# Port of Savannah's Channel

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# I General

## I.1 Background and Objectives

The following report was prepared by Asaf Ashar[1], a port and shipping consultant for the Southern Environmental Law Center (**SELC**). SELC asked Ashar to critically review the US Army Corps of Engineers' (**Corps**) studies on the Savannah Harbor Expansion Project (**SHEP**). The SHEP involves deepening and widening the access channel to the Port of Savannah.

The report summarizes Ashar's observations regarding two issues:

- Short-Term Forecast of Fleet Composition, mainly the deployment of Post Panamax vessels (**PPX**) on the Panama Canal trade routes following the Canal expansion in the Without Project (**W/O**) case; and
- Long-Term Forecast of Fleet Composition, mainly the deployment third generation of PPX (**PPX3**).

## I.2 Sources of Information

The main sources of information for this report are:

- US Army Corps of Engineers, General Re-Evaluation Report, January 2012 (**GRR**);
- US Army Corps of Engineers General Re-Evaluation Report, Appendix A: Economics (**EconApp**);
- Savannah River Maritime Commission, Notice of Proposed Decision, May 2012 (**SRMC**); and
- Corps Response to SELC.

Other sources are noted at the place they are discussed in the report.

# II Short-Term Future Fleet Composition

## II.1 Present Asian Services and Vessels

The services handling the Asia trade with the US East Coast (**USEC)** are commonly divided according to the canal they transit through, into:

- Asian services via Suez Canal (**Asia/Suez**), which the Corps refers to as those following the FE (Suez) ECUS trade route; and

[1] Ashar's professional resume is available at: ***www.asafashar.com***

- Asian services via Panama Canal (**Asia/Panama**), which the Corps refers to as those following the FE (Panama) ECUS, FE ECUS EU PEN, FE ECUS EU MED and RTW trade routes.[2]

A cursory review of the Asian services to the USEC yields that presently (May 2012), the USEC is served by 19 Asian services, 12 Asia/Panama and 7 Asia/Suez. The Asian trade is by far the largest trade of Savannah and expected to continue in this role. In 2017, the first year in which a fleet forecast is provided, the Asian trade is forecasted to account for about 85% of Savannah imports (the dominant direction). Within the Asian trade, Asia/Panama services account for 72% and Asia/Suez for the rest.

The Asia/Panama services, due to the restriction of Panama Canal, are provided by Panamax ships (**PX**); the Asia/Suez services are provided by first and second generation post-Panamax (**PPX1&2**). The Asia/Suez service provided by the largest vessels is that by Mediterranean Shipping Company (**MSC**), with average ship size of 6,050 TEUs. The largest ship deployed on this service is MSC Roma, with nominal capacity of 9,200 TEUs and dimensions of 1,105 x 151 ft (length x width) and 110,634 dwt. This ship is larger than Suzan Maersk, the ship considered for channel design, which has nominal capacity of 8,160 TEUs and dimensions of 1,138 x 138 ft and 110,381 dwt. On February 20, 2012, MSC service began calling Savannah. It is interesting to note that the width of MSC Roma at 151 ft exceeds that of the expanded channel at 144 ft. Likewise, its design draft of 49 ft is way deeper than the current channel depth of 42 ft.

