

**Material Handling and Storage Strategies
for a Containerized Shipping Port**

Title of Case: Material Handling and Storage Strategies for a Containerized Shipping Port

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Abstract: East Bay Terminal (EBT), a containerized shipping port for ACME Ports Authority, has had decreasing profit margins over the past few years. In addition, there is a concern by management that they will soon run out of space for the estimated demand increases in containerized cargo. Currently, EBT uses a combination of wheeled storage (where containers are left on chassis) and grounded storage (where containers are stored in block stacks by yard gantry cranes). Because of the large potential increase in space utilization from grounded storage, EBT is considering a move towards a completely grounded operation. An additional factor that is leading them in this direction is the fact that EBT is surrounded by the city and so purchasing additional land would be prohibitive. In this case, the specifics of EBT operations are provided, and students are asked to determine whether EBT should go to a completely grounded operation. In addition, students are asked to propose any further recommendations for the Port that will help EBT's profit margins.

1. Introduction

ACME Ports Authority runs a large shipping port located in Savannah, Georgia that is made up of three terminals. The Oglethorpe Street Terminal and Ruth Island Terminal are primarily for breakbulk operations, and the East Bay Terminal is exclusively for container transactions. ACME recently acquired these terminals after the local government privatized all of the shipping operations in the state. A map of the location of the three terminals is shown in the Appendix along with a layout of EBT.

A major concern of ACME is the decrease in profit margin for the common area (i.e. that area which can be used by any steamship line) for East Bay Terminal (EBT). Revenues have increased every year for the past 12 years, but costs have increased at a faster rate. Last year, revenue was \$766,500.00 and costs were \$698,500.00. The year previous, revenue was \$721,100.00 and costs were \$624,200.00. In addition, the operations manager for EBT is very worried about the limited container storage space. EBT is surrounded by the city, and the costs of additional land acquisition are prohibitive. The operations manager has therefore put a tremendous amount of effort towards convincing ACME to purchase state-of-the-art material handling equipment (primarily in the form of yard gantry cranes) in order to obtain better space utilization by block-stacking (or *grounding*) of containers.

2. EBT Operations

Four basic scenarios occur when a container moves through EBT.

- Export containers are brought by truck into the terminal and stored until they are loaded onto a vessel.
- Import containers are unloaded from a vessel and stored in the terminal until picked up by truck.
- Transship containers are unloaded from a vessel and stored in the terminal until loaded onto another vessel.
- Empty containers are brought by truck into the terminal and stored until picked up by another truck.

While contracts vary somewhat between shipping lines, US ports typically charge for each container moved from ship to shore, shore to ship or ship to ship (at a rate of approximately \$35.00 per container). There is often no charge for empty containers that come in and out the gate without crossing the dock. This is the contracting strategy employed by ACME for EBT.

2.1 Storage Strategies

There are two methods of storage of containerized cargo used at the terminal. With "wheeled" storage, a container is left on a chassis and stored in a parking slot (Figure 1). A toplifter (Figure 2) is used to move the containers on to and off of the chassis. In some

terminals, toplifters can also be used to block-stack (which is called “grounded” storage), but this is not the current practice at EBT. Grounding, of course, requires an unload/reload operation. The type of grounded storage that EBT currently uses is performed using a yard gantry crane. A yard gantry crane (Figure 3) is a crane that can move linearly, and stack 3-high and pass one over the stack.



Figure 1. Wheeled storage at EBT.



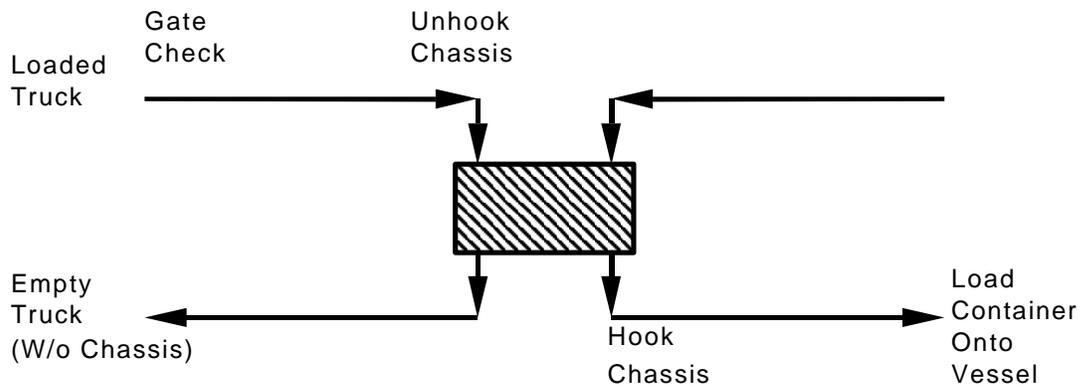
Figure 2. A toplifter loading a container.



