Selection of Excavation Material Disposal Sites for the Canal Expansion

International Seminar on Sustainable Dredging and Maritime Construction

Hortensia I. Broce
Environmental Management and Monitoring Section
Engineering and Programs Administration Department

Canal Expansion - Similar to Canal Construction - 100 years later
The Canal Expansion involves the removal of approximately 133 million cubic meters (Mm³) (83 Mm³ dry, 50 Mm³ dredged) of excavation material.

**Excavation Material to be Removed by Expansion Project**

- **Dry Excavation:** 62%
- **Dredged:** 38%

**Equator Principles:**
1. Review and categorization
2. Social and environmental assessment
3. IFC EHS guidelines
4. Action plan and management system
5. Community consultation
6. Grievance mechanism
7. Independent review of the assessment
8. Apply contractual environmental covenants
9. Independent monitoring and reporting
10. Public Reporting (applicable to lenders)
Canal Expansion Excavation Material Disposal Sites Selection Methodology

- Pacific side
  - Process started in 2002 for Estimated 70 Million Cubic meters
  - Workshop with brainstorming session - ACP personnel
  - Alternative analysis - Screening under Contract by Moffat & Nichol
  - Evaluation under Contract to Moffat & Nichol completed in March 2004
  - Environmental Impact Study for Deepening and Widening Pacific Entrance
  - Environmental Impact Study for Third Locks Project

- Atlantic Side
  - Process started in 2004
  - Workshops with brainstorming session – ACP personnel
  - Alternative analysis – Screening under Contract by Louis Berger
  - Evaluation under Contract to P B Consult completed in March 2007
  - Environmental Impact Study for Third Locks Project

Physical – Chemical Studies
Gatun Lake and Canal Sea Entrances

- Water Quality
  - Suspended solids and turbidity
  - Chlorides
  - Total dissolved solids
  - Conductivity
  - Inorganic chemistry

- Sediments
  - Grain size distribution
  - Metals

- Currents and tides
- Bathymetry
Hydrodynamic Studies at the Canal Entrances
(Dredging and disposal sites)

Currents simulations durante las mareas:
- Flooding tide
- Maximum high tide
- Falling tide
- Maximum low tide

Bathymetric studies at the canal entrances

Pacific Area
Atlantic Area
CANDIDATE DISPOSAL SITES OR OPTIONS
Pacific side

- For the Alternative Analyses, the sites chosen were taken from the following:
  - Projects identified before 1993
  - Sites listed in the Panama Canal Alternatives Study (1993)
  - Existing or Proposed ACP materials Disposal Sites
  - Abandoned US Dept of Defense Ranges within the former Canal Zone
  - Listing of Sites considered by ACP during Workshop in November 2001
  - Additional Sites suggested by the Consultant(s) or other studies

- Following the elimination of the repeat locations, the base list of candidate disposal sites was reduced to 29
Materials Sources

The Candidate list of disposal sites addressed the requirements of three different sections of the Pacific side Deepening and Widening project scenarios.

- Gaillard Cut widening and deepening project
- New Post Panamax vessel locks in the Miraflores/Pedro Miguel area
- Pacific Entrance Channel Deepening & Widening

Sites Screening Process

Pacific side

- The initial screening identified some 59 sites that had been proposed or suggested over the past 20 years or so for materials disposal, reclamation or fill.
- One criterion for passing to the next level in the screening process was that sites should be within an “economic” haul distance.
- Screening of 17 selected sites included Environmental Evaluation of each site.
Sites Selected for Additional Screening
Pacific Side

Sites Characterization Matrix
Technical Considerations
Pacific Side

- Site Capacity Evaluation
- Transportation Systems – combination of equipment to move material between source and destination
- Transportation Cost Estimates

<table>
<thead>
<tr>
<th>Site</th>
<th>Description</th>
<th>Estimated Capacity (Million cubic meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-1</td>
<td>Rio Mandingo</td>
<td>60.72</td>
</tr>
<tr>
<td>T-2</td>
<td>Rio Camacho</td>
<td>32.95</td>
</tr>
<tr>
<td>T-3</td>
<td>UXO (E-2)</td>
<td>28.13</td>
</tr>
<tr>
<td>T-4</td>
<td>Gaillard Cut East</td>
<td>7.28</td>
</tr>
<tr>
<td>T-5</td>
<td>UXO</td>
<td>7.29</td>
</tr>
<tr>
<td>T-6</td>
<td>UXO</td>
<td>53.30</td>
</tr>
<tr>
<td>T-7</td>
<td>Borinquen Dams</td>
<td>4.50</td>
</tr>
<tr>
<td>T-8</td>
<td>West Miraflores</td>
<td>3.45</td>
</tr>
<tr>
<td>T-9</td>
<td>Rodman</td>
<td>5.90</td>
</tr>
<tr>
<td>T-10</td>
<td>El Arado</td>
<td>87.60</td>
</tr>
<tr>
<td>A-1</td>
<td>Trinidad</td>
<td>33.50</td>
</tr>
<tr>
<td>M-1</td>
<td>Panama Bay Fill</td>
<td>61.70</td>
</tr>
<tr>
<td>M-2</td>
<td>Chorrillo Bay Reclamati on</td>
<td>6.60</td>
</tr>
<tr>
<td>M-3</td>
<td>Amador Causeway Expansion</td>
<td>11.20</td>
</tr>
<tr>
<td>M-4</td>
<td>Farfan / Palo Seco</td>
<td>15.00</td>
</tr>
</tbody>
</table>