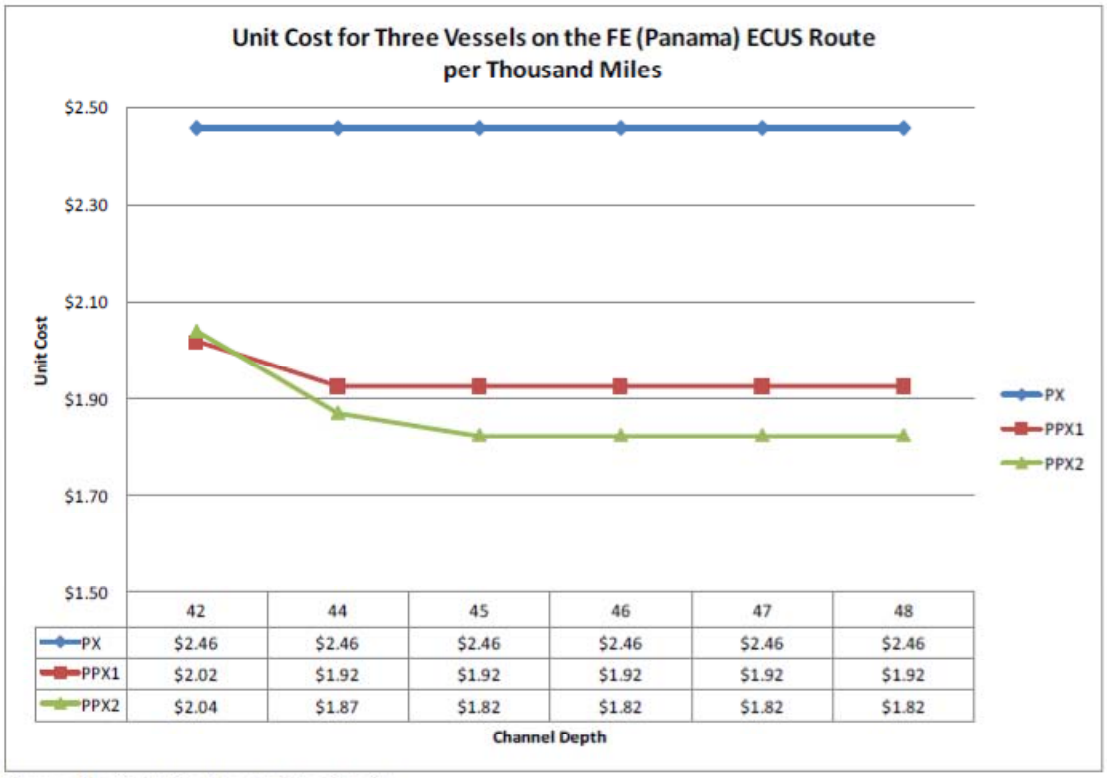
The Asia/Suez services are following the same rotation on the USEC as the Asia/Panama, except that they employ larger PPX while the Asia/Panama services employ PX. The largest PPX have design draft reaching 47 – 50 ft, although there is only one USEC port, Norfolk, with a 50-ft channel, allowing them to use their full draft (but only with the tide, since, assuming 3 ft under-keel clearance, they need a 53-ft channel). All other USEC ports, including Savannah, have drafts ranging from 42 to 45 ft. This raises a question why the Asia/Suez services use deep-draft PPX instead of shallow-draft PX? The apparent reason is that the PPX, even when serving ports constrained by draft, are more cost effective than PX.

## II.2 PX vs. PPX Cost for Asia Trades

There is some anomaly in the above suggestion that constrained and partially-loaded PPX are more cost effective than unconstrained and presumably fully-loaded PX. This anomaly is the result of the low-density nature of the Asian imports, which causes vessels to "cube out" or use all the space for containers before "weight out", or reaching their maximum draft. The PPX, are longer and, especially wider, than PX, and therefore have a larger slot capacity even if their draft is constrained, which apparently results in lower cost.

The following Figure 31 (EconApp, p. 67) illustrates the unit costs of PX, PPX1 and PPX2 in different channel depths. As seen in this figure, the cost of PX at a channel depth of 42 ft is $2.46, while that of PPX1 only $2.02. It is interesting to note in this figure that the PPX2's unit cost chart is flat once the channel depth reaches 45-ft, suggesting that the vessel at this point has fully utilized its slot capacity ("cubed out") and therefore cannot take advantage of the additional channel depth. Another interesting (or, perhaps, strange) observation is that the PPX2's cost is only $0.10 or about 5% (1.82/1.92) lower than that of the PPX1, while its capacity is about 40% (8,700/6,200) higher.