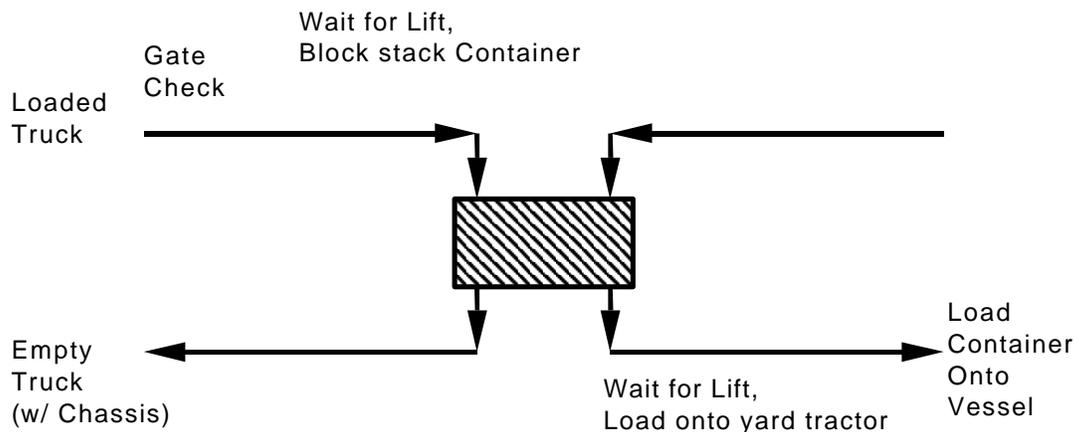
Figure 3. A yard gantry crane.

Figure 4 illustrates the following sequence of steps for an export container.

1. A truck brings a container to the port and is checked at the gate (a process which takes between 5 to 10 minutes). The driver is given a terminal location for the container.
2. If wheeled storage is used, the driver unhooks the chassis in a storage slot and leaves the terminal (this process takes about 5 minutes). If grounded storage is used, the driver goes to the location and waits for the grounding equipment (which takes about 5 to 15 minutes). The grounding equipment lifts the container from the chassis and stores it in a block stack (which takes less than a minute).
3. The driver leaves the grounding area with the chassis (which takes about 3 minutes).
4. Once a container's transporting vessel arrives (typically several days after the container arrives), the container is taken to a crane to be loaded. If the container is wheeled, then this is accomplished by a yard tractor that simply hooks up the chassis and drives it over to the crane (this process takes about 3 minutes). If the container had been grounded, then a yard tractor with chassis is driven to the container location where it waits for the grounding equipment (which takes about 4 to 5 minutes). The grounding equipment retrieves the container and places it on the chassis and the yard tractor drives it to the crane (which takes about 2 minutes).



Wheeled Operation



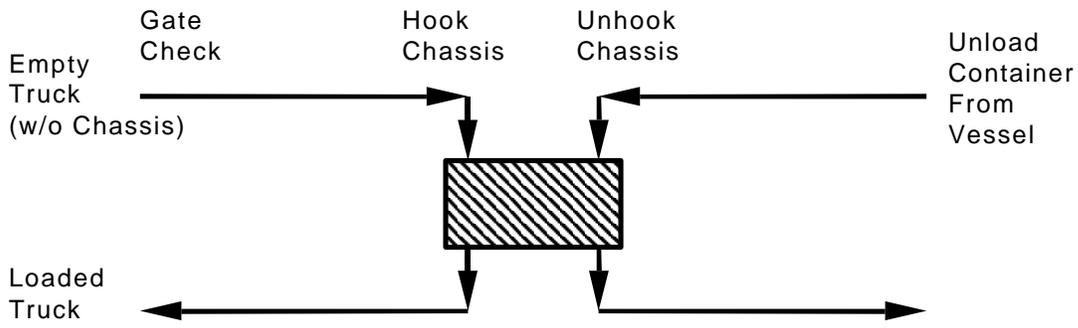
Grounded Operation

Figure 4. Sequence of steps for an export container.