Environmental Considerations
Pacific Side

- **Criteria for Terrestrial Sites**
- Land Ownership, administrative or tenure condition
- Ecological Structures present in the area
- Vegetation types based on UNESCO classification
- Presence of endangered/protected species under Panama laws
- Species under protection by international laws.
- Socio-economic conditions
- Cultural remains

Criteria for Marine Sites
- Habitat alteration and/or destruction
- Water quality impacts
- Impacts to biota
- Impacts to commercially important species
- Impacts to the socio-economic conditions of surrounding populations
- Legal and institutional issues
Site Evaluation Included
Artificial Island Feasibility Study

- Island Disposal is Valid Option Technically
- Transport by Rail is most economic
- Financial Viability is Sensitive to Costs

- Site Studies
  - Marine Geotechnical
  - Geophysical (Jan 2003)
  - Geotechnical/topo (Jan to May 2003)
  - Currents and tidal data (Jan to July 2003)
  - Environmental data & analysis (Nov. 2003)

Materials Disposal Costs

<table>
<thead>
<tr>
<th>Site</th>
<th>Base Cost (US$/m3)</th>
<th>Value Added?</th>
</tr>
</thead>
<tbody>
<tr>
<td>T 6</td>
<td>$3.43</td>
<td>Yes</td>
</tr>
<tr>
<td>Artificial Island</td>
<td>$4.25</td>
<td>Yes</td>
</tr>
<tr>
<td>El Arado</td>
<td>$5.96</td>
<td>No</td>
</tr>
<tr>
<td>Open Water</td>
<td>$5.08</td>
<td>No</td>
</tr>
</tbody>
</table>
Dredged material upland disposal sites
Pacific

Dredged material aquatic disposal sites
Pacific
Technical Considerations
Atlantic Side

<table>
<thead>
<tr>
<th>TERRESTRIAL SITES</th>
<th>AQUATIC SITES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Location</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Dimensions</td>
</tr>
<tr>
<td>Use</td>
<td>Use</td>
</tr>
<tr>
<td>Topography</td>
<td>Acces y Transport</td>
</tr>
<tr>
<td>Geotechnical</td>
<td></td>
</tr>
<tr>
<td>Drainage</td>
<td></td>
</tr>
<tr>
<td>Acces y Transport</td>
<td></td>
</tr>
</tbody>
</table>
Environmental Considerations
Atlantic Side

<table>
<thead>
<tr>
<th>TERRESTRIAL SITES</th>
<th>AQUATIC SITES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate and air quality</td>
<td>Climate and air quality</td>
</tr>
<tr>
<td>Geology</td>
<td>Geomorphology</td>
</tr>
<tr>
<td>Soils and Use</td>
<td>Sedimentology</td>
</tr>
<tr>
<td>Hydrology, drainage and water quality</td>
<td>Hydrodynamics and Water quality</td>
</tr>
<tr>
<td>Vegetation, Flora and Fauna</td>
<td>Biological Resources</td>
</tr>
<tr>
<td>Archeology and cultural aspects</td>
<td>Archeology and cultural aspects</td>
</tr>
<tr>
<td>Socio-economic aspects</td>
<td>Socio-economic aspects</td>
</tr>
</tbody>
</table>

Sediment Studies in Monte Lirio
Atlantic Side
Open Water Disposal Sites in Gatun Lake

Sites in deep areas previously used for maintenance and special projects

- Frijoles Bay
- Peña Blanca East and West
- Dump 14

Sites for Expansion Project

- Total of 23 Sites Selected
- Reviewed in Category III - Environmental Impact Study
- Approved by ANAM by Resolution

Atlantic Side

- Northwest Breakwater
- Tanque Negro Norte
- Tanque Negro Sur
- Mindi
- Monte Lirio

Pacific Side

- Victoria
- Rousseau
- Velasquez
- Cocoli
- Cocoli Sur
- Fanfan
- Tortolita
- Tortolita Sur
- Palo Seco

Gatun Lake and Gaillard Cut

- Frijoles
- Peña Blanca West
- Peña Blanca East
- Sites 12, 13, 14, 15 & 16