[2] RTW (Round-the-World) crosses both canals, but mainly uses the Panama for the Asian trade.




| | 42 | 44 | 45 | 46 | 47 | 48 |
|---|---|---|---|---|---|---|
| PX | $2.46 | $2.46 | $2.46 | $2.46 | $2.46 | $2.46 |
| PPX1 | $2.02 | $1.92 | $1.92 | $1.92 | $1.92 | $1.92 |
| PPX2 | $2.04 | $1.87 | $1.82 | $1.82 | $1.82 | $1.82 |

**Figure 31: Unit Cost by Sailing Draft**

## II.3 Vessels Deployed on Panama Asia/Panama Services after Canal Expansion

The Corps' consultant for shipping, MSI, using regression analysis, indicates that ship size is a direct function of the trade volume on the trade lane on which these ships are deployed. I generally agreed with MSI's observation that ship size is positively related to trade volume. Another commonly-agreed factor affecting ship size, although not indicated by MSI, is route length, with longer routes usually inducing the deployment of larger ships.

The Asia/Panama trade lane serves a larger volume than Asia/Suez; its route length is similar to Asia/Suez. It is therefore logical to assume that if the Panama Canal is expanded – *but the Port of Savannah remains unchanged at 42-ft* – the Asia/Panama services will replace their PX with PPX1&2, employing a similar fleet mix to that currently deployed on the Asia/Suez. The replacement process should be relatively fast because shipping lines had a long time to prepare for Panama expansion. In fact, many lines already have PPX on order.

The Corps, presumably taking a prudent approach, assumed a slow process of fleet conversion by the Asia/Panama services, with PPX1&2 gradually replacing PX. Table 43 (EconApp, p. 88) below presents the fleet composition forecasted for the period following the 2015 expansion of Panama Canal, 2017-2030. As seen in Table 43, in 2017, at the current depth of 42-ft, 599 (479+120) of the annual vessel calls are by PPX1&2, about 3 times th3 179 calls recorded in 2007 (EconApp, p. 39). Almost all the growth in PPX calls can be attributed to the Panama Canal expansion, since the channel depth of 42-ft remained unchanged and the forecasted growth in trade volume is only at about 5-6% annually. Interestingly, going down this table's columns, the number and composition of PPX1&2 calls beyond 44

ft remains fixed at 551 (312+239) calls. Going across the lines in Table 43 it can be observed that as the years go by the share of calls by PPX1&2 increases at the expense of smaller ships, reflecting the mentioned-above conversion (replacement) process. Still, even in 2030, the number of calls by PX, presumably mostly on Asia/Panama, remains high, at 975 for 47-ft channel, indicating that the conversion process is still on-going.

**Table 43: Forecast Vessel Calls by Vessel Size Class, Channel Depth, and Year**

| 42-Foot Depth | 2017 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| SPX | 497 | 593 | 758 | 947 |
| PX | 1,196 | 778 | 1,122 | 1,196 |
| PPX1 | 479 | 866 | 1,006 | 1,421 |
| PPX2 | 120 | 271 | 382 | 527 |
| *Total* | *2,292* | *2,509* | *3,267* | *4,092* |
| | | | | |
| **44-Foot Depth** | **2017** | **2020** | **2025** | **2030** |
| SPX | 497 | 593 | 758 | 947 |
| PX | 1,135 | 700 | 992 | 1,067 |
| PPX1 | 312 | 478 | 471 | 672 |
| PPX2 | 239 | 533 | 761 | 1,035 |
| *Total* | *2,183* | *2,304* | *2,982* | *3,720* |
| | | | | |
| **45-Foot Depth** | **2017** | **2020** | **2025** | **2030** |
| SPX | 497 | 593 | 758 | 947 |
| PX | 1,109 | 671 | 952 | 1,007 |
| PPX1 | 312 | 474 | 467 | 666 |
| PPX2 | 239 | 527 | 753 | 1,027 |
| *Total* | *2,157* | *2,265* | *2,930* | *3,647* |
| | | | | |
| **46-Foot Depth** | **2017** | **2020** | **2025** | **2030** |
| SPX | 497 | 593 | 758 | 947 |
| PX | 1,096 | 658 | 932 | 982 |
| PPX1 | 312 | 471 | 465 | 662 |
| PPX2 | 239 | 524 | 749 | 1,021 |
| *Total* | *2,144* | *2,247* | *2,903* | *3,613* |
| | | | | |
| **47-Foot Depth** | **2017** | **2020** | **2025** | **2030** |
| SPX | 497 | 593 | 758 | 947 |
| PX | 1,092 | 649 | 924 | 975 |
| PPX1 | 312 | 471 | 462 | 661 |
| PPX2 | 239 | 524 | 749 | 1,018 |
| *Total* | *2,140* | *2,238* | *2,892* | *3,601* |
| | | | | |
| **48-Foot Depth** | **2017** | **2020** | **2025** | **2030** |
| SPX | 497 | 593 | 758 | 947 |
| PX | 1,092 | 649 | 924 | 975 |
| PPX1 | 312 | 471 | 462 | 661 |
| PPX2 | 239 | 524 | 749 | 1,018 |
| *Total* | *2,140* | *2,238* | *2,892* | *3,601* |