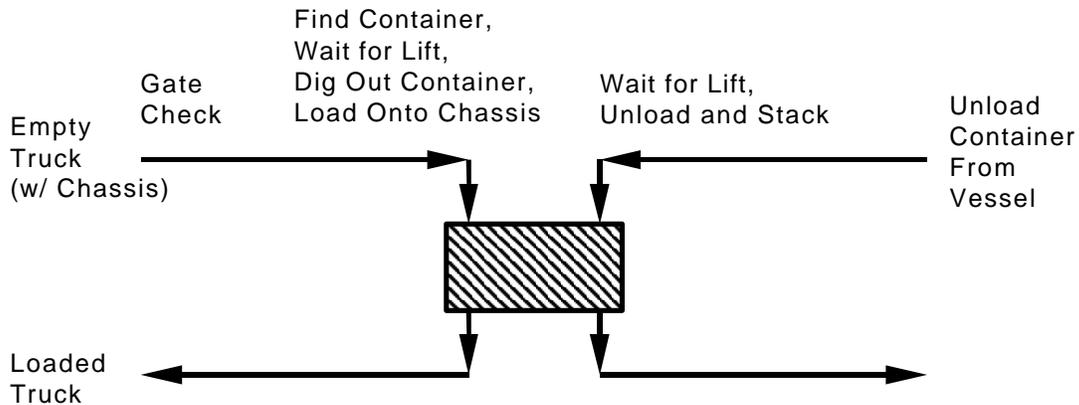
Figure 5 illustrates the following sequence of steps for an import container.

1. The container is unloaded from the ship to a yard tractor with chassis (which takes 20 to 30 seconds). The driver is given a terminal location for the container.
2. If wheeled storage is used, the driver unhooks the chassis in a storage slot and returns to the ship (which takes about 3 minutes). If grounded storage is used, the driver goes to the location and waits for the grounding equipment (which takes 3 to 5 minutes). The grounding equipment lifts the container from the chassis and stores it in a block stack (which takes about 20 to 30 seconds).
3. The driver returns to the ship for another container. If wheeled storage is used, the driver must hook up another chassis before returning to the ship for another container (which takes about 3 minutes).

4. A truck comes to the gate and the driver is given a terminal location for the import container.
5. If wheeled storage is used, the driver hooks to the chassis at the storage slot and leaves the terminal (which takes about 2 minutes). If grounded storage is used, the driver goes to the container location and waits for the grounding equipment (which takes 3 to 15 minutes). The grounding equipment then retrieves the container from the stack, lifts the container onto the chassis (which takes 20 to 30 seconds) and the driver leaves the terminal (which takes about 2 minutes).



Wheeled Operation



Grounded Operation

Figure 5. Sequence of steps for an import container.

2.2 Space Utilization of Storage Strategies

EBT uses the concept of “repeatable area” to define space. Each slot defined in this section is for 40 ft containers. For wheeled storage, a repeatable area is 296 ft by 675 ft

(or 4.59 acres) as illustrated in Figure 6. Of course fractional repeatable areas may be used in the Port.

