ACP
AUTORIDAD DEL CANAL DE PANAMÁ

CONTRACT CC-3-557

Architectural and Engineering Services for Engineering Site and Assessment, Conceptual Design and Related Services

Pacific Side Excavation & Dredging Material Disposal Alternatives Evaluation

Final Report

Volume 2 of 3

March 2004

MOFFATT & NICHOL
ENGINEERS

Golder Associates

LOUIS BERGER GROUP

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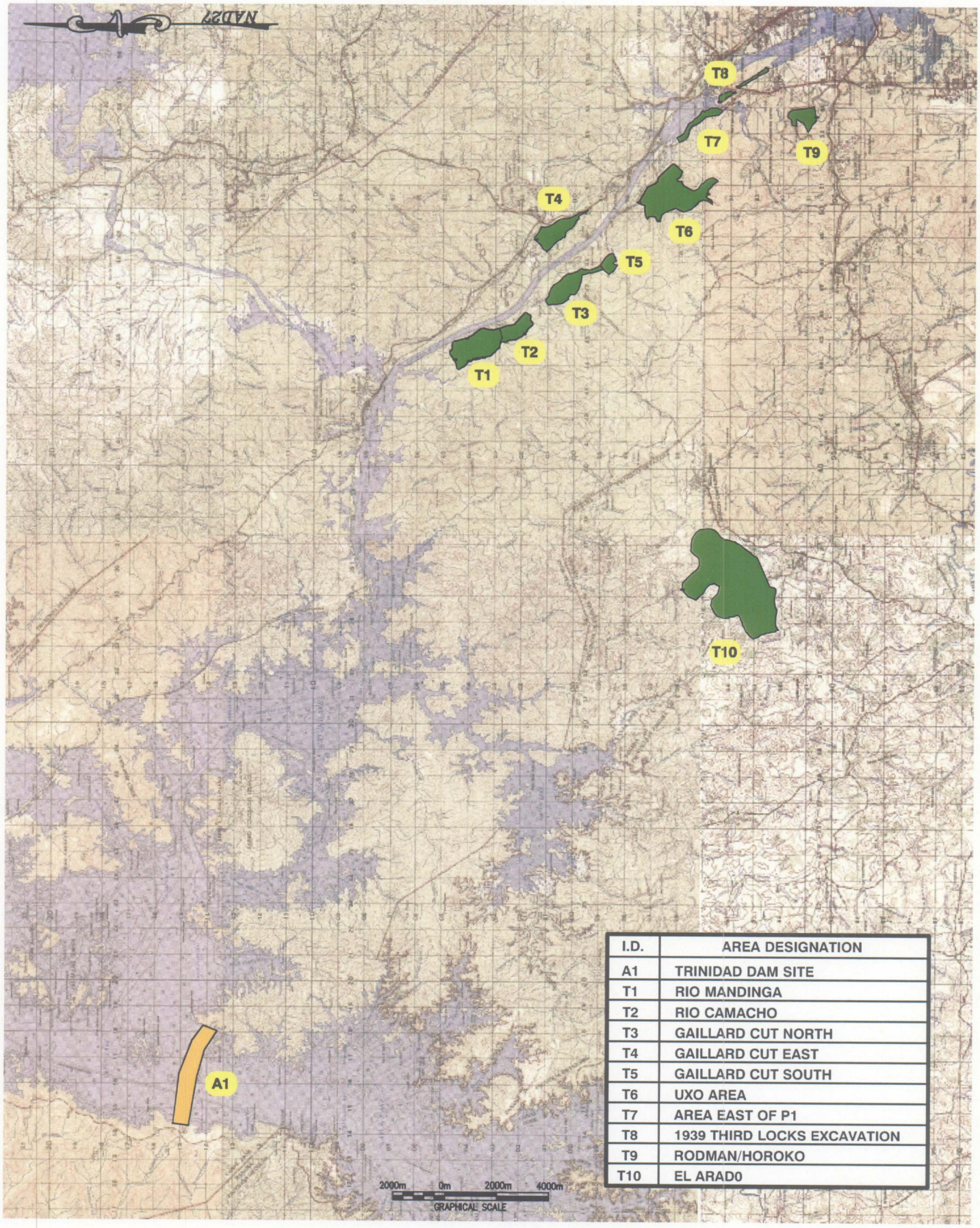
7 TECHNICAL EVALUATION OF TERRESTRIAL SITES

Following the environmental assessments presented in the previous sections, technical and cost evaluations were undertaken for each candidate disposal option. However, prior to the technical assessments, the boundaries of each site were examined and modified to exclude highly sensitive habitats or forested areas. This procedure applied primarily to sites T1 and T2, both of which contain critical habitats and ecologically valuable forested areas. The environmental assessment also identified important flora and fauna in site T9 (Rodman/Horoko) which lead to serious concerns over its suitability as a disposal site.

Figure 7-1 shows the general location of the terrestrial disposal sites, and a specific discussion on the technical elements of the modified or revised sites now follows.



I.D.	AREA DESIGNATION
A1	TRINIDAD DAM SITE
T1	RIO MANDINGA
T2	RIO CAMACHO
T3	GAILLARD CUT NORTH
T4	GAILLARD CUT EAST
T5	GAILLARD CUT SOUTH
T6	UXO AREA
T7	AREA EAST OF P1
T8	1939 THIRD LOCKS EXCAVATION
T9	RODMAN/HOROKO
T10	EL ARAD0

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Figure 7-1
Location of Potential Terrestrial Sites

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7.1 Site T1 – Rio Mandinga

Materials removed from the Canal drilling and blasting projects are currently moved to the existing T1 disposal area by dump truck but to date, deposition has been limited to the areas east of the Mandinga river.

Based on the environmental recommendation that the forested areas of Site T1 be excluded from consideration as a disposal area, the configuration of the location is reduced from 444 hectares to approximately 149 ha, as shown in Figure 7-2.

7.1.1 Geotechnical Considerations

The eastern boundary of this site runs parallel to the west bank of the Gaillard Cut and it is critical to maintain sufficient separation between the filled areas and the Canal banks to avoid instability issues or bank failures. Based on earlier assessments of the soils characteristics in the area[1] and reported ACP practice, it is recommended that a clear distance of 500 m be maintained from the west bank of the Canal to the toe of the filled area, and all slopes facing the Canal should be limited to 3 horizontal to 1 vertical.

Prior to any extensive filling at the site, a more detailed geotechnical investigation program is required to ensure stability of the slopes closest to the Canal and to also evaluate any potential concerns related to seismic events.

[1] Golder Associates. Evaluation of materials and geotechnical conditions within the area of the proposed Pacific Locks excavation.

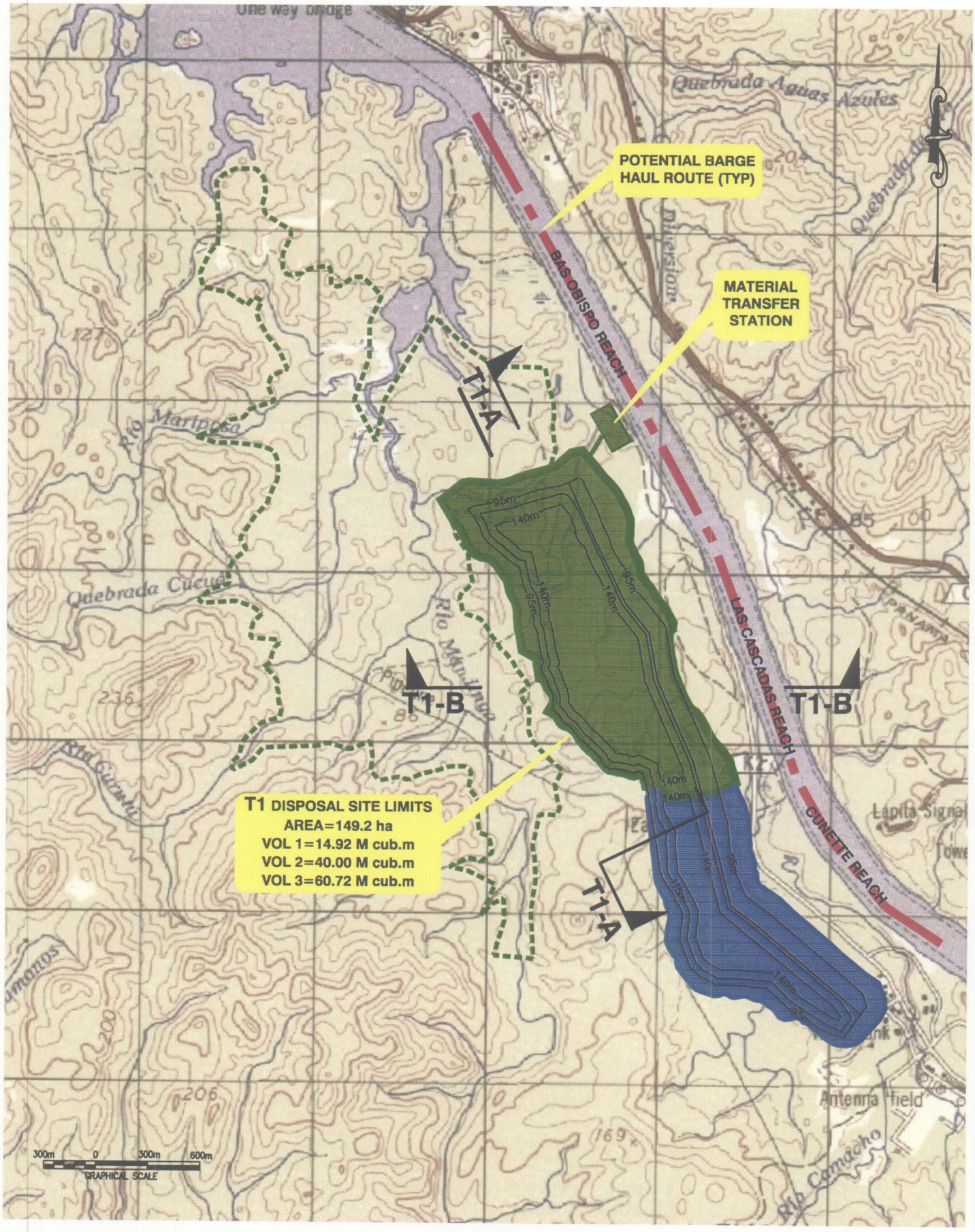

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Figure 7-2
Recommended Configuration for Site T1

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7.1.2 Site Holding Capacity

Material for the Site T1 will logically come from the west side dry excavations and dredging work generated by the Gaillard Cut deepening and widening project. It is also been assumed that all dry excavation from the east bank widening work would not be transported across the Canal.

As noted earlier, three scenarios are presented for fill capacity at the modified Site T1, as shown in Table 7-1, below:

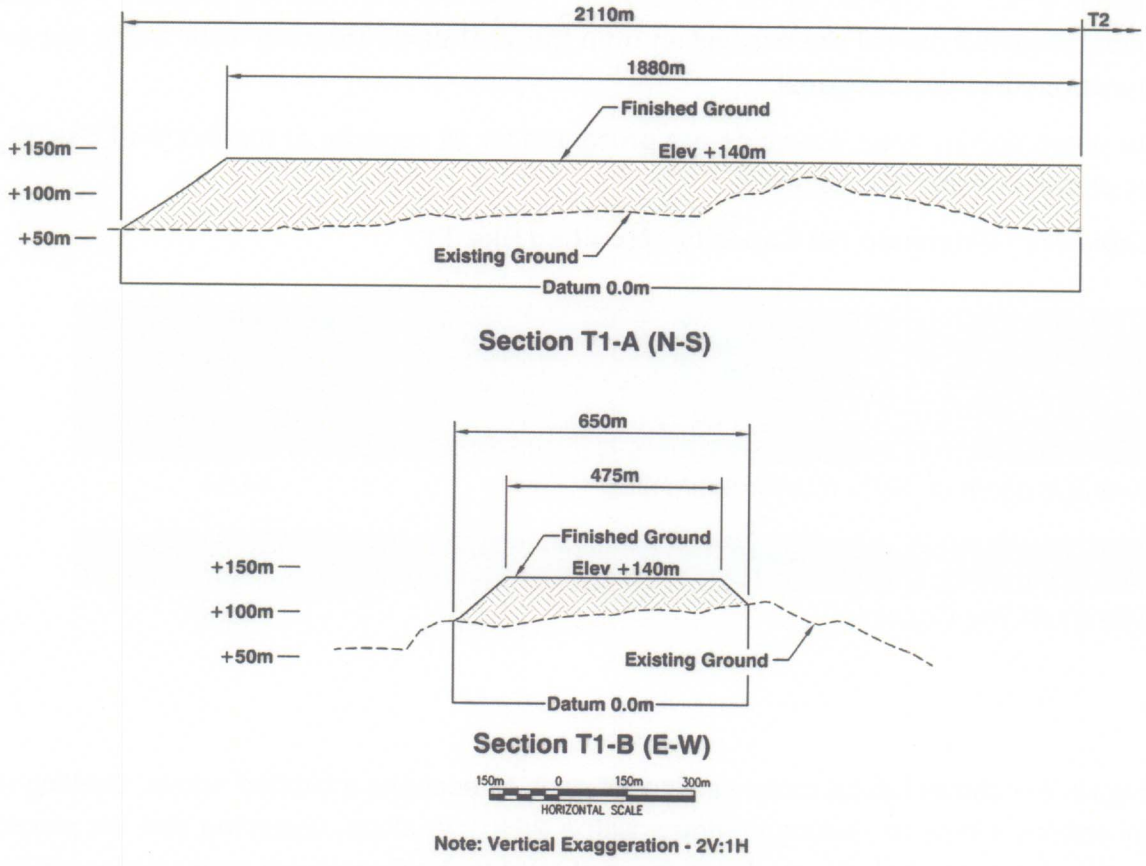
Table 7-1: Estimated Fill Capacity - Modified Site T1

Scenario	Estimated Fill Capacity (million x m3)
Average depth of 10.00 m over entire site	14.92
Fill to uniform Elevation of approx +115.00 m	40.00
Maximum Site Capacity	60.72

Figure 7-3 shows typical cross section for each fill scenario indicated above. Grading in all options will tie to existing contours with a 2(H):1(V) slope, assuming that the placed material is primarily rock. At the fill faces closest to the Canal west bank, slopes will be reduced to 3:1 for rock fill or 4:1 for overburden or other material and the height of fill reduced to avoid potential instability problems in the vicinity of the Canal.

In order to confirm or modify these preliminary recommendations, it is recommended that a series of boreholes be should be driven along the eastern limits of the site prior to placing any fill in the area. A stability analysis should then be conducted to determine the maximum allowable fill heights and slopes in the sections closest to the Canal.

Figure 7-3: Typical Fill Sections for Site T1



Note: Refer to Figure 7-2 for section cut locations.

7.1.3 Drainage Requirements

Since the original site configuration changed significantly following the first environmental assessment, the drainage requirements were re-evaluated for the reconfigured site. Since the reconfigured area now excludes the Rio Mandinga, the overall site drainage characteristics changed significantly. The presence of a ridge line through the reconfigured area naturally divided the site into two drainage areas, such that an individual analysis was carried out for each.