## II.4 Benefits Attributed to SHEP

The calculation of benefits, or transportation savings, is based on cost differentials between various channel depths. These savings are generated by replacing smaller vessels, PX, by larger and more economical ones, PPX1&2. For example, in 2020 if the channel remains at 42-ft, there will still be 778 PX; the number will decrease to 649 PX if the channel depth increased to 47 ft. Accordingly, deepening of the channel to 47 ft results in replacing 129 PX (778-649) by PPX1&2. Let's assume for the sake of example that all these PX were replaced by PPX1. According to Figure 31 above, the unit cost of PX at 42-ft is $2.46 and that of PPX1 at 47-ft is $1.92. The difference in unit cost of $0.54 (2.46-1.92) is the

transportation cost savings. These savings, or benefits, are later compared to the costs of deepening the channel and a benefit/cost ratio calculated.

It seems to me that the above calculation is erroneous, however. The cost savings have to be separated into those attributed to the Canal expansion and those to SHEP. The conversion from PX to PPX1&2 is unrelated to the deepening of Savannah's channel and will take place following the Canal expansion -- *even if Savannah's channel remains unchanged at 42 ft*. A clear evidence for this conversion is the present deployment of PPX1&2 on Asia/Suez services. The Corps assumes, as seen in Table 43, that the ship-replacement process will be gradual, extending over many years. Accordingly, in 2020 some of the Asia/Panama services will still be employing PX ships with unit cost of $2.46 (Figure 31). However, since in 2020 the Canal is expanded, these services will have the option to replace their PX by more economical PPX, such as PPX1 with unit cost of $2.02. *If they elect to continue employing PX, it should be assumed that the cost of their PX will be equal or lower than PPX*.

Accordingly, a reasonable assumption for the Without Project should be that the Asia/Panama fleet mix consists of PPX1&2 ships, similar to that employed by Asia/Suez services at that time. Then, in the case of With-Project, when the channel is deepened to 47 ft, the unit cost of the assumed PPX1 will be further reduced from $2.02 to $1.92 for PPX1 and from $2.04 to $1.82 for PPX2. Only these cost differentials should therefore be attributed to the channel deepening project.

To re-capitulate, the total unit savings of $0.54 (2.46 – 1.92) in the case of replacing PX by PPX1 should be separated into:

- ***Ship Replacement Savings due to Panama Canal Expansion*** –
  PX at 42-ft to PX1 at 42-ft = $2.46 – $2.02 = $0.44

- ***Channel Deepening Savings due to SHEP***–
  PX1 at 42-ft to PX1 at 47-ft = $2.02 – $1.92 = $0.10

Accordingly, the reduction in benefits attributed to the channel deepening in this case is substantial, from $0.54 to $0.10. A modified Figure 3 illustrates the 2-stage process of reduction in unit cost.