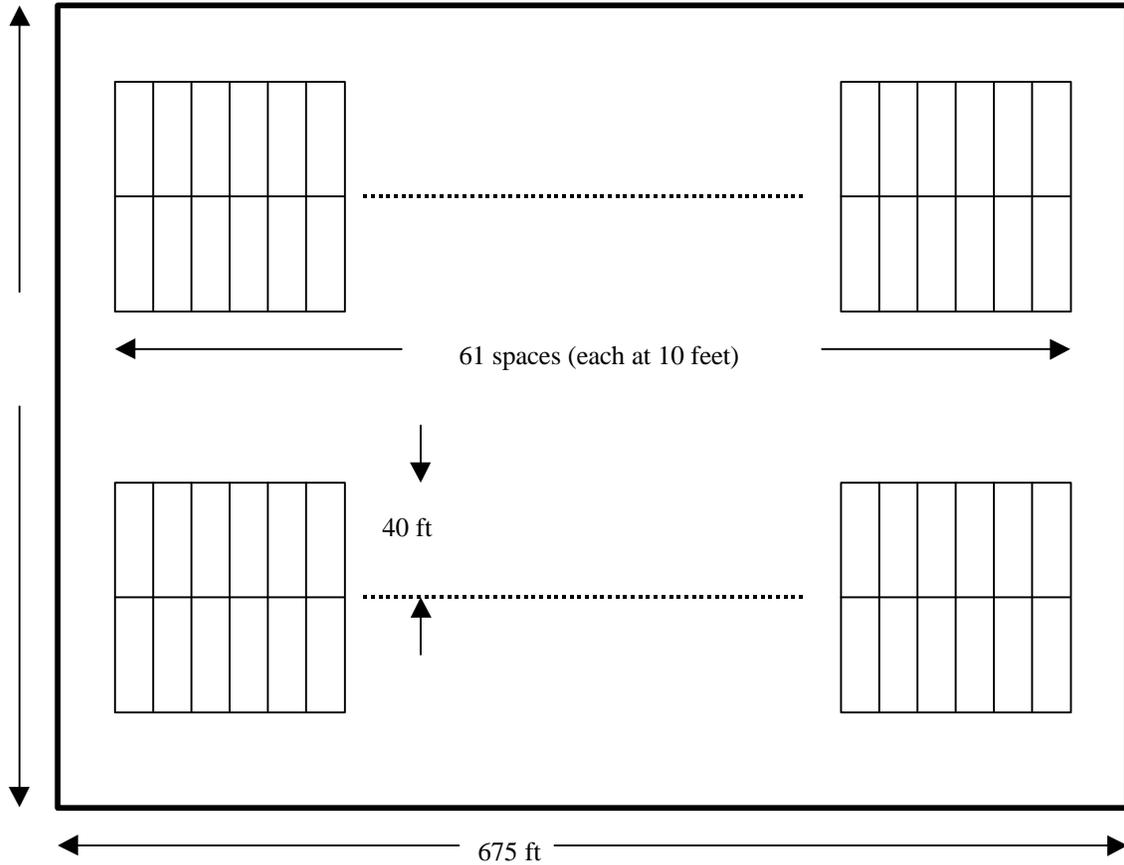


Figure 6. Repeatable area for wheeled storage

The repeatable area for grounded storage using a toplifter is 202 ft by 678 ft (or 3.15 acres) and is shown in Figure 7. Each slot can be stacked 2 high. Within the repeatable area there are two rows of slots. Each row is 14 spaces long (each at 43 ft 10 in) by 4 spaces wide (each at 9 ft). There is a 65 ft spacing between rows. One toplifter can adequately service two repeatable areas.

The repeatable area for grounded storage using a yard gantry crane is 416 ft by 678 ft (or 6.48 acres) and is shown in Figure 8. Each slot can be stacked 3 high. Within the repeatable area there are 4 rows of slots. Each row is 14 spaces long (each at 43 ft 10 in) by 6 spaces wide (each at 12 ft). There is a 15 ft spacing between rows. One yard gantry crane can adequately service one repeatable area (assuming that there is little lateral movement for the crane). It should be noted, however, that a yard gantry crane can only service a single row (so for Figure 7, four repeatable areas placed next to each other would require 4 cranes). It should be pointed out that for both types of grounded storage

that fractional repeatable areas are allowed, but must be rounded up to determine the required number of cranes and toplifters.

One final note is that the spacing between containers for both wheeled and grounded storage is the same. The spacing is required for wheeled to give some slack to the driver to back in and pull out containers. Similarly, the spacing is required for grounded since there is some sway from the crane.

