



**Technical Analysis of the  
Deepening of the Pacific Entrance to  
Drafts of 41.5', 46', and 50'**

**Análisis técnico de profundizar la  
entrada del Pacífico a calados de  
41.5', 46', y 50'**

**ACP**

**Septiembre del 2003**

**Descripción y Resumen  
(No existe Resumen Ejecutivo)**

# **Technical Analysis of the Deepening of the Pacific Entrance to Drafts of 41.5', 46', and 50'**

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September 2003

## Technical Analysis

Deepening of Pacific Entrance to Drafts of 41.5', 46', and 50'

## GENERAL DESCRIPTION OF THE STUDY

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Among major components of the Panama Canal Expansion Study are the deepening and widening of the Canal navigational channels, which include the Atlantic Entrance, Gatun Lake, Gaillard Cut, and Pacific Entrance. The deepening of the Canal navigational channels will allow the navigation of ships larger than the current Panamax size.

This study covers the technical analysis for deepening the Pacific Entrance navigation channel under three options as shown in the following table:

**PACIFIC ENTRANCE NAVIGATIONAL CHANNEL  
DEEPENING SCENARIOS**

Draft	New Design Channel Bottom (PLD)	Water Depth (MLWS)
41.5'	-54.1'	-46.5'
46'	-58.6'	-51'
50'	-62.6'	-55'

Notes:

1. Actual navigation channel bottom elevation: -52.1 ft PLD.

The deepening to a draft of 41.5' consists of dredging the Pacific Entrance navigational channels from the south end of Miraflores locks to station 85K+920, close to the whistle buoy. Please refer to Appendix No. 1 for a sketch of the Panama Canal Pacific Entrance. On the other hand, the dredging for the deepening to drafts of 46' and 50' start about 2.8 kms south of Miraflores locks, station 71K+200, near the new locks excavation of 1939, and continues down to station 85K+920.

The deepening for a draft of 41.5' was originally intended for the existing canal, provided the sills in some of the Canal lock chambers, such as the south end of the Pedro Miguel locks and the north end of Gatun locks are lowered to obtain at least 1.5 ft under-keel clearance (UKC), required to accommodate ships with a draft of 41.5 ft. At present the sills in canal locks chambers provide a minimum of 1.5' UKC for Panamax ships with 39.5' draft; therefore, to allow ships with an increased draft of 41.5', the locks chamber sills must be cut to restore the minimum UKC. Please refer to Appendix No. 2, which shows the sill elevations in Panama Canal locks.

As of today, according to the studies performed by the Department of Maritime Operations, it is not technically feasible to increase canal maximum allowable draft of 39.5' to 41.5'. Field visits of canal lock chamber shown that not only the

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sills should be lowered but whole chamber floor. Therefore massive civil works would be required. ACP is analyzing the possibility to raise Miraflores Lake to allow the transit of ships with 40.5' draft, that is, one foot of draft increase as opposed to 2 feet for 41.5' draft scenario.

The deepening to 41.5' draft is now intended to allow deeper draft Panamax ships to Panamanian ports: Balboa and Cristobal ports that were given in concession by the Panamanian government to Hutchinson Ports.

Unlike the deepening for a draft of 41.5', the deepening for drafts of 46' and 50' is part of the Panama Canal Expansion Study. If the new locks are built, the bottoms of the Canal navigational channels will require dredging to allow the safe navigation of post-Panamax vessels.

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## SUMMARY

- a. In summary, the total drilling and blasting areas, dredging volume, required dredging equipment, time frame, and costs of deepening the Pacific entrance navigation channels for the 3 options **without any contingency factor** and assuming that the Pacific entrance channel bottom is at -52.1 PLD are as follows:

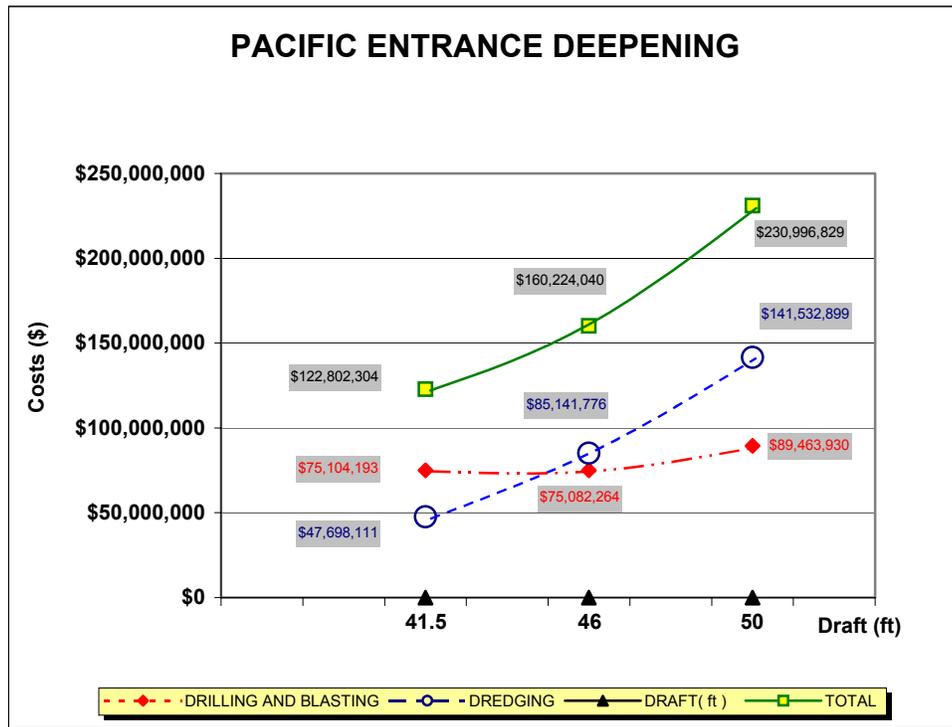
### SUMMARY OF VOLUME, AREAS, DURATION, EQUIPMENT, AND COST TO DEEPENING THE PACIFIC ENTRANCE NAVIGATION CHANNELS

DRAFT	D&B areas (m <sup>2</sup> )	Dredging volume (m <sup>3</sup> )	No. of Drillboats	No. of dredges	Total duration (years)	D&B cost (\$)	Dredging cost (\$)	Total Cost (\$)
41.5 ft	2,597,273	3,413,836	2	2	3.25	75,104,193	47,698,111	122,802,304
46 ft	2,085,323	6,359,871	2	2	4.00	75,082,264	85,141,776	160,224,040
50 ft	2,133,824	10,846,307	2	2	5.50	89,463,930	141,532,899	230,996,829

Notes:

1. The deepening for 41.5' draft initiates at Miraflores locks south end.
2. The deepening for 46' and 50' draft initiates near 1939 third set of locks excavation.

- b. The following graph shows the cost relationship between dredging and drilling & blasting for the 3 drafts depths. For drilling and blasting, the efficiency increases at deeper boreholes, as opposed to dredging, in which the costs are directly proportional to the dredging volume.



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- c. Deepening cost in phases assuming one-phase drilling and blasting would be as follows:

**SUMMARY OF VOLUME, AREAS, DURATION, EQUIPMENT, AND COST TO DEEPENING THE PACIFIC ENTRANCE NAVIGATION CHANNELS**

DRAFT	Dredging volume (m <sup>3</sup> )	No. of Drillboats	No. of dredges	D&B cost (\$)	Dredging cost (\$)	Total Cost (\$)
39.5 to 41.5 feet	3,413,836	2	2	75,104,193	47,698,111	<b>122,802,304</b>
41.5 to 46 feet	3,839,296	2	2	32,236,561	50,538,871	<b>82,775,432</b>
46 to 50 feet	4,486,436		2		55,433,061	<b>55,433,061</b>

Notes:

1. The deepening for 41.5' draft initiates at Miraflores locks south end.
2. The deepening for 46' and 50' draft initiates near 1939 third set of locks excavation.

- d. If the decision is to drill and blast initially for a 46'-draft channel bottom instead of going directly for a 50' draft, the total deepening cost could increase up to 21%, as shown in the following table:

**COMPARISON BETWEEN DRILLING AND BLASTING FOR 46' versus 50' DRAFT IN ONE PHASE AND TWO PHASES**

Design Channel Bottom	46' draft	50' draft	TOTAL
Dredging Volume (m3)	6,359,871	4,486,436	10,846,307
Drilling & Blasting areas (m2)	2,085,323	2,133,824	4,219,147
Duration with 2 dredges and 2 drillboats (years)	4	5.5	7.25
<b>TOTAL COST, ONE - PHASE D&amp;B (\$)</b>	<b>160,224,040</b>	<b>70,772,789</b>	<b>230,996,829</b>
<b>TOTAL COST, TWO - PHASE D&amp;B (\$)</b>	<b>160,224,040</b>	<b>118,416,443</b>	<b>278,640,483</b>

- e. The previous table does not contemplate any contingency factor.