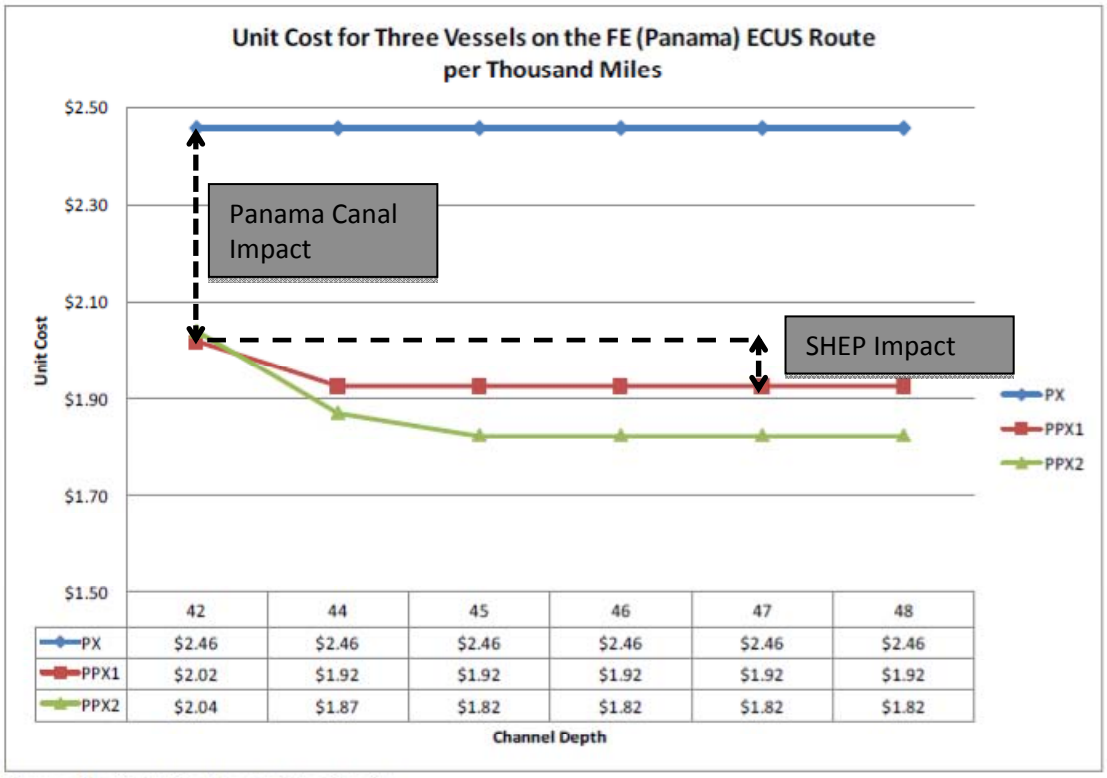



**Figure 31: Unit Cost by Sailing Draft**

## II.5 Two-Phase Conversion Process

The above claim about separating benefits is subtle and warrants another example. Let's reverse the order of events assuming the following two-phase process:

- Phase I -- Savannah channel is deepened to 47 ft; and later
- Phase II -- Panama Canal is expanded.

During Phase I, the Asia/Panama fleet will not change and will continue employing PX by necessity. According to Figure 31, these PX ships will not benefit from the deeper channel; their unit cost will remain at $2.46. Only the PPX1&2 deployed on Asia/Suez services could benefit from the deeper channel, although their savings will be quite small, $0.10 in the above case of PX1.

The replacement of PX by PPX will only take place in Phase II, when the Panama Canal is expanded. Hence, the savings due to the replacement, $0.44 in the case of PPX1 replacing PX, should be attributed to the Canal. Once the PX ships are replaced by PPX1 on the Asia/Panama services, the PPX1 can take advantage of the deeper channel and the respective savings of $0.10 due to the deepening, similar to those incurred by PPX1 deployed on Asia/Suez in Phase I. Altogether, most of the savings and benefits should be attributed to the Canal expansion and not to the channel deepening.