2.2 Costing Data

The interest rate that EBT pays for loans is 7% annually. The equipment costs for EBT are as follows. A toplifter costs \$300,000 and the loan is paid over a 10-year period. In addition, there is a maintenance cost of \$45,000 per year and an operator cost of \$35,000 per year. A yard-gantry crane costs \$1,400,000 and the loan is paid over a 15-year period. In this case the maintenance cost is \$50,000 per year and the operator cost is

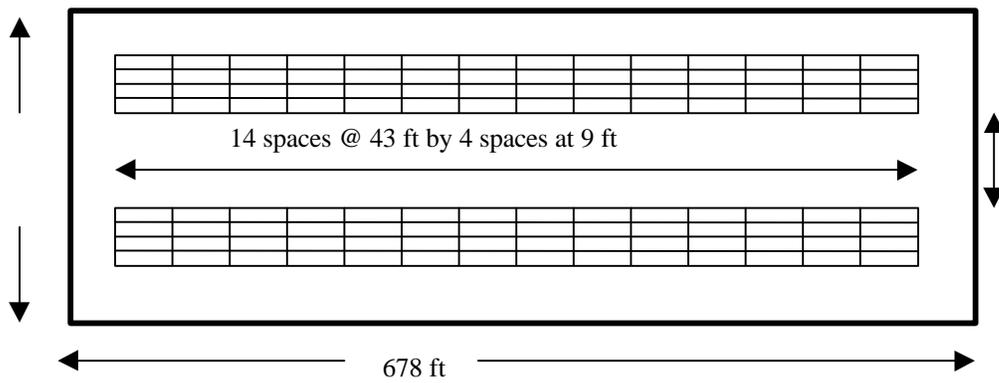


Figure 7. Repeatable area for grounded storage using toplifters

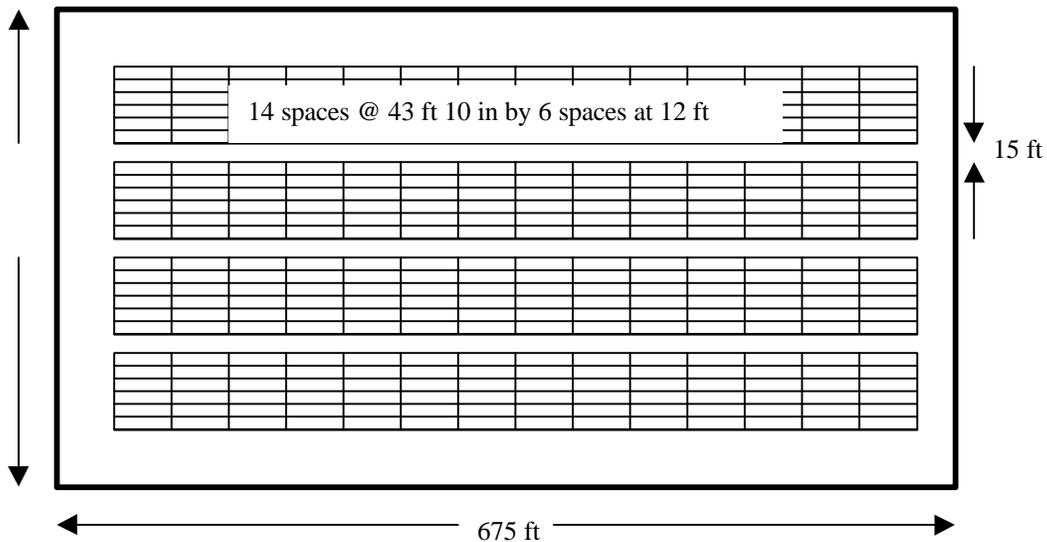


Figure 8. Repeatable area for grounded storage using yard gantry cranes

\$45,000.00 per year. Further, for grounding operations, the pavement must be reinforced. EBT pays \$11,000.00 per acre in pavement repair each year for their grounded operations. The land cost is paid over a 50-year period. The costs are the same for each alternative and work out to be \$40,000.00 per acre. However, the purchase of additional land would be prohibitive. In addition, the steamship lines own their own chassis and cost approximately \$400.00 each.

2.3 Grounding Policy

The policy used by EBT for grounded storage of export cargo is as follows:

1. When the first container for an export shipment arrives at the port, a contiguous block of space large enough to hold all of the containers for that shipment is allocated. The blocks are six containers wide and three containers high.
2. As containers arrive over time, they are placed in the allocated block.
3. Once the vessel arrives, the containers are removed from the block and loaded. The space used for the storage can then be reassigned.

A contiguous block of storage space is used since a yard gantry crane cannot move along the terminal very quickly. It is much more efficient for the yard gantry crane to operate with a minimum of travel between blocks. As discussed previously, the blocks are 6 containers wide and three high because this is the work envelope for the yard gantry crane. Obviously the length of the block depends on the number of containers assigned.