The revised watershed areas were calculated to be 68 hectares for sub-basin B1, on the north side of the site and 123 hectares for sub-basin B2 on the south side of the site, as shown in Figure 7-4. The land cover of the reconfigured area consists of fair grassland with some work areas and wooded areas, yielding a weighted SCS Curve Number of 75,

which was applied for both sub-basins. Finally, the design rainfall selected for the modeling analysis, was changed slightly to 17.58 cm, based on the Cascadas gage rainfall statistics. Having updated the watershed characteristics, the HEC-HMS model was developed and run for the revised site, yielding the expected 100-yr, 24-hr peak flows for each sub-basin. These peak flows were used to estimate the required channel size for the sites (see Table 7-2).

Table 7-2: Results of Drainage Analysis for Reconfigured Site T1

Site	Watershed Area (hectares)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Chann. Area (m^2)	Chann. Bottom Width (m)	Chann. Top Width (m)
T1-B1	68	75	17.58	6.8	5	0.4	8.8
T1-B2	123	75	17.58	10.3	6	0.5	9.7

As can be seen in the table, the peak flow and required channel area and width calculated for the 100-yr, 24-hr event are quite small for both sub-basins. Therefore, the creation of a diversion channel or channels along site boundaries or internal sub-basin boundaries (depending on filling sequencing and/or ACP preference) of the site should pose no significant impediments. The final decision on whether to divert flows to the site boundaries versus providing interior drainage versus allowing natural rivulets to form will largely depend on the time taken to fill the site. The quicker the site fills, the more organized and detailed the drainage construction will have to be. These questions cannot be answered until later design phases and therefore the overall staging of drainage construction will be determined at that time.

However, given the site's proximity to Canal waters, erosion and sediment control during filling will be especially important as to not divert sediments directly into the system that will eventually have to be dredged. A possible alternative may consist of temporary dikes constructed across the diversion channel(s) at various locations to create stilling basins to encourage settling. Depending on the proximity to the Canal waters, silt curtains may also be required.

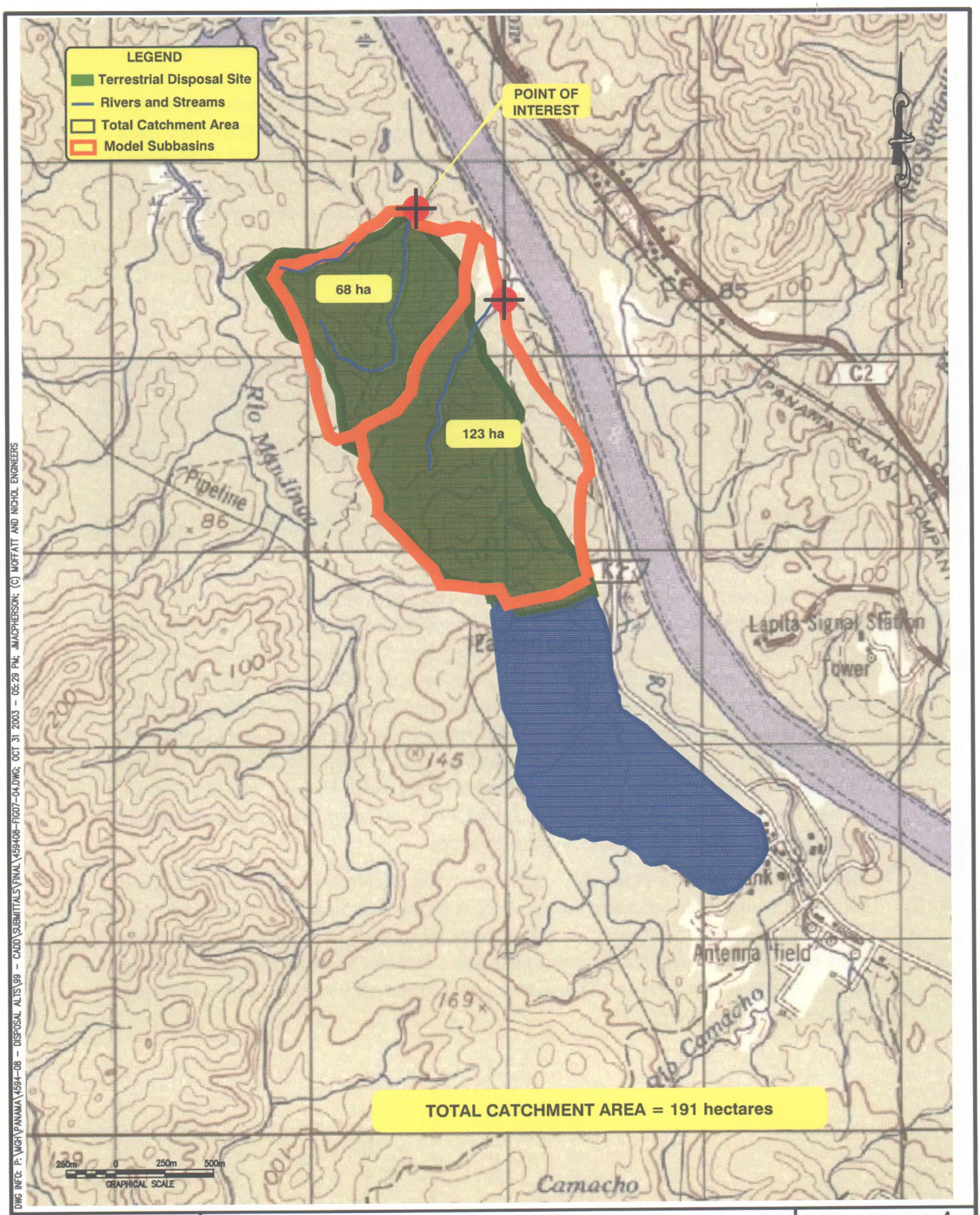


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Figure 7-4
Reconfigured Watershed Delineation - Site T1

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7.1.4 Site Preparation

Given the fact that much of the land in the reconfigured area has already been cleared of forest and native vegetation, only minimal site preparation is required prior to the commencement of fill operations. For the purposes of this analysis, it is considered that internal access roads would be constructed from dry or wet material from the excavation work, with the expectation of a high percentage of rock content. Other preparation work will involve the construction of temporary drainage diversion channels, which would be modified and reconfigured as fill progresses over a period that could extend several years, as noted above.

7.1.5 Materials Transportation Analysis

Haul Corridor

Material for the disposal site will comprise dredged material from the deepening and widening work, plus dry material from the west bank widening project. The Bas Obispo reach of the Gaillard Cut is adjacent to this site, and as seen in Figure 7-1, it would be possible to service the site from a central location. The haul distance from this point to site T1 will be approximately 1.5 km in length and could partially follow the route of the existing Panama Canal Western Access Road.

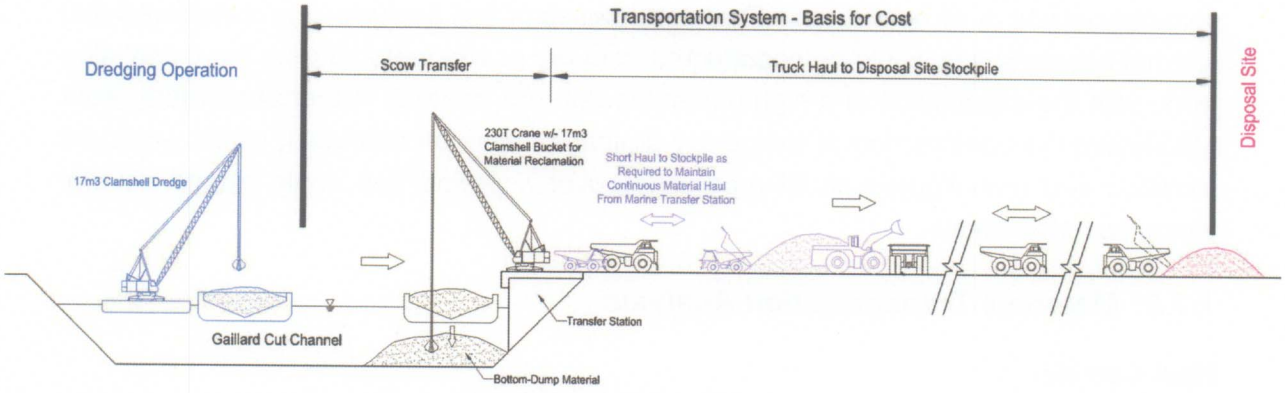
Materials Transportation System

Given the short distance from the Bas Obispo reach to Site T1, it is expected that materials will be moved and placed from high capacity dump trucks over temporary haul roads. The high percentage of rock from the dredge projects indicates that the haul road bases will be of high quality material.

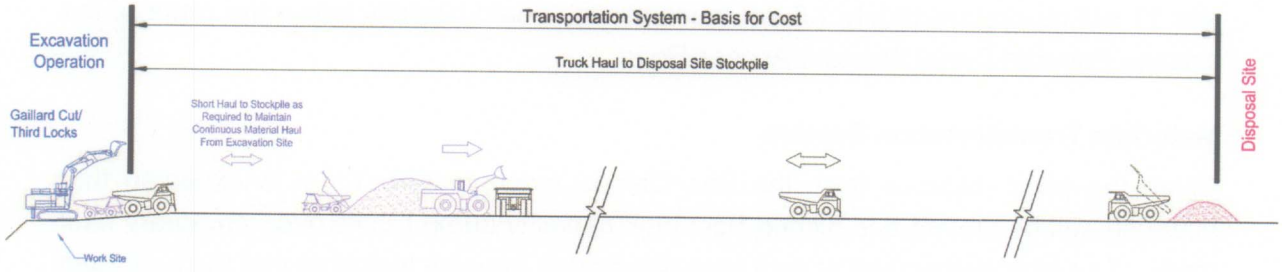
Existing roads would not be used due to the high axle loads from the heavy equipment and the need to maintain access for ACP and emergency vehicles over the existing road system.

Dredged material would being moved across the Canal from the worksite to a marine transfer station for loading onto the dump trucks, as indicated in Figure 7-5, below:

Figure 7-5: Material Transportation Systems for Site T1



System C
Typical Scow/Truck Haul Operation (Wet Excavation Source)



System E
Typical Truck Haul Operation (Dry Excavation Source)

7.1.6 Materials Transport Costs

The analysis indicates the following unit rates for materials transport to Site T1. All unit prices are expressed in present US dollars. No attempt is made to apply inflation due to the uncertain fill and site development schedules.

- Wet material (dredging) [1.5 km haul] ..... $3.85 per m3
- Dry Material (from west bank widening) [1.5 km ave. haul) ..... $2.06 per m3

Full details of the materials transport cost computations and assumptions are presented in Appendix C of this report.

7.1.7 Site Restoration

As part of the Canal watershed, the reforestation of the fill site will make an important contribution to the ecosystem once the placement of material has been completed. Using the example of reforestation recently undertaken the area, the following site restoration costs are estimated[2]

- Reforestation (ACP previous projects)..... $3,000 per hectare
- Reforestation (according to ANAM guideline) ..... $1,000 per hectare
- Monitored natural vegetation regrowth..... $100 per hectare
- Natural Re-vegetation, with fire control buffers ..... $80 per hectare

None of the above costs include placement of surface filter material organic materials or topsoil. It is expected that the following materials would be used in coordination with the alternative site restoration methods noted above

- Reforestation - 15 – 20 cm imported soil + 10 cm filter ..... $7,500 per hectare
- Reforestation according to ANAM guidelines – as above..... $7,500 per hectare
- Monitored natural vegetation regrowth – 5 – 10 cm of selected overburden…..... $2,500 per hectare
- Natural Re-vegetation, with fire control buffers – 5 – 10 cm of dredged material ..... $1,000 per hectare

7.1.8 Cost Estimate

As noted earlier, the schedule and quantities of fill material cannot be clearly defined at this stage of the evaluation process. Since the fundamental objective of this study is the characterization and prioritization of the candidate sites, it is logical to present the cost estimates in terms of unit cost per cubic meter of fill. In this way, ACP or its future contractors can select disposal sites on the basis of the potential transportation and site development costs, regardless of the volumes to be placed and the filling schedule.

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[2] Source: Louis Berger Group from projects in the Canal watershed and other locations in Panama.

Table 7-3 presents the estimated site preparation and restoration costs for site T1, based on the assumption that the site will eventually filled to its maximum capacity as presented in Table 7-1.

Materials transportation costs are also presented in the table, based on the estimated total volumes of dry or wet material generated by the Gaillard Cut work. It should be noted that while the maximum capacity of the site exceeds the volume of material to be generated by the deepening and widening work, the extended work front of the Gaillard Cut project implies that several disposal sites should be made available to the contractor in order to reduce the transport costs and interference with normal Panama Canal Operations. It therefore follows that it is unlikely that Site T1 would be filled to more than approximately 60% of its available capacity.

Again, for the purposes of this evaluation, it is assumed that this reduced volume of material would cover the full area of the site, but to a lesser depth as compared to the maximum fill scenario. Site preparation and restoration costs are converted in Table 7-3 to an equivalent unit cost per hectare and also shown per cubic meter of fill. However, it is important to note that filling the site to a shallower depth than indicated in the maximum fill scenario increases the equivalent unit cost per cubic meter, but would not change the base cost per hectare.

Final evaluations of the combined cost of site preparation, restoration and materials transport should therefore be assessed based on an agreed fill volume, once a target quantity estimate and materials budget has been determined for each site.

Expanded transportation cost estimates for each of the study sites are presented in the technical Appendices included in Volume 3 of this report.

Table 7-3: Summary of Estimated Costs - Site T1

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$365,000**
Archaeological Survey	1	sum	40,000.00	$40,000
Mobilization	1	sum	200,000.00	$200,000
Construct Internal Access Roads	2,500	m	50.00	$125,000
Site Clearance & Preparation		ha		**$449,600**
Vegetation Clearance	149.20	ha	500.00	$74,600
Construct Drainage Diversion channels	5,000	m	75.00	$375,000
Site Restoration				**$3,160,500**
Site Regrading	140.00	ha	10,000.00	$1,400,000
Construct Internal Drainage Channels	4,000	m	125.00	$500,000
Erosion Control Measures	2,500	m	350.00	$875,000
Top Soil for Reforestation (15 cm)	25.00	ha	7,500.00	$187,500
Overburden material for natural Revegetation	5.00	ha	2,500.00	$12,500
Dredged Spoils for Surface cover	110.00	ha	1,000.00	$110,000
Reforestation per ACP guidelines	25.00	ha	3,000.00	$75,000
Selected Natural Revegation	5.00	ha	100.00	$500
Environmental Mitigation				**$124,689**
Construct Buffer Areas	5.00	ha	15,000.00	$75,000
Mitigation Allowance			1.25%	$49,689
Sub Total				**$4,099,789**
Contingencies			15%	$614,968
Total Estimated Cost of Site Preparation & Restoration				**$4,714,757**
Equivalent Unit cost of Site Development ($/m3 of fill)		m3	**$0.07**	
Equivalent Unit cost of Site Development ($/ha)		ha	**$31,600**	
Materials Transport and Placement Costs				
Wet Materials Transport to Site	34,524,112	m3	3.85	**$132,917,831**
West bank dry Materials Transport to Site	32,900,678	m3	2.06	**$67,775,397**

Note: Volumes of wet and dry material are totals from Gaillard Cut project, but exclude east side dry excavation which would move to site T4. Actual quantity of material to be placed at Site T1 may be less than these totals if multi sites are used.