## II.6 Recalculation Benefits

The calculations of benefits in the Corps report is performed by a complex model with many assumptions. Short of delving into this model, which is not provided by the EconApp, it is difficult to estimate the extent of the reduction in benefits resulting from the reallocation of transportation savings. Nevertheless, I believe that this reduction could critically affect the feasibility of the entire SHEP. Hence, my recommendation is that the Corps should re-do its calculations, incorporating appropriate assumptions regarding benefits directly attributed to SHEP. I also suggest that the revised calculations be presented in a way that facilitates close examination of assumptions underlying the calculations and the calculation process itself, desirably in electronic form (spreadsheets).

# III Long-Term Future Fleet Composition

## III.1 Corps' Dismissal of PPX3

The Corps Response (1928) states: "MSI determined that even by 2030, Gen 3 would not call at Savannah while by then Gen 2 would constitute more than 50% of the ship traffic". And "The MSI conclusions regarding Gen 3 ships are reasonable", because "Vessels of the Emma Maersk class with 18,000 TEUs are too large to fit through the expanded Panama Canal". Similar statements regarding the impossibility of Gen 3, or PPX3, are also included in the GRR and EconApp. For example, in Table 28 of the EconApp (see below), the share of Gen III is assumed at 0% (in red frame).

**Table 28: Forecasted Post-Panamax Share of Vessel Capacity**

| Approximate SHEP Vessel Classes | Forecasted Share by TEU Band of Nominal Vessel Capacity at Savannah | | | | | |
|---|---|---|---|---|---|---|
| | TEU Bands | 2011 | 2017 | 2020 | 2025 | 2030 |
| Gen I | 5.2 - 7.6 k TEU | 17.7% | 21.4% | 25.5% | 20.2% | 23.9% |
| Gen II | 7.6 - 12.0 k TEU | 6.5% | 22.5% | 39.9% | 45.9% | 51.9% |
| Gen III | 12.0 k TEU + | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Total TOTAL** | | **24%** | **44%** | **65%** | **66%** | **76%** |

Source: MSI

I believe that MSI's statement regarding the 18,000 TEU is factually wrong, since such ships can be deployed on Asia/Suez services that do not transit the Panama Canal. More important, as already discussed above, I disagree with MSI's regression-based forecasting methodology of the Savannah future fleet, which I consider too rough. It also seems to me that the Corps' dismissal of PPX3 is simply due to the fact that these ships cannot physically call at Savannah even with its expanded channel. PPX3's air draft will not fit under the Talmadge Bridge and PPX3's 160-ft beam is greater than the maximum allowed in the expanded Savannah's channel (144 ft). The Corps is concerned that adding the cost of Bridge and channel modifications to accommodate PPX3 would turn the SHEP economically infeasible and environmentally prohibitive. Hence, the Corps re-states that "There is no expectation that "Generation three" ships will call at Savannah on any regular bases even if the Talmadge Bridge were raised" (765-DC-149-EC30, p. 74, underline added).

## III.2 MSI Fleet Forecast Methodology

MSI methodology (EconApp p. 52- 55) for forecasting Savannah fleet is based on "blunt" mathematical regression equation, relating vessel capacity (nominal slot-TEU) to trade volume (TEUs). The positive relationship between vessel size and trade volume is generally correct as already stated in the previous chapter. However, applying the regression equation for predicting vessel size of a specific port range (South Atlantic) is too rough, inaccurate and in the case of Savannah, leads to misleading observations. Fleet forecast for a specific port range is highly dependent on specific factors and *should be prepared separately for each trade route and service pattern*. The main factors that should be considered include, in addition to volume: route distance, en-route navigation and port constraints, number of lines involved in the trade, alliances and vessel-sharing agreements, etc. An obvious example of navigation constrain is the Panama Canal's locks. As noted above, Asia/Suez services handle a trade volume considerably smaller than Asia/Panama. Still, the vessels deployed on the Suez route are all PPX1 & 2 while those on the Panama route are all PX.

