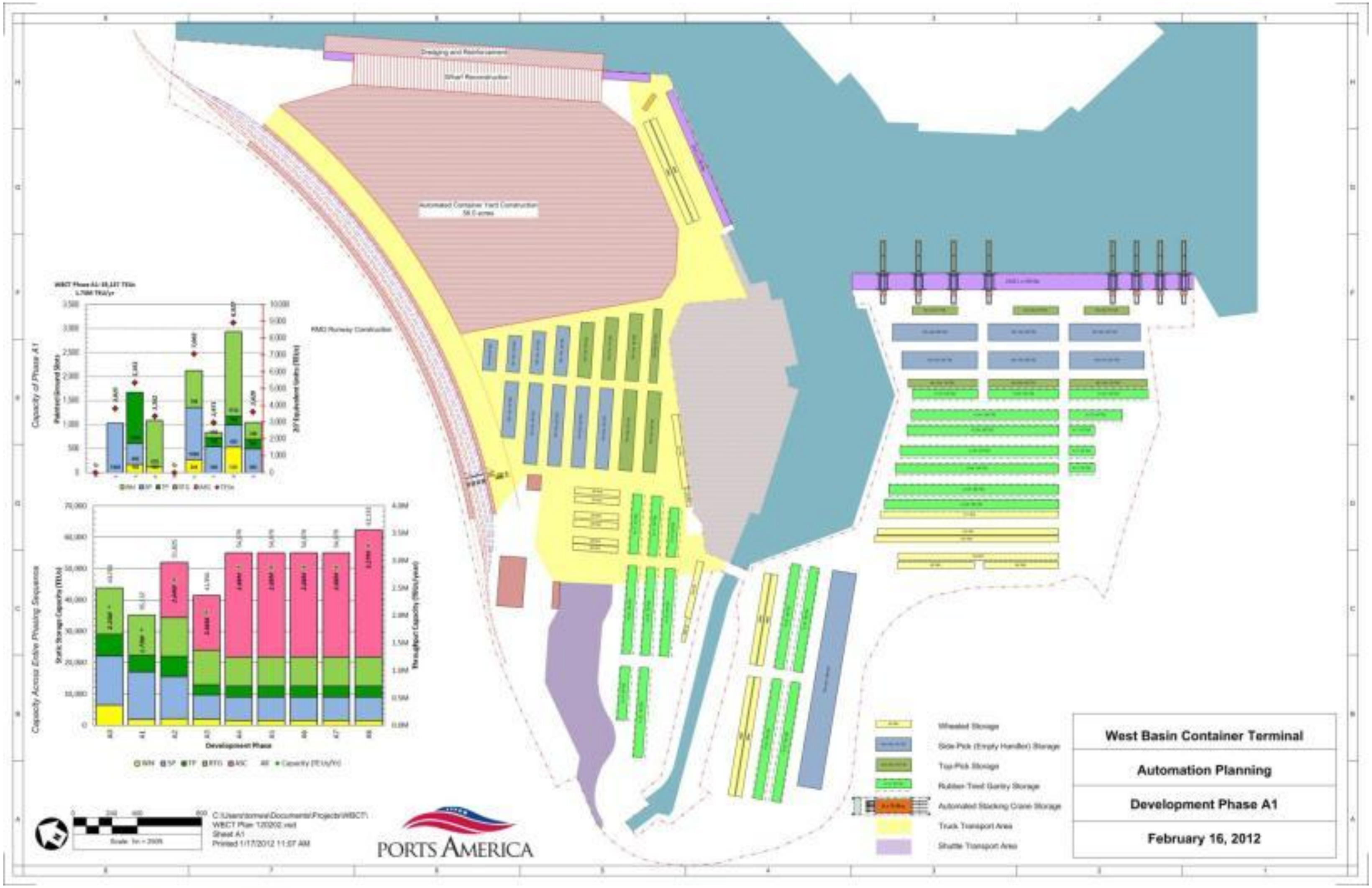
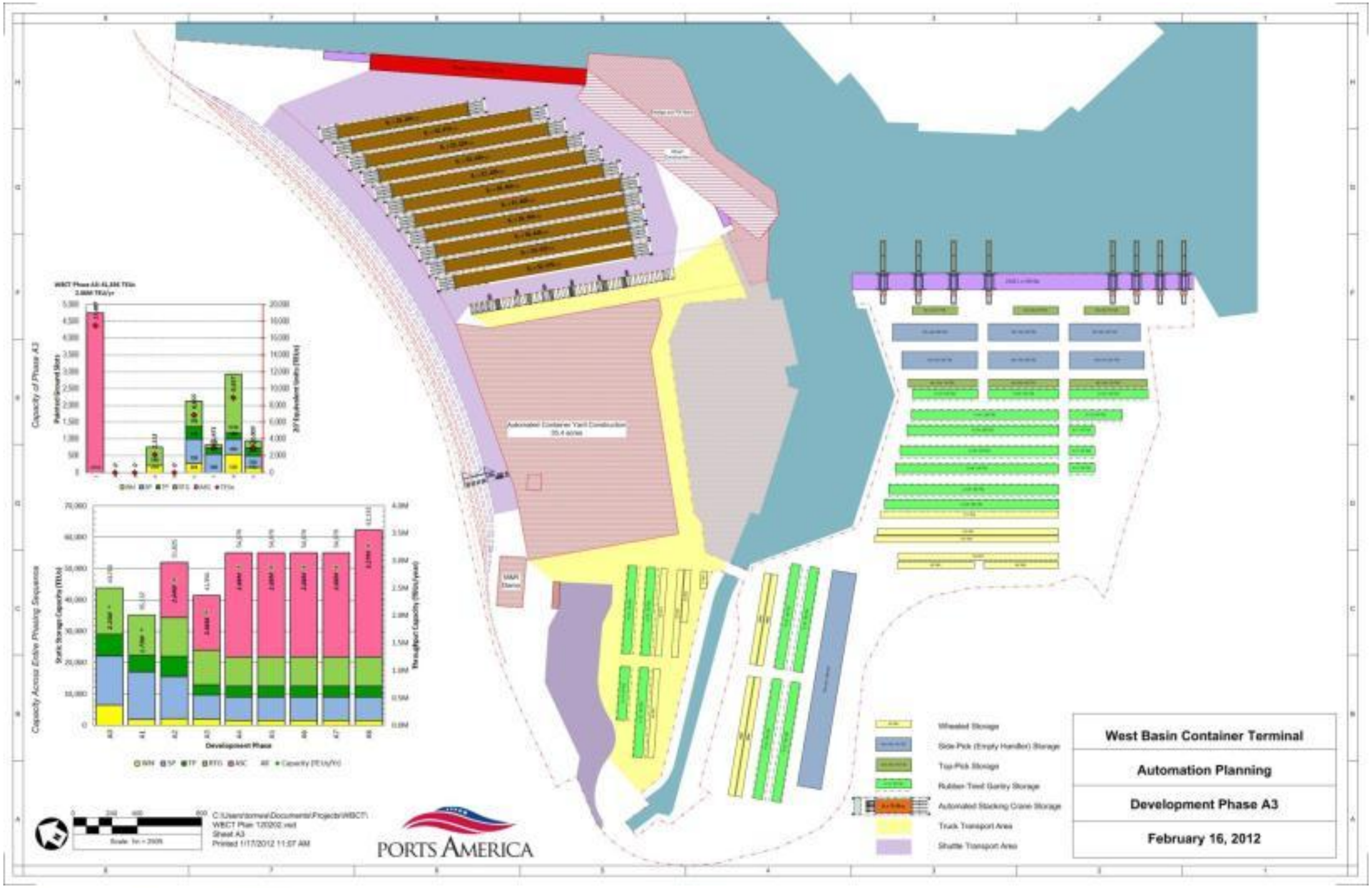
Current Layout, 2.2M TEUs



Rail Yard, Berth 126 Yard, to 2.6M TEUs



Dredge, Fill, Berth 122, to 2.9M TEUs



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