7.1.9 Value Added Potential

There would not appear to be any financial value added potential from the use of this site for receipt of dredged and excavated materials. However, as noted earlier, the careful restoration of the site after filling offers the opportunity to enhance the eco-tourism experience of the area, which in turn will have economic benefits to the Panamanian tourist industry.

7.1.10 Summary of Findings – Site T1

Site T1 is considered to be a highly sensitive site from an environmental standpoint and it is strongly recommended that the extents of fill be limited to unforested areas east of the Mandinga River.

This effectively reduces the area for receipt of fill materials from 444 ha to approximately 150 ha, which offers the capacity to receive from 14.90 to 60.72 million m3 of fill, depending on the fill profile and configuration selected. The maximum capacity of the site is close to the total volume of wet and dry material to be excavated from the entire Gaillard cut project, with the exception of the east side widening work, which would be moved to an east side deposit site to minimize the impact on Panama Canal navigation.

However, prior to any work at the site, the optimum capacity and configuration of the site should be recomputed following geotechnical assessment of slope stability for the areas closest to the west bank of the Canal.

Based on the range of full options, the estimated cost of materials transportation for site T1 is on the order of $2.06 per m3 for dry materials excavated from the west banks of the Gaillard cut for the Canal widening project, or $3.85 per m3 for dredged material for the deepening and widening projects.

Adding site preparation and site restoration costs then increases the anticipated unit costs for use of Site T1 by $0.07 per m3 if the site is filled to its maximum capacity. Alternatively, and perhaps more appropriately, site preparation and restoration costs are estimated to be $31,600 per hectare or $4.24 million for the 150 hectare site.

As reconfigured, Site T1 is an important element of the Widening and Deepening project due to its relatively high potential capacity. However, given the concerns over the existing habitat quality, it is recommended that significant attention given to the establishment of buffer areas between the restored fill areas and the existing forests and rivers bordering the revised site limits.

7.2 Site T2 – Rio Camacho

7.2.1 Materials Holding Capacity

Taking into account the modifications to the site, as recommended in the earlier sections, the revised configuration of the area at T2 available for materials disposal is shown in Figure 7-6. The new boundaries will offer some 88.9 hectares for fill receipt.

As noted earlier, three scenarios are presented for fill capacity. These scenarios are illustrated in Figure 7-7 with respective volume capacities shown in Table 7-1, below.

Table 7-4: Estimated Fill Capacity - Modified Site T2

Scenario	Estimated Fill Capacity (million x m3)
Average depth of 10.00 m over entire site	8.89
Fill to uniform Elevation	23.83
Maximum Site Capacity	32.35

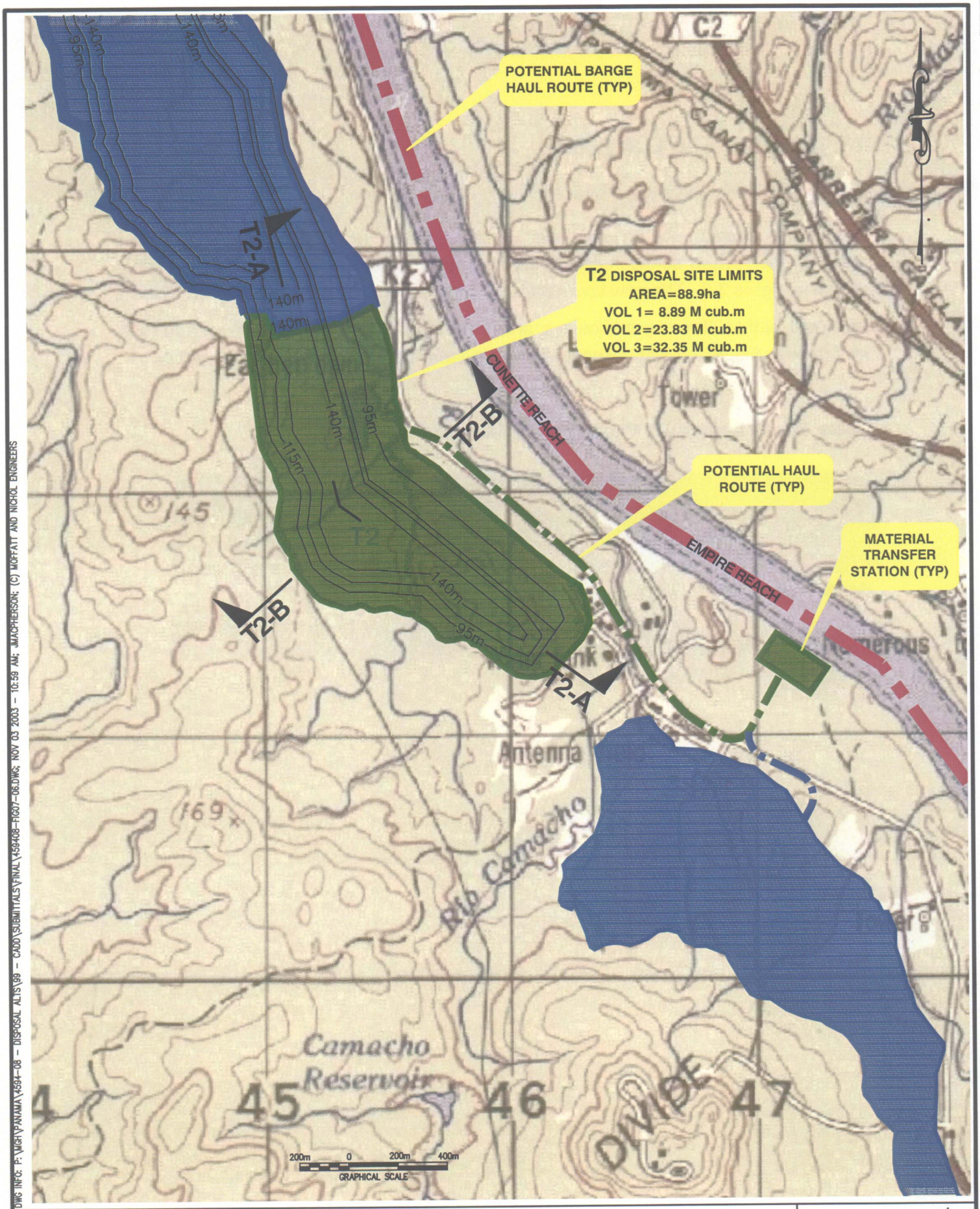

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Figure 7-6
Recommended Configuration of Site T2

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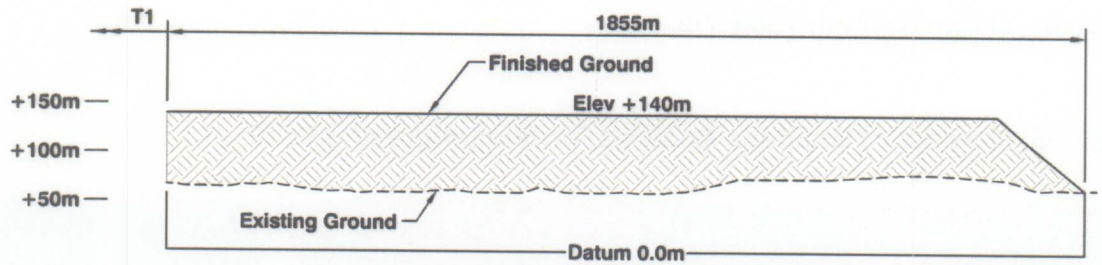
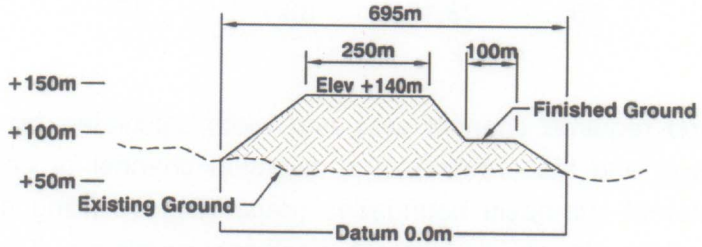
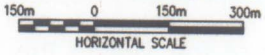
Figure 7-7: Typical Fill Sections for Site T2



Section T2-A (N-S)



Section T2-B (E-W)



Note: Vertical Exaggeration - 2V:1H

7.2.2 Drainage Requirements

The reconfiguration of Site T2 (see Figure 7-8) did not generate any significant changes in the drainage requirements for the project, as indicated in the results from the modified model run, shown below in Table 7-5.

Table 7-5: Results of Drainage Analysis for Reconfigured Site T2

Site	Watershed Area (hectares)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T2	279	68	23.16	33.7	17	1.8	16.6

The peak flow and required channel area and width calculated for the 100-yr, 24-hr event are not large and the creation of a diversion channel or channels along site boundaries or internal sub-basin boundaries (depending on filling sequencing and/or ACP preference) of the site should pose no significant problems. The final decision on whether to divert flows to the site boundaries versus providing interior drainage versus allowing natural rivulets to form will largely depend on the schedule to fill the site.

However, given the proximity of the site to the Canal, erosion and sediment control during filling will be especially important to avoid the diversion of sediments directly into the navigation channels. A possible alternative may consist of temporary dikes constructed across the diversion channel(s) at various locations to create stilling basins to encourage sediment settling. Depending on the proximity to the Canal waters, silt curtains may also be required.

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Figure 7-8
Reconfigured Watershed Delineation - Site T2

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7.1 Site T1 – Rio Mandinga

Materials removed from the Canal drilling and blasting projects are currently moved to the existing T1 disposal area by dump truck but to date, deposition has been limited to the areas east of the Mandinga river.

Based on the environmental recommendation that the forested areas of Site T1 be excluded from consideration as a disposal area, the configuration of the location is reduced from 444 hectares to approximately 149 ha, as shown in Figure 7-2.

7.1.1 Geotechnical Considerations

The eastern boundary of this site runs parallel to the west bank of the Gaillard Cut and it is critical to maintain sufficient separation between the filled areas and the Canal banks to avoid instability issues or bank failures. Based on earlier assessments of the soils characteristics in the area[1] and reported ACP practice, it is recommended that a clear distance of 500 m be maintained from the west bank of the Canal to the toe of the filled area, and all slopes facing the Canal should be limited to 3 horizontal to 1 vertical.

Prior to any extensive filling at the site, a more detailed geotechnical investigation program is required to ensure stability of the slopes closest to the Canal and to also evaluate any potential concerns related to seismic events.

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[1] Golder Associates. Evaluation of materials and geotechnical conditions within the area of the proposed Pacific Locks excavation.

7.2.3 Site Preparation

Minimal site clearance of the modified area will be required, since virtually the entire area recommended for filling has already been cleared of all substantial growth.

7.2.4 Materials Transportation Analysis

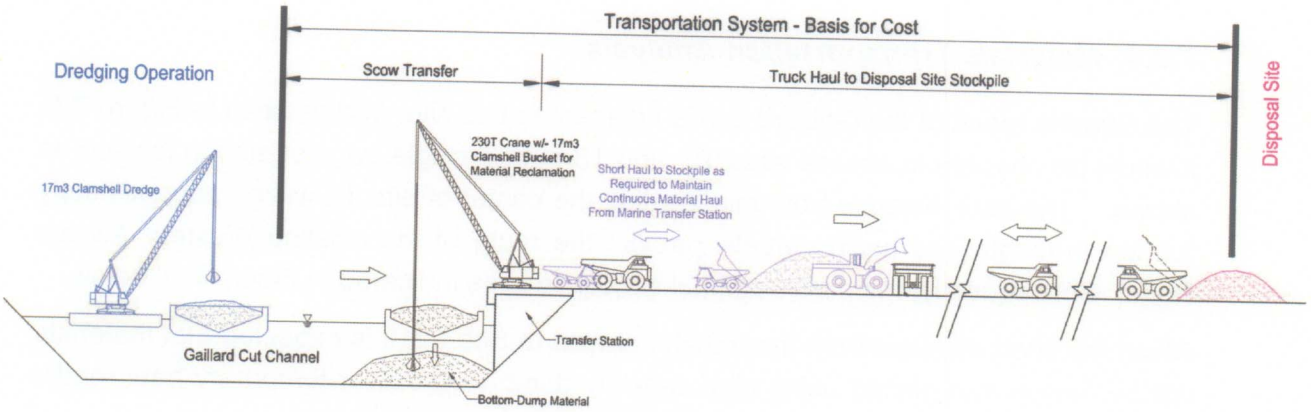
The Cunette reach of the Gaillard Cut is adjacent to this site, and as seen in Figure 7-6, it would be possible to service sites T2, and T3 from a single transfer station located as shown. The haul distance from this location the center of site T2 will be approximately 2.5 km in length and could partially parallel the route of the existing Western Access Road. Consequently, the preferred haul sequence is as indicated in Figure 7-9, below.

Given the short distance from the transfer station to Site T2, it is expected that materials will be moved and placed using high capacity dump trucks over temporary haul roads, made from the rock obtained from the dredging work, as previously discussed.

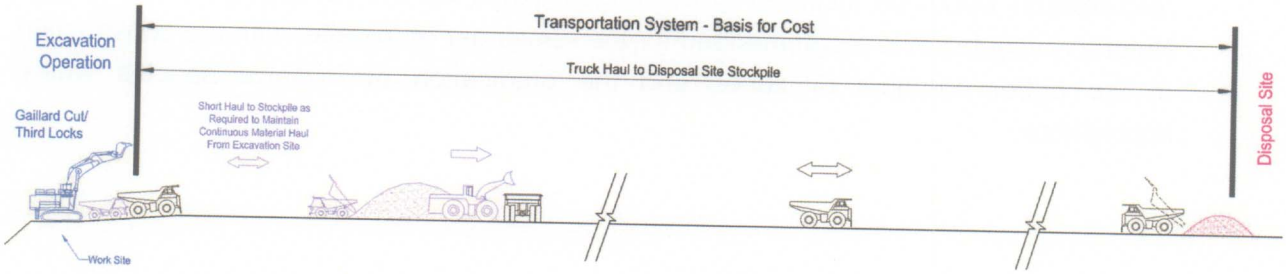
7.2.5 Site Restoration

In order to maintain the continuity of the T1/T2 forested area, it is expected that partial reforestation would be included in the project plans for the rehabilitation of this site. Natural revegetation is recommended for the remainder of the site, with the construction of fire buffer corridors or zones and the eradication of invasive species where appropriate.

Figure 7-9: Material Transportation Systems for Site T2



System C
Typical Scow/Truck Haul Operation (Wet Excavation Source)



System E
Typical Truck Haul Operation (Dry Excavation Source)

7.2.6 Haul Costs

Assuming that Site T2 would be serviced from a transfer station at the north of Site T3, the estimated cost of materials transport are $4.39 per m3 for dry material and $2.64 per m3 for dredged material.