Another important consideration is vessel availability or the so-called "cascade effect". The new buildings of shipping lines tend to concentrate on the largest size category, currently at about 14,000 TEUs. When the 14,000-TEU ships are deployed, usually on the Asia/Europe trade lane, they push out smaller ships of say 10,000 TEUs to other trade lanes, such as Asia/North America. In this respect, it seems that MSI's forecast for deliveries (Figure 21), showing parallel band line, does not account for the recent surge in the 14,000+ TEU category. This surge, in turn, is less related to the overall trade growth and more to: (a) the emergence of super alliances; and (b) changes in ship technology due to the high fuel cost, among them lower service speed and respective smaller engines, more boxy hull shape and more fuel-efficient machinery. I believe that both trends portend accelerated introduction of larger ships beyond that predicted by MSI's regression equation.

## III.3 PPX3 Deployed in North Europe and US West Coast

As I noted above, MSI dismissed the possibility of PPX3 presumably due to the insufficient trade volume on the USEC. My rough estimate of the current USEC volume is 15 million TEUs which, using the Corps' assumed growth rate may double by 2020, reaching 30 million TEUs. I estimate that the present trade volume handled by the North Europe port range also is at around 30 million TEU. The dominant ships on the Asian trade routes to Europe will soon be PPX3, some of which have been deployed there for several years. For example, the 15,000-TEU Emma Maersk was launched 5 years ago, in 2006. Moreover, the 18,000-TEU class will be deployed on the Asia/Europe trade in 2013. It seems, therefore, that in terms of trade volumes, USEC will soon be "ripe" for the deployment of PPX3.

Another parallel can be derived from the US West Coast (**USWC**), which currently handles about 20 million TEUs. For example, in March 2012, MSC deployed PPX3 ships to its Asia/USWC service. The largest ship on this service is MSC Fabiola (1,201 x 158 ft), 146,092 dwt and nominal capacity of 12,500 TEUs. Based on past experience, other lines are likely to follow through as well.

## III.4 Panama Canal Studies regarding PPX3

The largest ship that fits through the Panama Canal's new third lock, the New Panamax (**NPX**), has the dimensions of 1,200 x 160 ft and capacity of 12,600 TEUs (similar to the above MSC Fabiola). Hence, according to the Corps' definition NPX, mainly because of its width, belong to the PPX3 category. The NPX was the design ship for the Panama Canal expansion project conceived in 2002. The main reason

for the Panama Canal construction of locks of this size was the expectation that these ships will dominate the Asia/Panama services in the long-term.

Since the cost of locks rises dramatically with size, the Canal conducted a long and exhaustive series of studies focusing on future ship size before settling on the NPX. These studies included, among others, extensive discussions with shipping lines, naval architects, shipyards, etc. The Canal also conducted a series of meetings with USEC ports and compiled their views regarding the size of future ships.

## III.5 Future Service Patterns of PPX3

Future PPX3 deployed on Asian trades will have two generic service patterns to select from:

- ***Direct Call*** -- Continue with the present service pattern, based on direct call at major USEC hubs, but bypassing Savannah; or
- ***Hub & Spoke*** – Serve the USEC via smaller feeder vessel, using foreign transshipment hubs in the Caribbean and Canada.

A third option, using a domestic hub, is ruled out at this point, mainly because of the high cost of port handling in the US and the high cost of Jones Act vessels to be employed for feedering.

The deployment of PPX3 and their possible service pattern is also extensively discussed in professional literature. A study by the Corps/IWR, *Implication of Panama Canal Expansion to U.S. Ports and Coastal Navigation Economic Analysis*, authored by Kevin Knight (December 2008), includes a section on Vessel Itineraries Post-Expansion of the Panama Canal (p. 8). In this section the IWR presents four alternative itineraries, which are elaborations of the two generic service patterns presented above. A more recent study by Southern Legislative Conference, *The Panama Canal Expansion and SLC State Ports*, authored by Sujit Canaga Retna (June 2010), presents a similar analysis of alternative service patterns following the Canal expansion, including the possibility of hub & spoke.