The policy used by EBT for grounding of import cargo is as follows:

1. When the vessel arrives, each container is placed in a contiguous block of space large enough to hold all of the containers for that shipment. Again, the blocks are six containers wide and three high.
2. As trucks arrive to pick up the cargo then the containers are removed from the allocated block.
3. In order to increase space utilization, the blocks are “tightened” by re-stacking by the yard gantry crane once a significant number of containers have been picked up.

2.4 Example Demand Data

Due to poor record keeping by EBT, very limited demand data is available. However, the following data was collected on a particular shipment of containers stored for export (i.e., the following data is an example of arrivals for export on a single vessel):

Days Until Vessel Departure	Number of Containers Arrived
16	1
15	0
14	0

13	0
12	6
11	9
10	11
9	8
8	0
7	2
6	0
5	38
4	19
3	16
2	5
1	2

According to the operations manager of EBT, this is a very typical example. In addition, a typical example for import cargo (i.e., containers brought in from a single vessel and picked up over time by truck) is:

Days After Vessel Arrival	Number of Containers Removed
1	2
2	2
3	19
4	23
5	41
6	0
7	7
8	0
9	3
10	7
11	7
12	0
13	2

Data is also available on the total number of gate-side and water-side transactions for the past year. A gate side transaction occurs each time a container either comes in the gate or out the gate. A water-side transaction occurs each time a container passes from ship to shore or shore to ship. It was found that there were on average 60 water-side transactions per day and 190 gate-side transactions per day.

Finally, daily inventory records for EBT were kept. Currently, EBT can hold a total of 4000 containers (of those 1200 are wheeled and 2800 are grounded). Over the past 6 months, the daily inventory of containers is plotted in Figure 9.

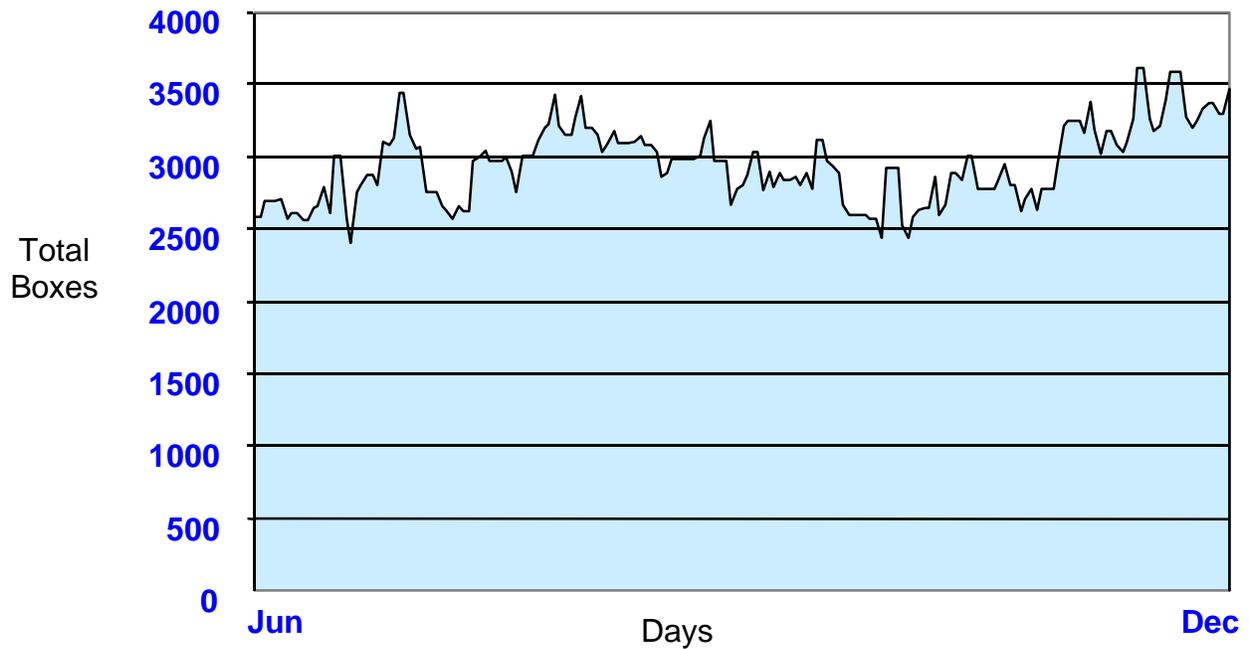


Figure 9. Daily container inventory at EBT.