7.2.7 Cost Estimate

As noted earlier, the schedule and quantities of fill material cannot be clearly defined at this stage of the evaluation process. Hence for those sites that cannot accommodate the full amount of material produced by the excavation or dredging project, the cost estimates are presented in terms of the maximum site capacity. Given the location of the site and the relatively low transport costs, it is a reasonable assumption that site T2 would be a priority location for materials disposal from the deepening and widening work. Table 7-6 presents the estimated costs for site T2, based on the assumptions indicated above.

Table 7-6: Summary of Estimated Costs - Site T2

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$190,000**
Archaeological Survey	1	sum	40,000.00	$40,000
Mobilization	1	sum	100,000.00	$100,000
Construct Internal Access Roads	1,000	m	50.00	$50,000
Site Clearance & Preparation				**$194,500**
Vegetation Clearance	89.00	ha	500.00	$44,500
Construct Drainage Diversion channels	2,000	m	75.00	$150,000
Site Restoration				**$1,235,150**
Site Regrading	75.65	ha	10,000.00	$756,500
Construct Internal Drainage Channels	1,000	m	125.00	$125,000
Erosion Control Measures	500	m	350.00	$175,000
Top Soil for Reforestation (15 cm)	10.00	ha	7,500.00	$75,000
Overburden for natural Revegetation	5.00	ha	2,500.00	$12,500
Dredged Spoils for Surface cover	60.65	ha	1,000.00	$60,650
Reforestation per ACP guidelines	10.00	ha	3,000.00	$30,000
Selected Natural Revegation	5.00	ha	100.00	$500
Environmental Mitigation				**$792,939**
Construct Buffer Areas	5.00	ha	15,000.00	$75,000
Mitigation Allowance			0.50%	$717,939
Sub Total				**$2,412,589**
Contingencies			10%	$241,259
Total Estimated Cost of Site Preparation & Restoration				**$2,653,847**
Equivalent Unit cost of Site Development ($/m3 of capacity)		m3	**$0.10**	
Equivalent Unit cost of Site Development ($/ha)		ha	**$29,819**	
Materials Placement				
Wet Materials Transport to Site	32,350,000	m3	4.39	$141,968,054
West bank dry Materials Transport to Site	32,350,000	m3	2.64	$85,404,000

7.2.8 Value Added Potential

As for Site T1, there does not appear to be any direct value added potential from the use of this site for receipt of dredged and excavated materials. However, the careful restoration of the site may enhance the eco-tourism experience of the area, which in turn will have economic benefits to the Panamanian tourist industry.

7.2.9 *Summary of Findings – Site T2*

Site T2 is considered to be a moderately sensitive site from an environmental standpoint and the boundaries were modified to avoid the potentially negative impacts of the fill project. This effectively reduces the area for receipt of fill materials to approximately 89 ha, which offers the capacity to receive from 8.89 to 32.35 million m3 of fill, depending on the fill elevation and configuration selected.

Based on the range of fill options, the estimated cost of materials transportation for site T2 is on the order of $2.64 per m3 for dry materials excavated from the banks of the Gaillard Cut for the Canal widening project, or $4.39 per m3 for dredged material for the deepening and widening projects.

Adding site preparation and site restoration costs then increases the anticipated unit costs for use of Site T2 by $0.09 per m3 or $28,537 per hectare, which is similar to the costs applicable to Site T1. As such, Site T2 is an important element of the Widening and Deepening project due to its potential capacity and relatively central location. However, given the concerns over the existing habitat quality, it is recommended that buffer areas be incorporated into the design to protect the forested areas and biological corridors in the area.

However, as for site T1, geotechnical investigations should be implemented before the placement of any fill in the areas closest to the west bank of the Canal.

7.3 UXO Concerns at Sites T3, T5 and T6

Terrestrial sites T3, T5 and T6 all fall within the former US Department of Defense firing ranges as indicated in Figure 7-10. Certain sections of these areas were cleared under US Army Corps of Engineers contracts in the late 1990s but little is known of the amounts, type, extent and danger posed by unexploded ordnance over the entire area.

The following discussion presents a preliminary assessment of the existing information and discusses various survey and clearance techniques that will be required before any of these sites can be safely used as disposal areas.

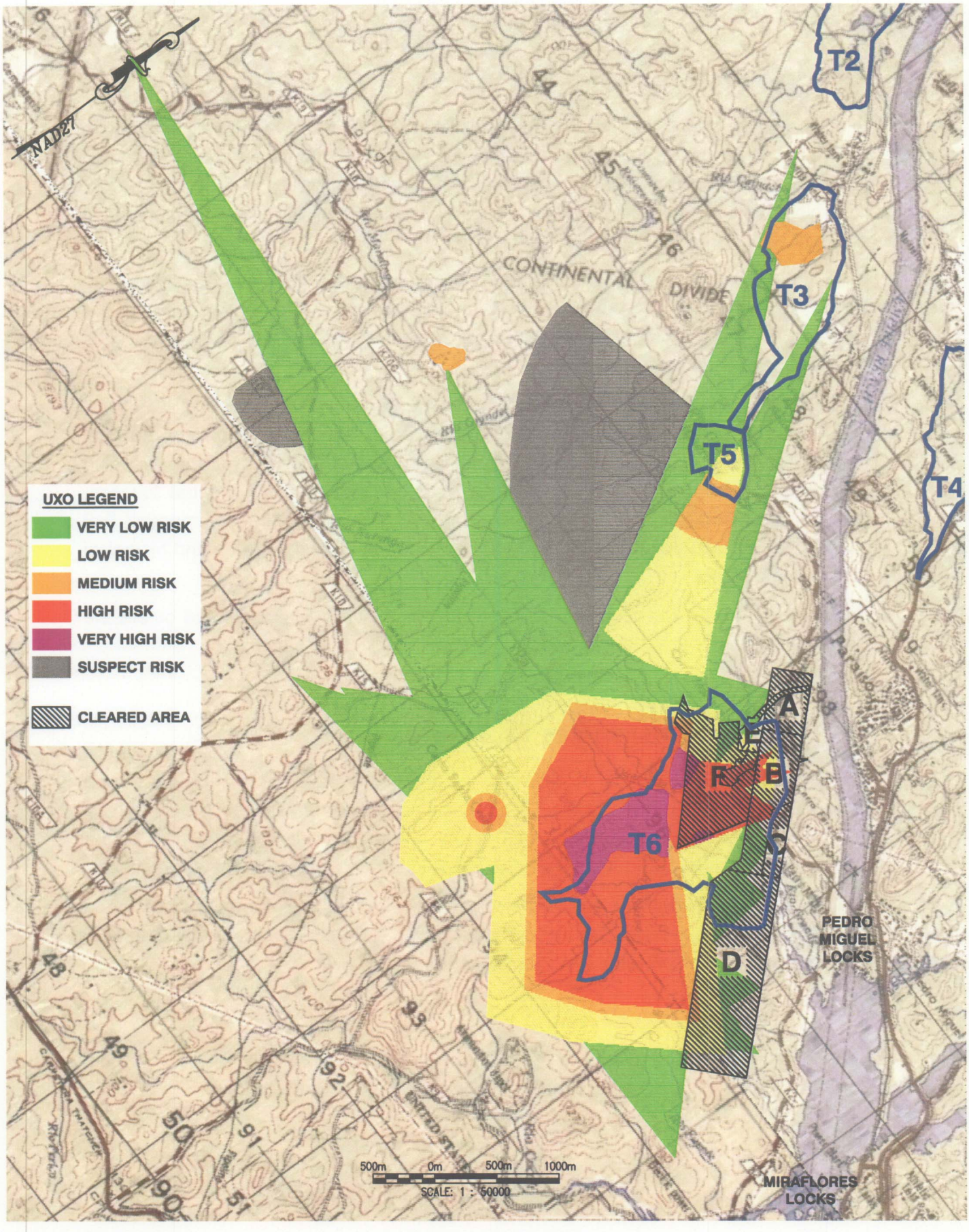


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Figure 7-10
Former U.S. D.O.D. Firing Ranges

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7.3.1 Background

The US Army maintained an active presence in the former Panama Canal Zone from 1911, shortly after construction of the Canal was completed to the end of 1999. In support of this role, the US Army conducted several weapon systems testing exercises and training activities in Panama. Some of these activities involved using explosive devices, and as a result, some areas contain Unexploded Ordnance devices, known as UXOs. Since the end of the 1940s, most of the weapon systems testing and training activities were conducted in the Campo de Emperador, the Oeste de Balboa, and the Campo de Piña. These fields are located adjacent to the western side of the Panama Canal and occupy a combined area of close to 15,139 hectares.

As can be seen in Figure 7-10, sites T3, T5 and T6 are all located within the areas listed as having unexploded ordnance. Site T3 includes some zones considered UXO Areas of Concern (AOC)s, such as the area of the Camacho River, Range FP16, Range 1A, FP14, and Range 14. Range FP14 is part of the Area of Primary Impact. Both FP14 and FP 16 were shooting ranges for artillery and mortars.

Since Range 1A was frequently used as a rifle shooting range, range maintenance activities such as movement of soil and controlled fires were routinely conducted. Consequentially, the area's vegetation consists of short pastures. This is a UXO AOC area since several unexploded devices have been found in the vicinity.

7.3.2 Information Base

It is not clear when the U.S. Army began to use the Shooting Rage of Emperador for mortar and artillery practices. However, the oldest armament (mortar supply) registered in the first Emperador Range dates from the period of 1920 to 1940.

There is no specific information available on the issue of location of impact areas, shooting zones, training sectors, fields and targets used between 1949 and the first half of the 1960s. Likewise, there is very little information for the period from the 1960s to 1979. However, there are some records covering the years from 1970 up to the 1990s.

Due to the lack of historical records on the use of each of the training areas that existed in the Shooting Range of Emperador, it is impossible to determine the type of munitions that can be found at sub-surface levels. Considering that these areas were used since the beginning of the 20th century, this lack of specific information is a cause for serious concern.

Pursuant to Law 5 of February 25, 1993, the Administración Regional Interoceánica (ARI) currently administers and has custody of the lands that were returned to Panama at the end of 1999. Due to the presence of unexploded munitions in these areas, ARI is currently prohibiting access to these areas, as a consequence of the high level of potential risk to life.

7.3.3 Sources of Information on Survey and Removal of UXOs

Ordnance and explosives (O&E) or UXO materials are defined as consisting of ammunition, ammunition components, chemical or biological warfare material or explosives that have been abandoned, expelled from demolition pits or burning pads, lost, discarded, buried or fired and that are no longer under accountable record control or any Department of Defense (DoD) organization or activity.

Unfortunately not all munitions explode on impact or ignition and consequently training areas can accumulate "duds" or unexploded ordnance (UXO) or other ordnance and explosives (OE). To assist in evaluating and mitigating potential problems associated with UXOs the U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville (USAESCH) was established as the Mandatory Center of Excellence (CX) for the Ordnance and Explosive program within the U.S. Army Corps of Engineers. The responsibility of the organization is to safely eliminate or reduces risks from ordnance, explosives, or chemical warfare material at current or formerly used defense sites (FUDS). The Center of Expertise is responsible for Ordnance and Explosives in support of Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS0, Installation Restoration (IR), Base Realignment and Closure (BRAC) and Services for Others (SFO) programs. These programs currently have approximately 2,000 projects in inventory with 60 to 80 active projects ongoing at any given time. Most of these sites were part of the military downsizing after World War II and the Korean War and many have been "cleared" and turned over to the civilian population.

The Army Range Inventory Program, operated under the US Army Environmental Center, is an extensive effort to develop a data base of military ranges and other sites that may have UXOs. This information is being collected from all Army properties around the globe including detailed information on closed ranges within the US and US territories. The program was initiated in January 2000 and will be completed in 2003. It is not known whether this inventory will include ranges that are located on properties outside of US jurisdiction such as Panama.

Under the terms of the 1977 Torrijos-Carter Panama Canal Treaty "the US shall be obliged to take all measures to ensure insofar as may be practicable that every hazard to human life, health, and safety is removed." The United Nations Chemical Weapons Convention, which was signed by the US in 1997, also requires cleanup of any contamination.

7.3.4 Evaluation of UXO Risk

Prior to the return of the Canal and former Canal Zone to Panama at the end of 1999, the US Army Corps of Engineers sponsored and contracted several reports to characterize and remove ordnance in the former Firing range areas.

From data made available by ACP, the following work was undertaken:

- Work Plan for Site Characterization and Removal of Ordnance for Gaillard Cut Widening, Volumes I and II, US Army COE and EOD Technologies , February 1998
- Briefing on Panama Canal Ordnance Contract Support Project, US Army COE, March 26, 1998
- Draft Sampling & Risk Analysis, US Army COE, March 1998.

Key findings from these reports included:

- Surface clearance removes approximately 30 percent of all ordnance
- Clearance to 2 ft removes approximately 70 percent of all ordnance
- There is minimal expectation that UXO materials will be found at depths below ground of 10 ft or more

Costs were also given for a range of clearance scenarios, covering surface clearance and clearance to 2.0 ft depth.

Finally, it is understood that some 63 hectares were cleared to depths varying from 2.0 to 4.0 ft in 1999 by EOD Technology Inc, in the area indicated in Figure 7-10, with surface clearance of an additional 67 hectares.

7.3.5 Risk Characterization Techniques

One of the first steps in the UXO assessment and removal process is the preparation of a Risk Characterization Analysis. This is conducted to:

- Evaluate the proposed removal alternatives (including site cover) to support a decision; and/or
- Prioritize among different sites or different areas of the same site to focus additional investigation or develop more efficient removal alternatives.

The risk associated with OE (Ordnance and Explosives) in a particular area is a function of the following factors:

- the likelihood of ordnance of various types and magnitudes being present in that area
- the likelihood of that ordnance being encountered (e.g., by people or construction crews on the site),
- the likelihood of that ordnance to detonate if encountered, and
- the potential consequences of such a detonation.

The risk assessment is done over the entire area of interest for all types and magnitudes of ordnance to determine the likely consequences of possible detonation.

Using this process, various site treatment alternatives, including no action or site cover, as well as removal, can be evaluated in terms of their implementation costs and likely consequences. Each alternative may affect one or more of the above risk factors (i.e., ordnance likelihood, encounter likelihood, detonation likelihood, and detonation consequences). For example, detection and removal of some ordnance would reduce ordnance likelihood, but the consequences of detonation of the remaining ordnance might rule out this option.

Clearly, the preferred alternative would be the one that has the most favorable combination of implementation costs and likely consequences. However, this may be subject to requirements for removal or maximum allowable risks (consequences).

The uncertainties in the risk factors can be reduced by additional investigation and analysis, thereby improving the confidence level of decisions on removal alternatives. For example, based on large uncertainties, a conservative (expensive) alternative may be preferred, whereas additional investigation and analysis would reduce uncertainties and might (say 50% chance) result in showing that a less conservative (less expensive) would be preferred, reducing the chance that the conservative alternative would still be preferred to 50% (from 100%). The value of the investigation and analysis program should exceed its implementation cost, and the most cost-effective program would be preferred.

Figure 7-11 shows the key steps to be taken in the evaluation of UXO risk, which covers the following elements. A more extensive discussion on survey techniques is presented in Appendix A of this report.