The Corps dismisses the hub & spoke possibility stating: "A foreign hub port would have a considerable cost disadvantage from the perspective of double port handling of containers shuttled to domestic spoke ports. The double handling of containers could easily add another $150 to $250 per box associated with transshipment port costs. Unless the mother vessel calling at the foreign port had very substantial economies of scale compared to the use of distinctly smaller vessels (not regularly calling U.S. South Atlantic container ports) with direct services, the extra handling costs will increase the shippers' freight costs with no other benefits. "(EconApp, Regional Port Analysis, p. 30, p. 835 of the entire report, underline added). I agree with the Corps' determination that the hub & spoke service pattern only makes sense when large PPX3 ships are deployed on the Asian trade routes, which I, indeed, predict at least for some services. In this case, I expect that the savings on ocean shipping outweigh the additional port costs (transshipment). I would also like to note that my recent studies indicate that the cost of transshipment for large-volume lines are closer to $100 per box and the overall cost trend is pointing down in light of the new transshipment hubs planned in the Caribbean region.

## III.6 The Impact on Savannah of PPX3 on SHEP Benefits

### III.6.1 Direct Calls

The emergence of Asian services employing PPX3, either through the Suez or Panama Canal, directly calling at USEC ports may have an adverse impact on the Port of Savannah's traffic. Since PPX3 cannot access the port, services employing PPX3 will have to bypass Savannah, calling instead at other South Atlantic ports (Norfolk?), fully or partially loaded. Asian services employing smaller PPX1&2 will continue calling at Savannah. Being unable to accommodate PPX3, it is reasonable to assume that Savannah will lose some of its traffic to other South Atlantic (and other) ports. Long-term, as PPX3 ships become more dominant, it is quite likely that Savannah's distribution centers, presently accounting for about 60% of its traffic, will relocate to the vicinity of competing, unconstrained ports.

### III.6.2 Hub & Spoke

The emergence of Asian services employing PPX3, using smaller feeder vessels to call at USEC ports, also is likely to have diverse impact on the Port of Savannah traffic. Unlike line-haul services that tend to "load-center" at large ports, feeder services tend to call at both large and small ports. For example, a feeder service employing small ships, may call in addition to Savannah at all Florida main ports. At present, most of the Asian services bypass the Floridian ports, with much of Florida's Asian traffic handled via Savannah. This situation will change, once feeder services start calling directly at Florida ports with Asian traffic – at the expense of Savannah.

"Repatriation" of Asian traffic and handling discretionary South Atlantic and Midwest traffic was indeed listed as the main objective of the Port of Miami's master plan. A presentation titled *The Dynamic of the US Container Market and Shifting Trade Patterns – Implications for the Florida Ports*, by Martin Associates (December 2011), included in this masterplan, estimates the volume of Florida cargo handled by non-Florida ports, including the neighboring Savannah, at 2.8 million TEUs(!). Interestingly, in order to induce this repatriation, the masterplan calls for "Attraction of import distribution centers – competition with Savannah/Atlanta" (p. 23).

## III.7 Recalculation Benefits

The emergence of PPX3 on Asia/Panama and/or Asia/Suez services following either a direct or hub & spoke service pattern is bound to result in traffic loss for Savannah along with benefits attributed to SHEP.

It preliminarily seems that the reduction in SHEP benefits in the case of hub & spoke could be more significant than in direct call because: (a) the traffic loss due to repatriation and competition on discretionary traffic from smaller ports could be much larger than that due to bypassing PPX3 services; and (b) feeder services by smaller vessels also may replace direct services by PPX1&2 along with their benefits.

It is difficult to predict when and to what extent PPX3 will be deployed on Asian services. (Mathematical regression such as MSI's is definitely useless here). My expectation is that PPX3 ships are likely to be introduced within 10 years following the Canal expansion, or around 2025. Accordingly, the reduction of SHEP benefits of PPX3 may not be as large as due to the short-term adjustment of fleet composition discussed in the previous chapter. Still, the combination of the two proposed change to the calculation of benefits may push the benefit/cost ratio below the range required for the SHEP's approval. Hence, as

in the case of the short-term fleet composition, it is recommended that the Corps will re-do its calculations, defining appropriate scenarios reflecting the impact of PPX3.