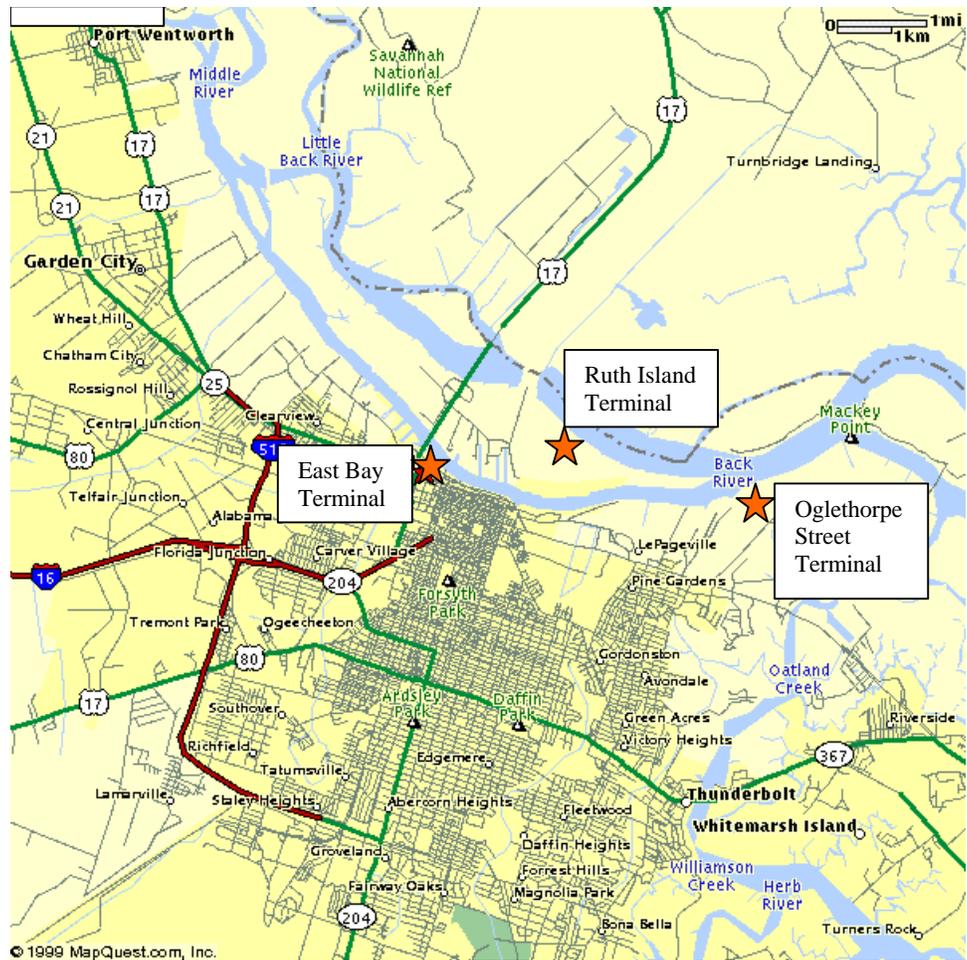
3. Assignment

ACME Ports Authority is very concerned about the decreasing profit margins at EBT. They are also well aware of the concerns of the operations manager at EBT and feel that converting all of the terminal to grounded storage might be the best way to alleviate the space concern.

You should prepare for ACME a report containing at a minimum the following information:

1. A determination of the relevant grounding and wheeled costs per container for EBT, as well as the potential savings for a completely grounded operation.
2. Discussion of your views of ACME's proposal to move towards more grounded storage.
3. Recommendations and implementation details for EBT.

APPENDIX



Map of the Three Terminals for ACME Ports Authority

A sketch (i.e. not drawn to scale) of the layout of EBT is shown below. Both grounded and wheeled storage areas are shown. EBT currently has two vessel berths and five container cranes to load and unload containers onto and off of vessels.