General Program for Geophysical Survey of UXO materials

Archives Search Report: This task is an evaluation of past OE activities at the site. The purpose is to assemble historical records and available data and assess potential ordnance presence.

Conceptual Site Model: A description of the site and its environment including information on sources of OE, anticipated future land use. The model is important as a planning instrument, a modeling and data interpretation aid assists in communication among team members.

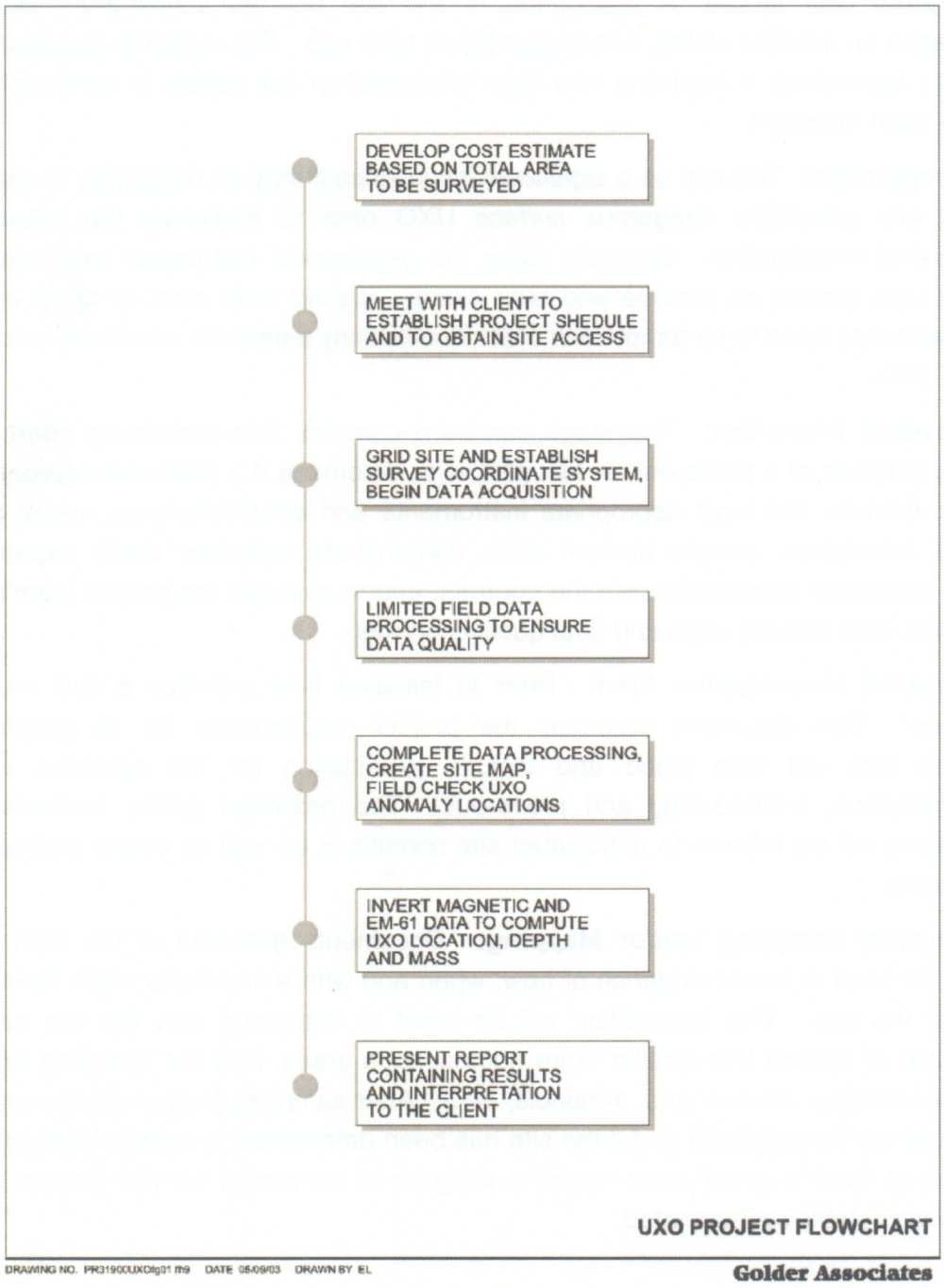
Site Preparation: This can be a significant issue since it may be necessary to clear the site of any potentially dangerous surface UXO prior to beginning the subsurface geophysical investigation. Secondly since the geophysical instrument must travel as close to the ground as feasible and over closely spaced lines most or all of surface vegetation may need to be removed in order to efficiently detect the maximum amount of buried UXO.

Geophysical Prove-Out: This stage can be a complex time-consuming effort. The primary purpose of a prove-out, or test-plot, is to determine if a particular approach will work, determine the most appropriate instruments and operations (e.g. height above ground, orientation, sample interval etc.), demonstrate detection depth capabilities; assure contractor compliance with the contract, and to evaluate the project team's data collection, data transfer rates and data quality controls.

Geophysical Investigation Plan: Prior to initiating field activities a GIP must be prepared. This document describes the project requirements for all geophysical activities that will take place and include justification for the selection of the instrumentation, methodology and prove-out. The proposed goals, methods, and procedures will be tailored to anticipated site conditions as well as safety and security regulations.

Geophysical Sampling and/or Mapping: Documents gathered in the ASR study should be used to locate evidence of how, when and where munitions might have been used at the site. This information will be used to determine how the site may be sectorized or divided into smaller more homogenous areas, how the sampling will take place (probability, random grid, transects, etc.). After sampling (representative portions of the site are investigated) and if the site has been determined to contain unacceptable amounts of UXO a geophysical mapping program is performed on 100 percent of the area unacceptably contaminated.

Figure 7-11: Decision Sequence - UXO Risk and Clearance Analysis



Analysis and Interpretation: Ongoing with the field program, the data must be analyzed and interpreted. This information is presented on a series of maps that clearly show the location of anomalies and if possible predicted size, depth of burial and orientation. This information is provided to team members responsible for reacquisition and marking of the anomalies. This often requires the use of the same instrument used to acquire the original data set in order to pinpoint the location of the anomaly and reduce the area the excavation team needs to search to find the object.

Anomaly Excavation: Following location of a subsurface anomaly by the reacquisition team the anomaly is excavated, identified, and properly disposed. This is potentially an extremely hazardous activity and is undertaken by qualified personnel working under an approved Work Plan. The excavation team should provide detailed information on the nature of the object (size, weight, nature of metal, depth of burial) to the geophysics team. Comparison of the type of item found in the field to the original geophysical data will allow the geophysics team to adjust the processing methodology and reduce the number of false selections.

7.3.6 Estimated Costs for Survey & Clearance

As part of the preparatory work for this site, it will be necessary to obtain technical and cost proposals for the survey, risk assessment and clearance of the UXO material. The evaluation and clearance activities may include one or more of the following elements. Costs for the work will vary considerably, according to vegetation cover, density of UXOs, topography and type of UXO encountered. However the following costs are indicative[3] of what might be expected for the survey, risk assessment and clearance work.

- Survey and Risk Analysis, using geophysical methods - approximately $3,000 to $10,000 per hectare depending on UXO density, topography and vegetation cover
- Survey[4] & Surface clearance – approximately $15,000 to $25,000 per hectare assuming minimal vegetation cover
- Survey & Clearance to 60 cm depth – approximately $25,000 to $75,000 per hectare

[3] Costs are estimated from ACP records, Louis Berger Group, US Army Corps of Engineers

[4] Includes the preparation of a Risk Assessment and Specifications for Site Clearance.

7.3.7 Options for Filling in UXO areas

One potential solution to the UXO concern might be to place a sufficiently thick blanket of fill material over the contaminated areas, such that the potential risk from explosion after filling is reduced to an acceptable level. Unfortunately, there is insufficient information on the nature and density of the ordnance in the studies areas at this time to make a judgment on the depth of fill that might be considered "safe".

However, it is clear that the objective of maximizing fill capacity in the sites that have no significant environmental limitations coincides with the option to cover the UXO materials with the maximum depth of material, wherever possible.

At first glance, it would appear that the placement of at least 10.00 m of fill over the UXO suspect areas would meet this requirement, assuming that a survey, risk assessment and either surface clearance or clearance to 60 cm was also undertaken. However, as stated earlier, this assumption represents the unqualified opinion of this consultant and cannot be substantiated without the characterization of the UXO materials and the professional opinion of a UXO risk assessment specialist following the procedures described earlier in this section.

7.3.8 Summary – UXO Risk Evaluation for Sites T3, T5 and T6.

It is clear that no fill or advance survey work can take place at Sites T3, T5 and T6 until the UXO hazard has been clearly defined. According to the work already undertaken in the area, it is likely that surface clearance or ordnance removal to depths ranging from 60 cm to 1.20 m could well be required to provide the necessary level of confidence that the danger from UXO presence has been reduced to an acceptable level.

In order to provide a first indication of the potential cost implications of the resolution of the UXO issues, the following discussion on each of the sites containing UXO materials assumes a full survey of the entire disposal site, surface clearance of materials within the low risk areas and clearance to a depth of 60 cm in the medium and high risk areas indicated by the available mapping of the area.

7.4 Site T3 – Gaillard Cut North (W3)

With the exception of a medium sensitive area to the west of the site, there are few environmental concerns related to the use of Site T3 as a disposal area. However, as noted earlier, at least 60 % of the site falls within a medium risk UXO area.

7.4.1 Materials Holding Capacity

The area at T3 available for materials disposal is shown in Figure 7-12. The area within the designated site limits will offer some 115 hectares for receipt of fill materials.

As noted earlier, three scenarios are presented for fill capacity, as shown in Table 7-7, below:

Table 7-7: Estimated Fill Capacity - Site T3

Scenario	Estimated Fill Capacity (million x m3)
Average depth of 10.00 m over entire site	11.50
Fill to uniform Elevation	17.09
Maximum Site Capacity	28.13

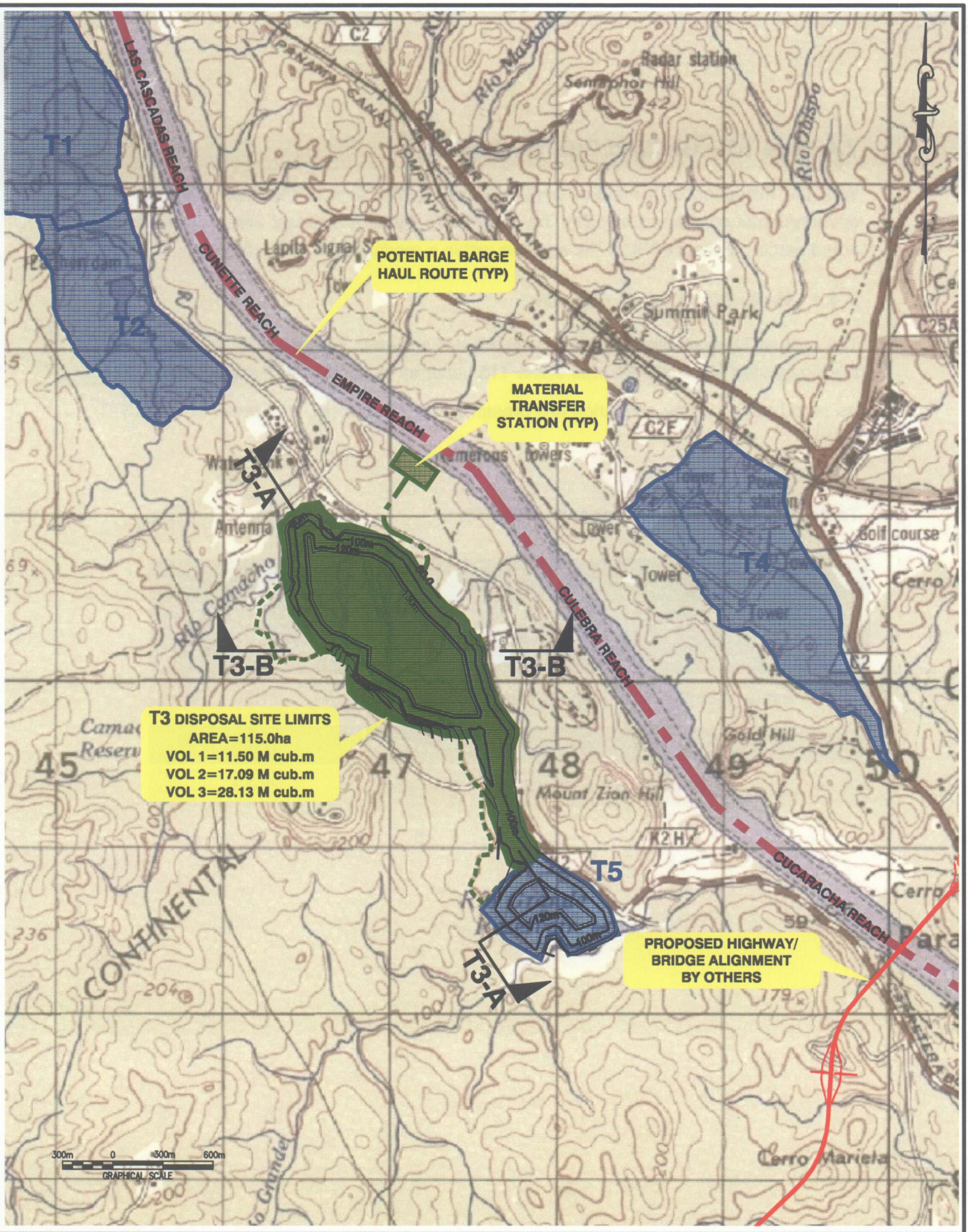


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Figure 7-12
Recommended Configuration of Site T3

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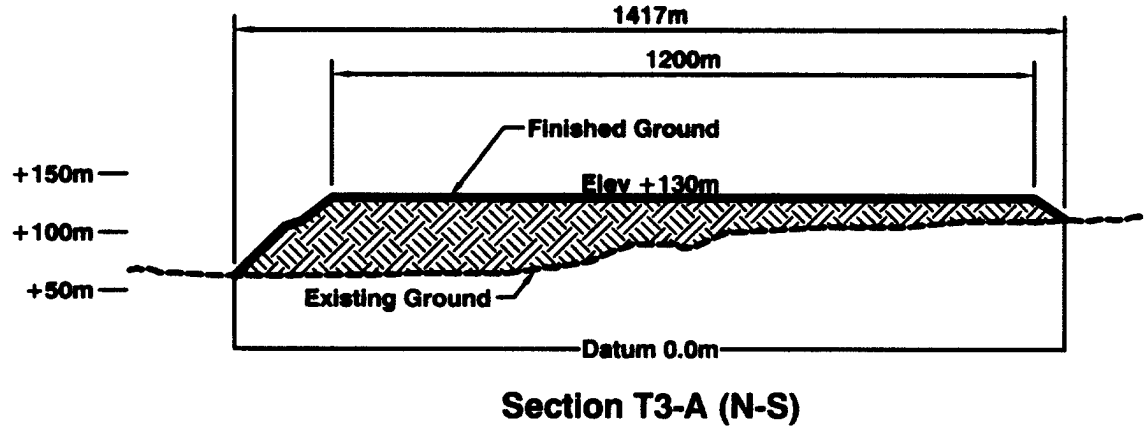
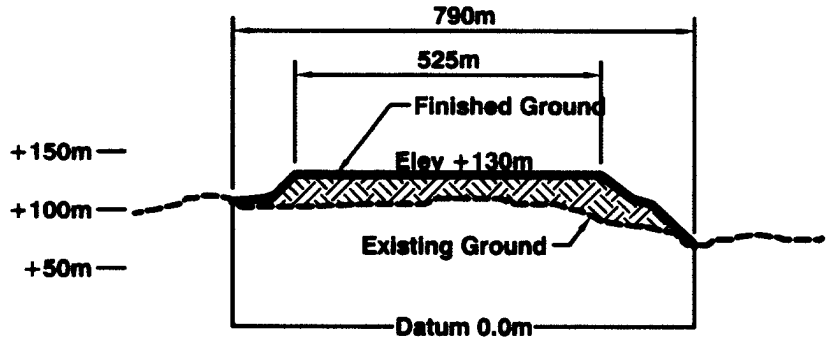
Figure 7-13: Typical Fill Sections for Site T3



Section T3-A (N-S)



Section T3-B (E-W)

Note: Vertical Exaggeration - 2V:1H

Note: Refer Figure 7-12 for section cut locations.