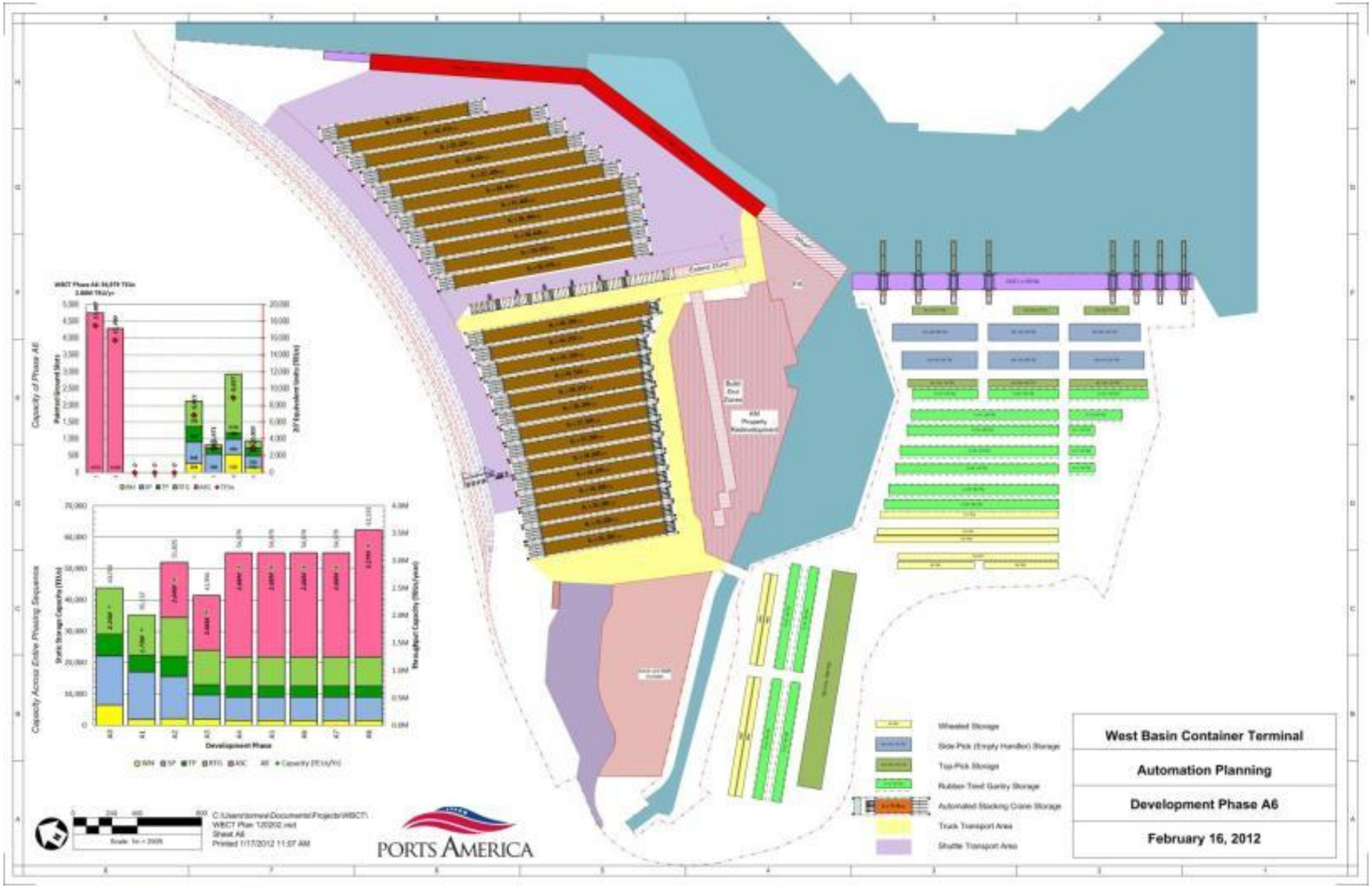
Future Expansion into KM



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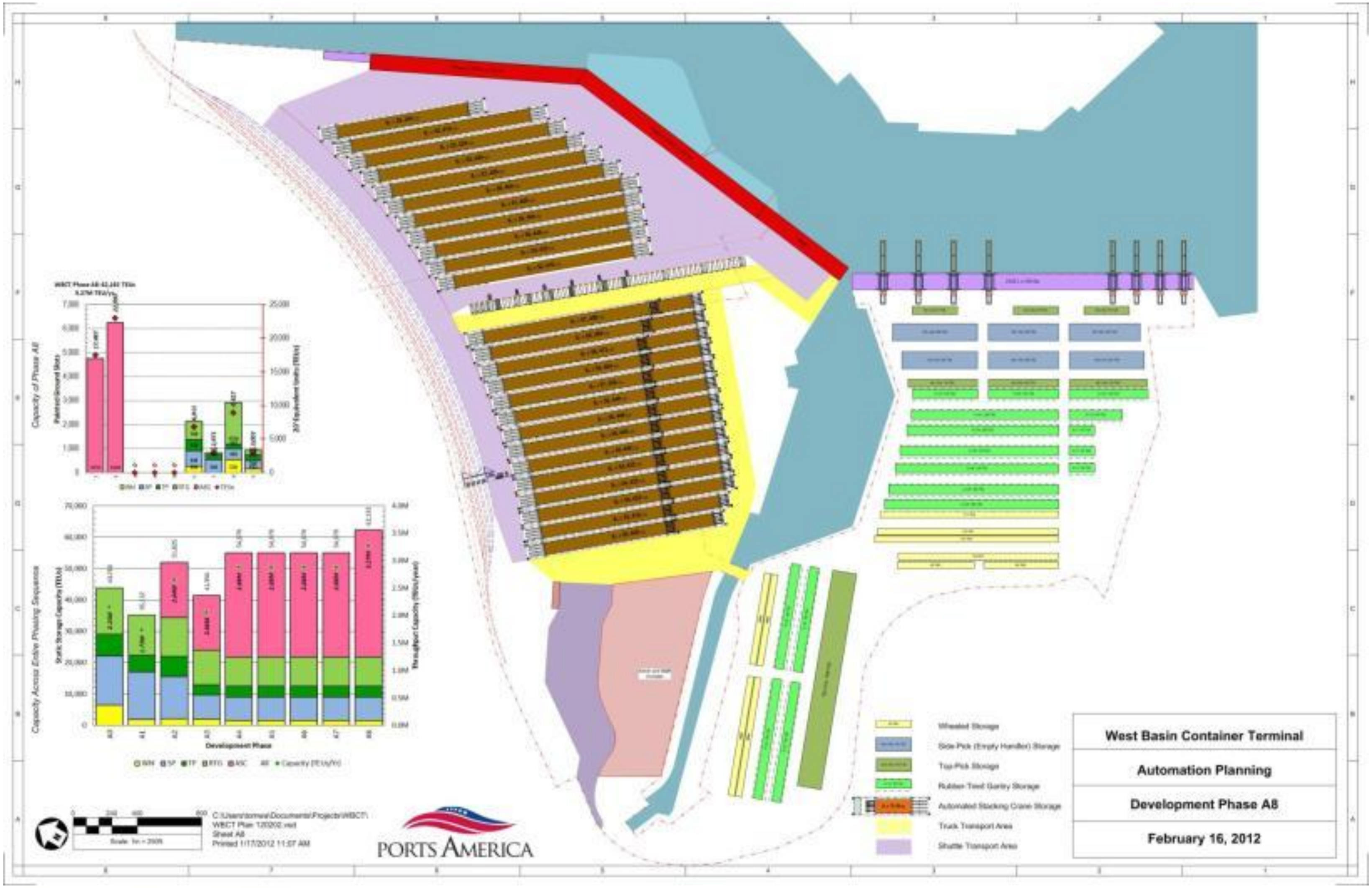
Future Buildout, 3.3M TEUs



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From Past to Future through Present

- Many “Terminals of the Future” will be built atop “Terminals of the Present”
- We must adapt to big ships using big, fast, efficient cranes backed by dense, fast, efficient yards
- We will use our existing terminal resources
- We will reconfigure yards while operating
- We will run “two terminals in one”
- We will have parallel resources (TOS, etc.)
- We will flex manned and automated models
- We will cope with construction