7.4.2 Drainage Requirements

The results from the modified drainage model run are shown below in Table 7-8.

Table 7-8: Results of Drainage Analysis for Reconfigured Site T3

Site	Watershed Area (hectares)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T3 – B1	94	84	22.68	18.9	10	0.6	12.6
T3 – B2	213	68	22.68	32.9	13	1.3	14.6

The peak flows and required channel areas and widths calculated for the 100-yr, 24-hr event are not excessive and the construction of a diversion channel or channels along site boundaries or internal sub-basin boundaries should present no significant concerns

7.4.3 Site Preparation

Minimal site clearance of the modified area will be required, since most of the area has already been cleared of all substantial growth. However UXO clearance over at least 50 percent of the area will be necessary, and surveys should be also be conducted outside this area to confirm the limits of the ordnance.

Based on work done by the US Army Corps of Engineers in 1998 for the sites adjacent to Sites T5 and T6, it would seem reasonable to assume clearance to a depth of 60 cm, particularly if the site is to be filled to a depth of at least 10.00 m. However, it is emphasized that these assumptions represent the opinion of this consultant and must be substantiated by a professionally qualified UXO survey, risk assessment and clearance specialist.

As noted earlier, it is recommended that the cost of survey, risk characterization, surface clearance and partial clearance to 60 cm shall be included in the cost estimates for all areas expected to contain UXO materials until site specific data is available.

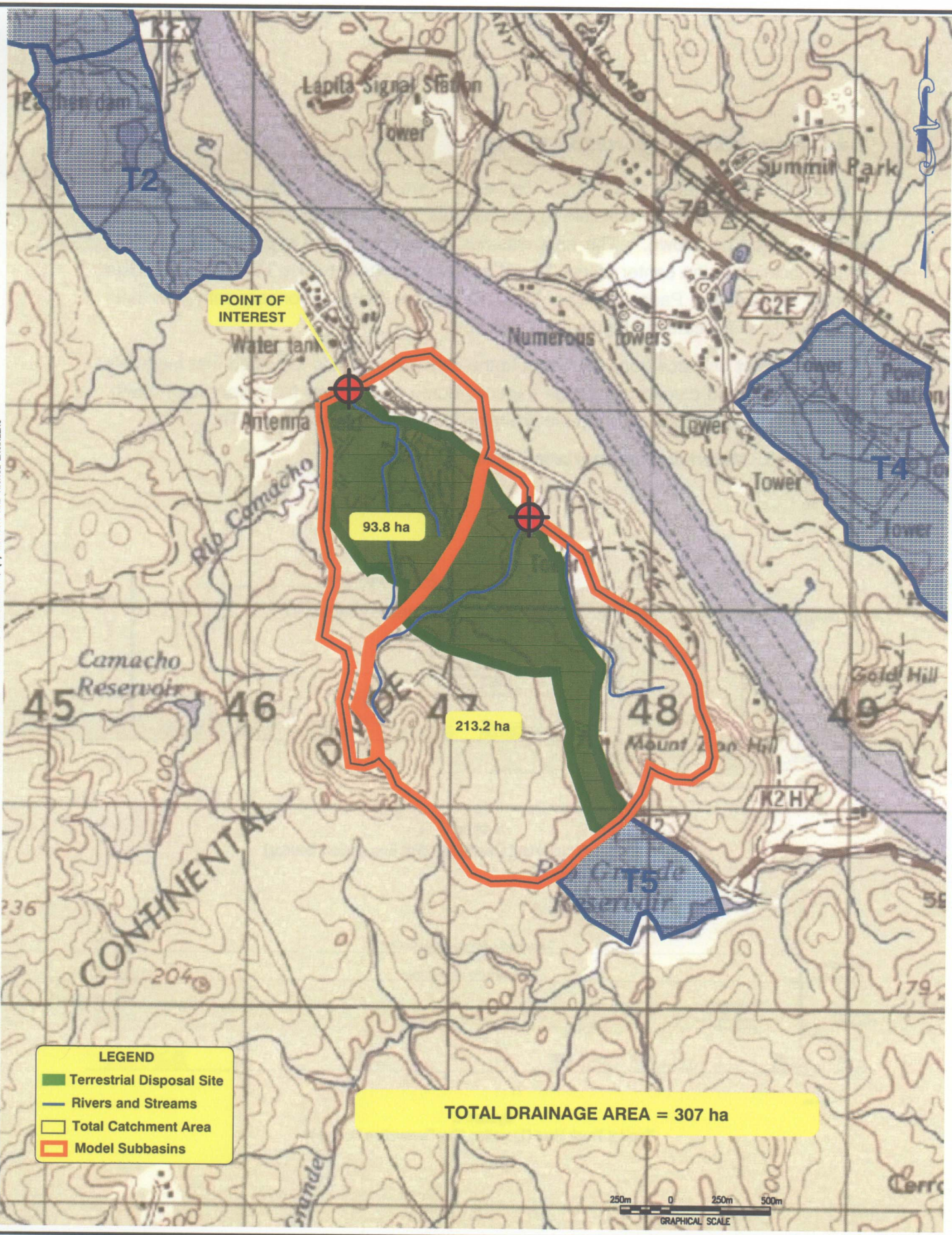


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Figure 7-14
Watershed Delineation - Site T3

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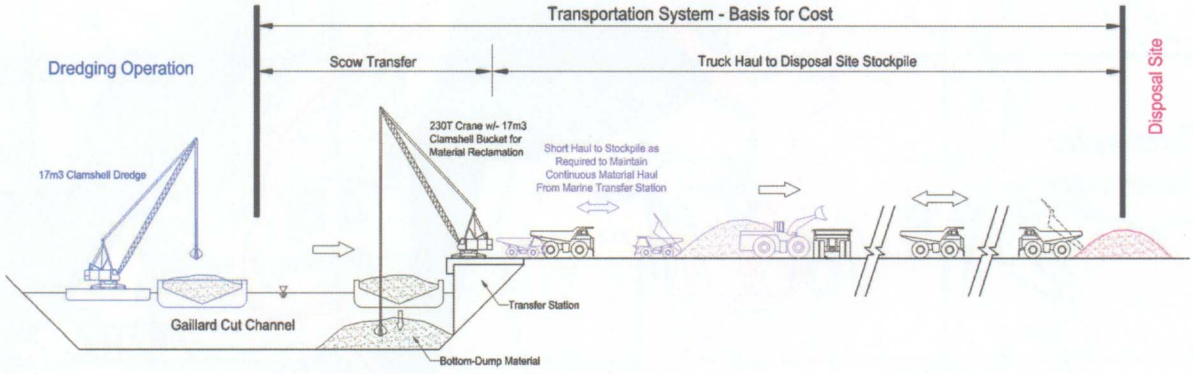
7.4.4 Materials Transportation Analysis

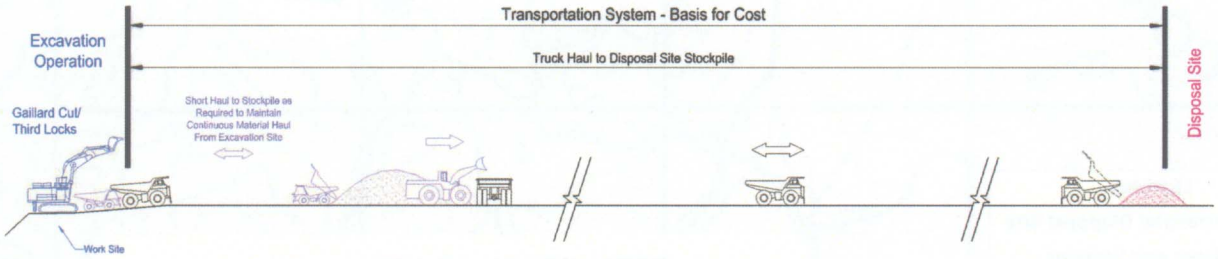
The Empire and Culebra reach of the Gaillard Cut are adjacent to this site, and as seen in Figure 7-12, it would be possible to service sites T2, T3 and T5 from a single transfer station located as shown. The haul distance for both wet and dry material from this central location to the center of site T3 will be approximately 1.5 km in length and could parallel the existing Panama Canal Western Access Road. Consequently, the haul sequence is as indicated in Figure 7-15, below.

Given the short distance from the Canal to the disposal site, it is expected that materials will be moved and placed using high capacity dump trucks over temporary haul roads, made from the rock obtained from the dredging work, as for sites T1 and T2.

Figure 7-15: Materials Transportation Systems for Site T3



System C
Typical Scow/Truck Haul Operation (Wet Excavation Source)



System E
Typical Truck Haul Operation (Dry Excavation Source)

7.4.5 Haul Costs

Based on an average round trip haul distance of 3.0 km, the estimated costs for materials transport to Site T3 area are $3.35.m3 for dry material and $3.86 per m3 for wet or dredged material respectively.

7.4.6 Site Restoration

One completion of the filling operations, it is expected that partial reforestation would be included in the project plans for the restoration of this site to protect the forest areas on the western borders of the site and sites T2 and T1. The remainder of the site would be re-vegetated, using dredged spoils or imported overburden material as a basis for new growth.

7.4.7 Cost Estimate

As noted earlier, the schedule and quantities of fill material cannot be clearly defined at this stage of the evaluation process. Table 7-9 presents the estimated costs for the preparation of restoration of site T3, based on the maximum capacity assumption presented in Table 7-7. It can be seen from the estimate that the cost of site preparation is relatively high at $73,012 per hectare, but translates to $0.30 per m3 of fill material if the site is filled to its maximum capacity of 28.13 million m3. Given the relatively economical transportation costs for dry material, Site T3 represents a useful disposal site option, even when the need for clearance of the UXO materials is taken into consideration.

Table 7-9: Summary of Estimated Costs - Site T3

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$535,120**
Archaeological Survey	1	sum	40,000.00	$40,000
UXO Survey & Risk Analysis	115.04	ha	3,000.00	$345,120
Mobilization	1	sum	100,000.00	$100,000
Construct Internal Access Roads	1,000	m	50.00	$50,000
UXO Clearance				**$4,601,600**
UXO Surface Clearance	57.52	ha	25,000.00	$1,438,000
Clearance to 60 cm Depth	57.52	ha	55,000.00	$3,163,600
Site Clearance & Preparation				**$207,520**
Vegetation Clearance	115.04	ha	500.00	$57,520
Construct Drainage Diversion channels	2,000	m	75.00	$150,000
Site Restoration				**$1,668,440**
Site Regrading	115.04	ha	10,000.00	$1,150,400
Construct Internal Drainage Channels	1,000	m	125.00	$125,000
Erosion Control Measures	500	m	350.00	$175,000
Top Soil for Reforestation (15 cm)	10.00	ha	7,500.00	$75,000
Overburden material for natural Revegetation	5.00	ha	2,500.00	$12,500
Dredged Spoils for Surface cover	100.04	ha	1,000.00	$100,040
Reforestation per ACP guidelines	10.00	ha	3,000.00	$30,000
Selected Natural Revegation	5.00	ha	100.00	$500
Environmental Mitigation				**$623,017**
Construct Buffer Areas	3.00	ha	15,000.00	$45,000
Mitigation Allowance			0.50%	$578,017
Sub Total				**$7,635,697**
Contingencies			10%	$763,570
Total Estimated Cost of Site Development & Restoration				**$8,399,267**
Equivalent Unit cost of Site Development ($/m3 of capacit		m3	**$0.30**	
Equivalent Unit cost of Site Development ($/ha)		ha	**$73,012**	
Materials Placement				
Wet Materials Transport to Site	28,132,315	m3	3.86	$108,590,736
Dry Materials Transport to Site	28,132,315	m3	3.35	$94,243,255

Note: Clearance areas based on firing range classification from available records (eg primary, secondary etc)

7.4.8 Value Added Potential

As for Sites T1 and T2, there does not appear to be any financial value added potential from the use of this site for receipt of dredged and excavated materials. Site T3 is also outside the area of interest for eco-tourism or other tourist related activities.

7.4.9 Summary of Findings – Site T3

Apart from the medium sensitive areas to the west of the site and the potential for sites of archaeological interest, there are no serious environmental concerns associated with the filling of Site T3. The site has already been heavily altered and has also been used for the placement of maintenance materials from work in the Gaillard Cut. The major issue related to the use of this site is the need to fully assess the UXO risk and the requirement to either clear the ordnance or fill over it to a depth that will substantially reduce or eliminate the risk to human life.

Given the overriding policy of ACP, ARI and the Panama Government to protect all areas within the Canal limits and prohibit any form of commercial or residential development that is not directly related to Canal operations or maintenance, it would seem appropriate for this site to be filled to the maximum depth possible and then restored by re-forestation or planting of selected species in order to return it to its originally condition.

As such, the site offers the potential to receive up to 28.13 million m3 of dry or wet material from the Deepening and Widening projects and therefore constitutes a major element of the materials disposal plan for this work.

In terms of cost, the site also represents one of the lower cost scenarios for disposal, even when the UXO survey and clearance requirements are taken into consideration.

7.5 Site T4 – Gaillard Cut East (E2)

7.5.1 Materials Holding Capacity

The area within the designated site limits shown in Figure 7-16 will offer some 105.6 hectares for receipt of fill materials. As for the other terrestrial sites, three fill scenarios are proposed for site T4 with the resulting volumes as indicated in Table 7-10.

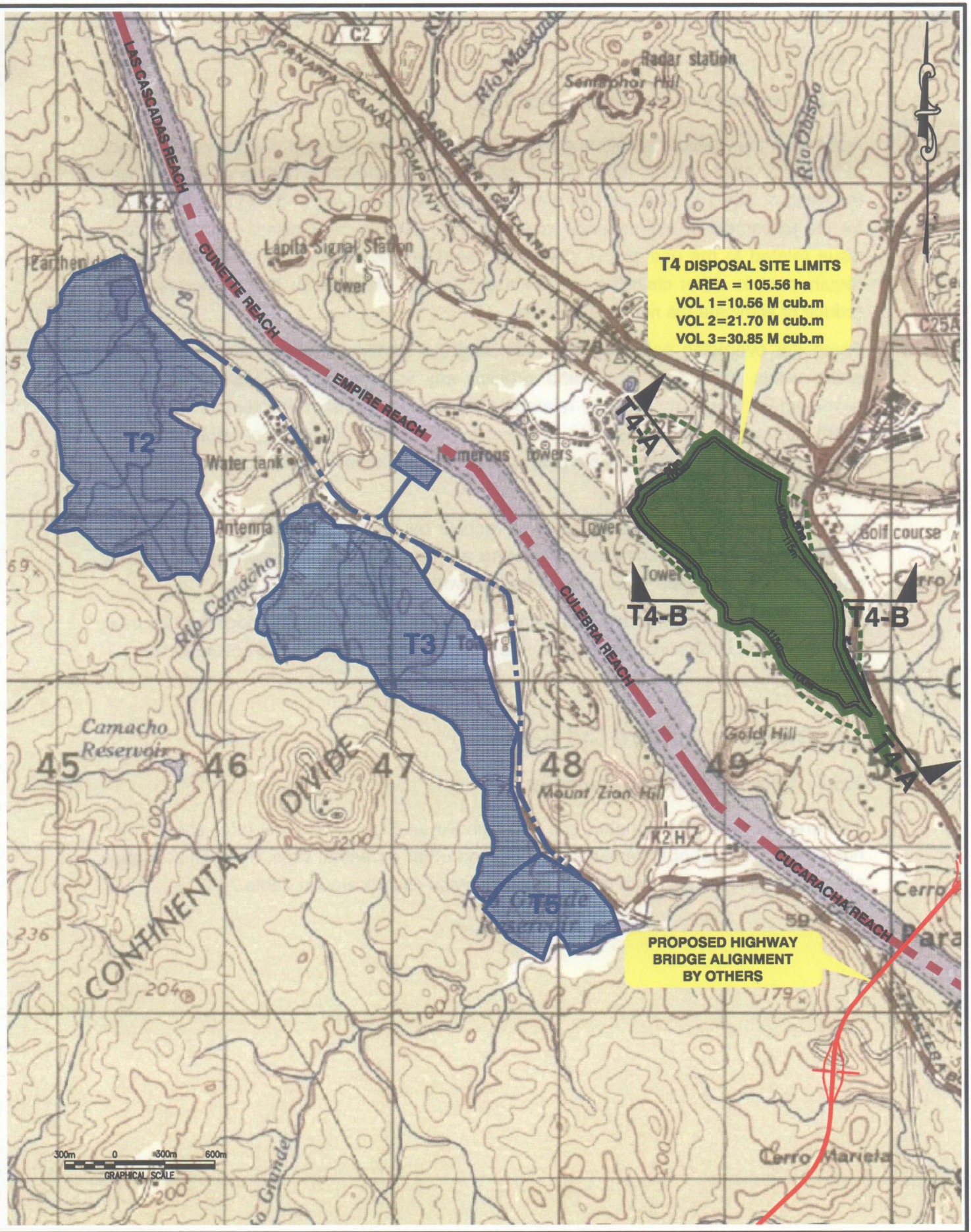


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Figure 7-16
Recommended Configuration for Site T4

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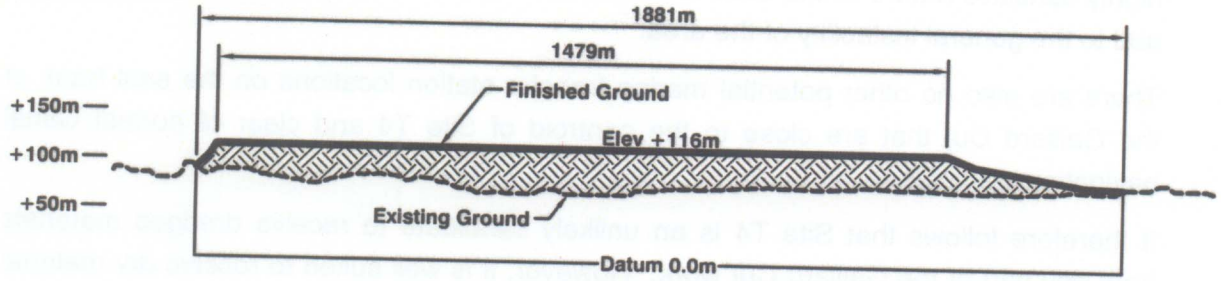
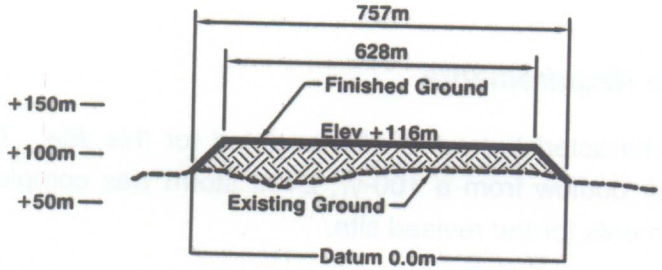
Figure 7-17: Typical Fill Sections for Site T4



Section T4-A (N-S)



Section T4-B (E-W)

Note: Vertical Exaggeration - 2V:1H

Note: Refer Figure 7-16 for section cut locations.

Table 7-10: Estimated Fill Capacity - Site T4

Scenario	Estimated Fill Capacity (million x m3)
Average depth of 10.00 m over entire site	10.56
Fill to uniform Elevation	21.70
Maximum Site Capacity	30.85

T4 is the only site being evaluated on the east side of the Gaillard Cut. However, the only location for a materials transfer station for dredged material destined for Site T4 would be at the base of the Cucaracha slide and that is not a practical option due to the highly sensitive nature of the slide area and the extreme care that must be taken not to add to the general instability of the area.

There are also no other potential marine transfer station locations on the east bank of the Gaillard Cut that are close to the centroid of Site T4 and clear of normal Canal navigation channels.

It therefore follows that Site T4 is an unlikely candidate to receive dredged materials from any part of the Gaillard Cut work. However, it is well suited to receive dry material from the east bank widening work. The anticipated excavation volume of 12.56 million m3 of dry material is then comfortably within the capacity ceiling of the site.

7.5.2 Drainage Requirements

The watershed characteristics were also updated for this site. AHEC-HMS model to estimate the peak outflow from a 100-yr, 24-hr storm was completed to determine the drainage requirements for the revised site.

Specifically, the reconfigured area excluded the Rio Obispo, since a drainage diversion channel has already been constructed at the north end of the disposal area. The total revised watershed area was calculated to be 471 hectares (4.71 km^2), as shown in Table 7-11. The reconfigured area land cover and resulting SCS Curve Number did not change, since the site location did not change significantly. The design rainfall depth was increased slightly based on the site configuration such that the rainfall statistics for the Empire Hill gage were used. Having updated the watershed characteristics, the HEC-HMS model was developed and run for the revised site, yielding the expected 100-yr, 24-hr peak flows for each sub-basin.

Table 7-11: Results of Drainage Analysis for Reconfigured Site T4

Site	Watershed Area (hectares.)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T4	470	79	22.20	77.0	44	3.1	28.0

The primary drainage channel entering this site has already been diverted and connected to a large swale and conduits at the north of the site. Smaller drainage channels have been cut to connect to this main flow path and it would only be necessary to install temporary internal drainage channels during fill operations.

However, given the site's proximity to Canal waters, erosion and sediment control during filling will be especially important to prevent the flow of sediments directly into the navigation channel. Temporary dikes constructed across the diversion channel(s) at various locations should be placed to create stilling basins and encourage settlement of fine sediments. Depending on the proximity to the Canal waters, silt curtains may also be required during the filling operations and at times of heavy rainfall until vegetative cover can be re-established.

7.5.3 Site Preparation

Minimal site clearance of the modified area will be required, since most of the area has already been cleared of all substantial growth.

7.5.4 Transportation Alternatives

As noted earlier, it is recommended that Site T4 should only be used to receive dry material from the widening and slope stabilization works on the east side of the Gaillard Cut. This then simplifies the transportation network, in that large volume dump trucks will be used to move material directly from the work faces to various locations within the disposal site, with no real need to provide buffer storage or transfer stations.

7.5.5 Haul Costs

Based on an average round trip haul distance of 7.0 km, the estimated cost for dry materials transport from the widening area work faces to Site T4 is $3.32.

7.5.6 Site Restoration

One completion of the filling operations, it is expected that the areas to the south of the site would be reforested to develop a corridor to those areas already recovered under earlier ACP initiatives. As for the other sites, vegetation over the remaining areas would be encouraged by the placement of overburden on the surface and elimination of invasive species where possible.

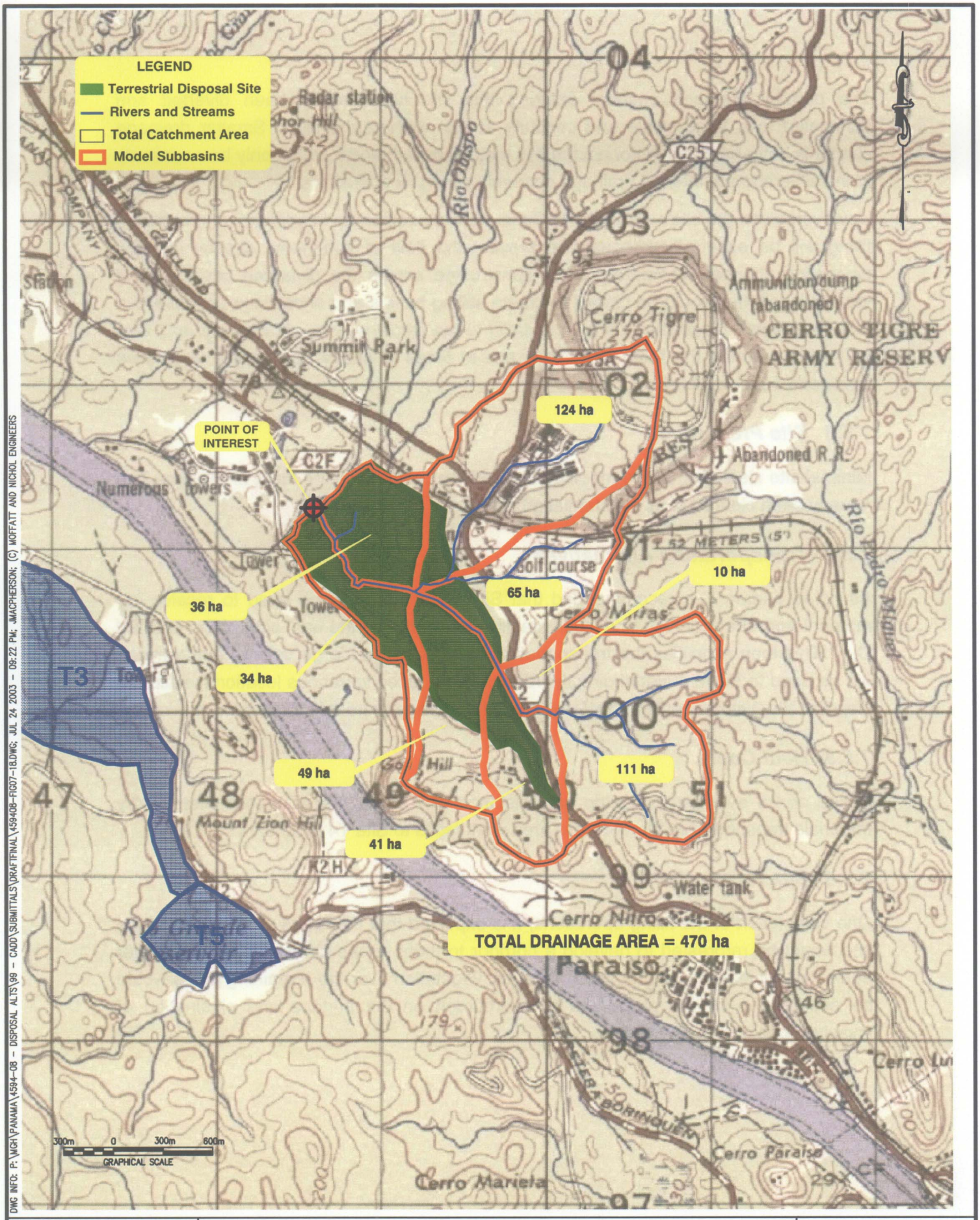


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Figure 7-18
Reconfigured Watershed Delineation - Site T4

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7.5.7 Cost Estimate

A combined cost estimated is presented for Site T4 in Table 7-12. From the table, it can be seen that T4 is one of the more economical sites to develop, place materials and restore. The estimated cost of site preparation and restoration is relatively low at $9,767 per hectare or $0.08 per m3 of fill, and the materials transport costs are also low at an estimated $3.32 per m3.

Table 7-12: Summary of Estimated Costs - Site T4

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$80,000**
Archaeological Survey	1	sum	5,000.00	$5,000
Mobilization	1	sum	50,000.00	$50,000
Construct Internal Access Roads	500	m	50.00	$25,000
Site Clearance & Preparation				**$53,334**
Vegetation Clearance	31.67	ha	500.00	$15,834
Construct Drainage Diversion channels	500	m	75.00	$37,500
Site Regrading	52.78	ha	10,000.00	$527,815
Site Restoration				**$562,000**
Construct Internal Drainage Channels	1,000	m	125.00	$125,000
Erosion Control Measures	500	m	350.00	$175,000
Top Soil for Reforestation (15 cm)	20.00	ha	7,500.00	$150,000
Overburden material for natural Revegetation	20.00	ha	2,500.00	$50,000
Reforestation per ACP guidelines	20.00	ha	3,000.00	$60,000
Selected Natural Revegation	20.00	ha	100.00	$2,000
Environmental Mitigation				**$241,896**
Construct Buffer Areas	2.00	ha	15,000.00	$30,000
Mitigation Allowance			0.50%	$211,896
Sub Total				**$937,231**
Contingencies			10%	$93,723
Total Estimated Cost of Site Development & Restoration				**$1,030,954**
Equivalent Unit cost of Site Development ($/m3 of capacity)		m3	**$0.08**	
Equivalent Unit cost of Site Development ($/ha)		ha	**$9,767**	
Materials Transport to Disposal Site				
Dry Materials Transport to Site	12,555,399	m3	3.32	$41,683,925

7.5.8 Value Added Potential

While it is possible that part of the site could eventually be used for commercial, residential recreational or tourist related development, the filling of the area will not increase the property value over the existing condition. It is therefore considered that there is no value added to the site by its selection as a disposal area.

7.5.9 Summary of Findings - Site T4

Site T4 is an altered ecosystem where stream branches have been modified and canalized. The site has already been intensively used for disposal and fill is still taking place in the area. Two areas within this low sensitivity forested habitat have been identified as being potential cultural resources sites. Immediately south of the site there is also a reforestation program by Prorena that should be avoided.

Given the difficulties of locating and building a marine transfer station, the site should be reserved for the receipt of dry materials from the east side of the Canal, which primarily involve slope reconfiguration for stability purposes following the widening project.

Since the total volume of dry material from the East side excavation in the Gaillard Cut is not expected to exceed 12.56 million m3, including an allowance for bulking, and given the extensive area available for materials disposal, the site can readily accommodate this amount of material. This then indicates that it will probably not be necessary to encroach on the secondary forest areas or the sites of potential archaeological interest.

7.6 Site T5 – Gaillard Cut South (W5)

7.6.1 Materials Holding Capacity

The area within the designated site limits offers approximately 29.76 hectares for receipt of fill materials. As for the other terrestrial sites, three fill scenarios are proposed, with the resulting volumes as indicated in Table 7-13, below.

Table 7-13: Estimated Fill Capacity - Site T5

Scenario	Estimated Fill Capacity (million x m3)
Average depth of 10.00 m over entire site	2.98
Fill to uniform Elevation	4.22
Maximum Site Capacity	7.28

The study area also falls within the suspected UXO hazard area although filling has already taken place over several sections of ACP site W5. The new bridge over the Panama Canal is also under construction in this area and it is understood that the access corridor to the new bridge will be located some 1.5 km south of the site.

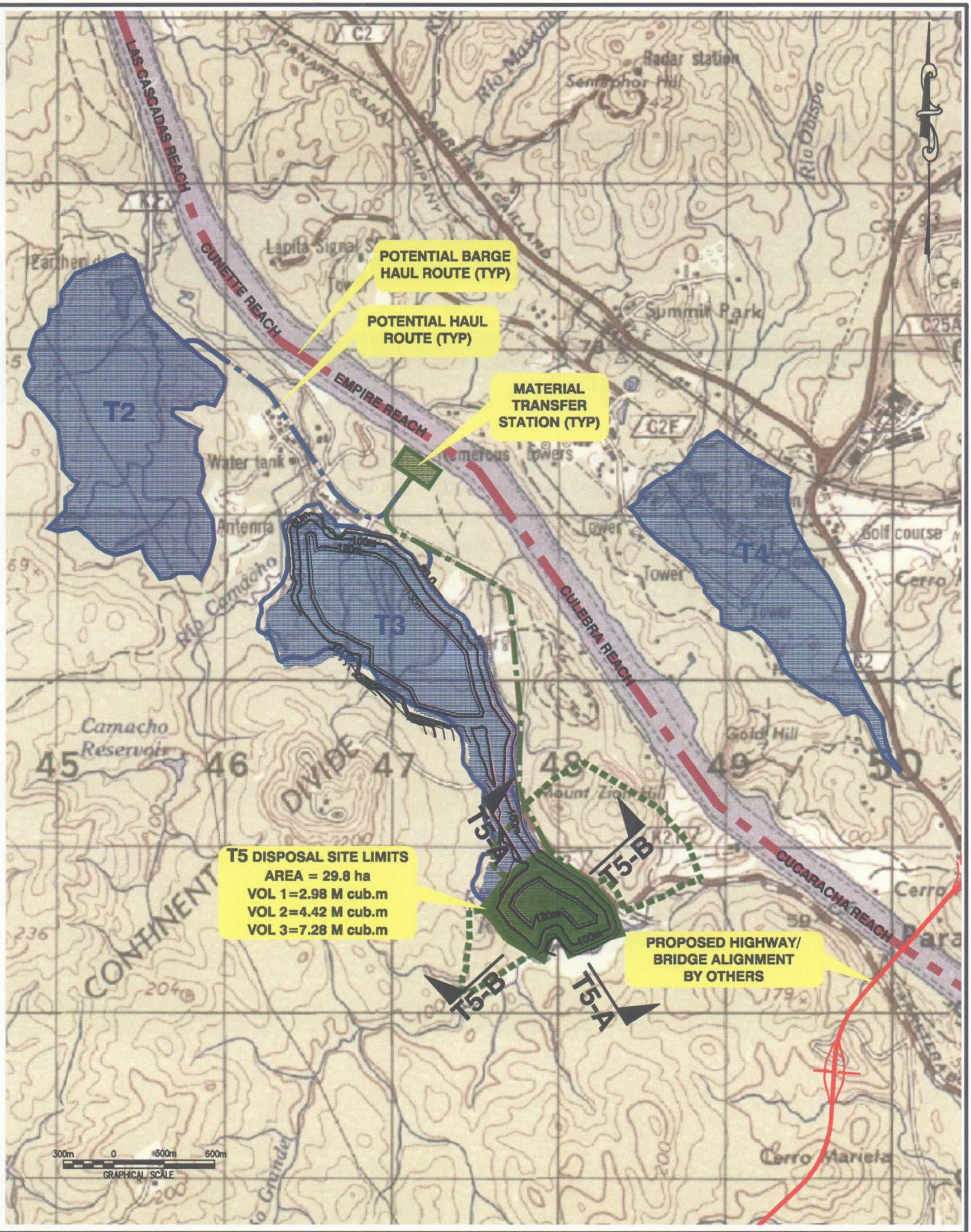

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Figure 7-19
Recommended Configuration for Site T5

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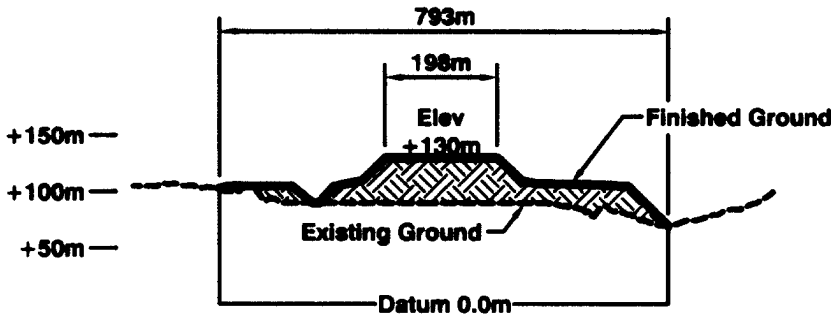
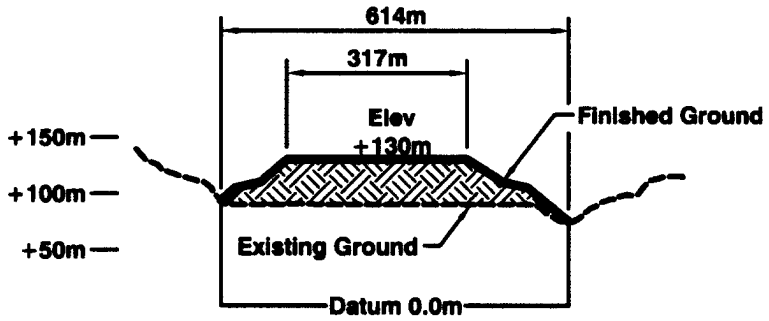
Figure 7-20: Typical Fill Sections for Site T5



Section T5-A (N-S)



Section T5-B (E-W)

Note: Vertical Exaggeration - 2V:1H

7.6.2 Drainage Requirements

The land cover of the reconfigured area shown in Figure 7-19 consists of fair grassland with some work areas, yielding an SCS Curve Number of 83. The design rainfall selected for the modeling analysis, was changed to 22.20 cm during the second level of analyses, based on the Hodges Hill gage rainfall statistics. Having updated the watershed characteristics, the HEC-HMS model was developed and run for the revised site, yielding the expected 100-yr, 24-hr peak flow indicated in Table 7-14, below.

Table 7-14: Results of Updated Drainage Analysis for Reconfigured Site T5

Site	Watershed Area (hectares.)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T5	30	83	22.20	6.4	3	0.2	6.8

The peak flow and required channel area and width calculated for the 100-yr, 24-hr event are relatively modest and the creation of a diversion channel or channels along site boundaries or internal sub-basin boundaries would meet the drainage requirements for this site.

As for the other west side terrestrial sites, care will be required to prevent the ingress of sediments into the Canal waters, during site filling and subsequent periods of heavy rainfall before vegetative cover can be re-established.

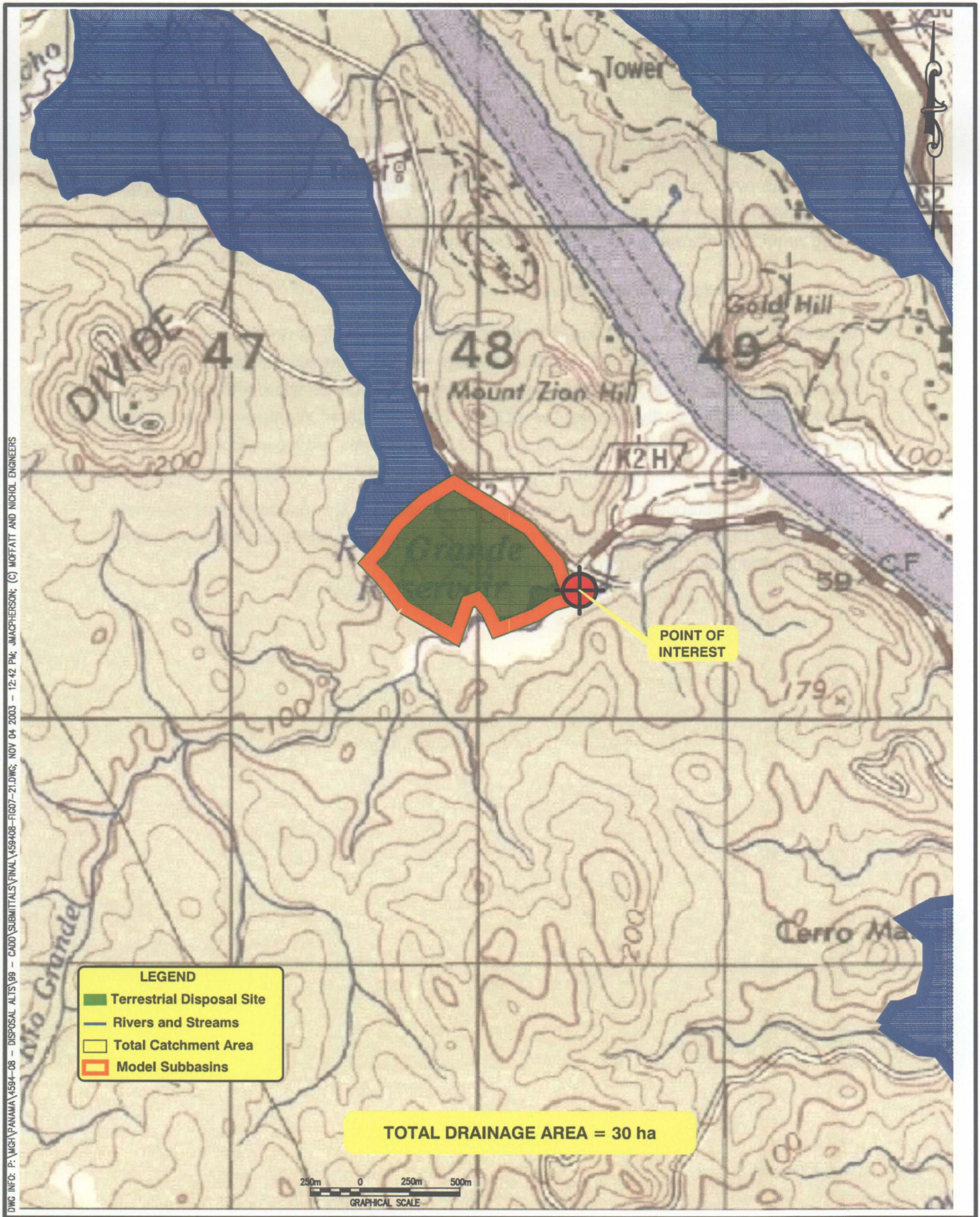


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Figure 7-21
Watershed Delineation - Site T5

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7.6.3 Site Preparation

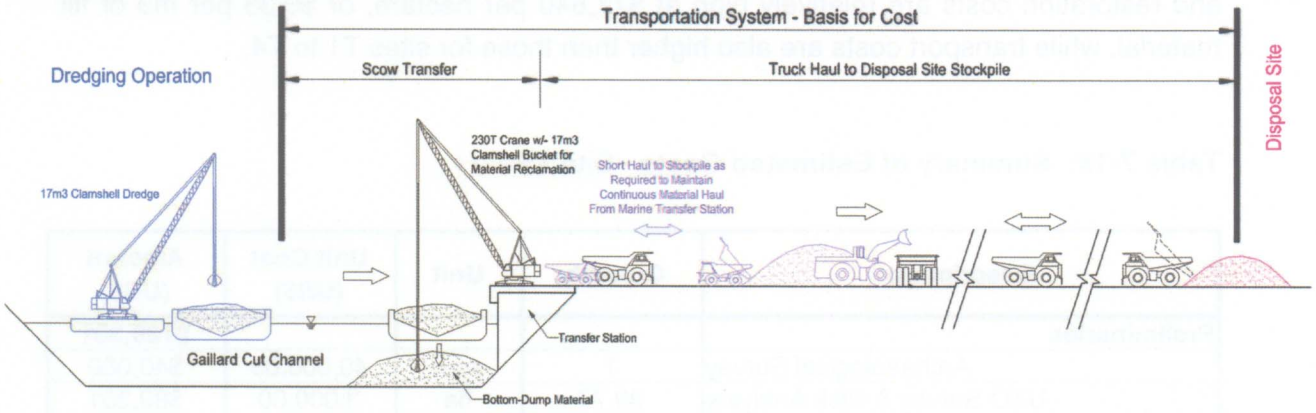
Minimal site clearance of the modified area will be required, since most of the area has already been cleared of all substantial growth. However, UXO surveys and clearance will be required before any work can take place at this site.

7.6.4 Transportation Alternatives

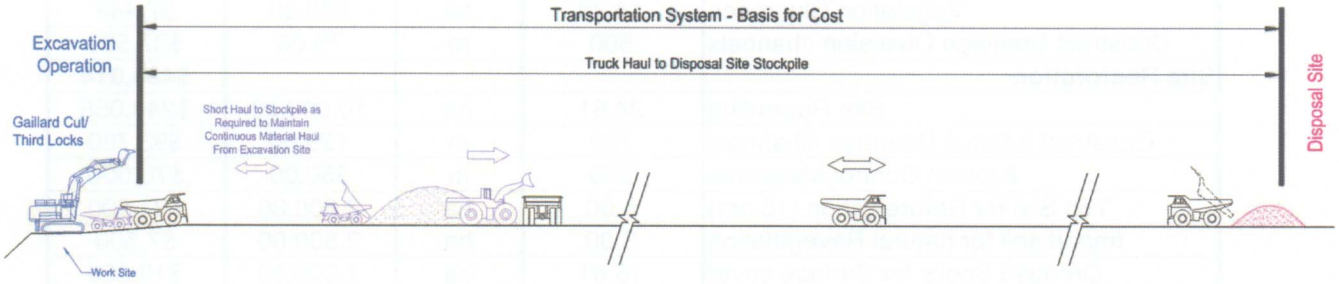
As seen in section 7.2 it is recommended that the movement of dredged materials to sites T2, T3 and T5 would be handled through a single transfer station. The haul distance from this central location to the center of site T5 will be approximately 3.50 km in length and could partly parallel the existing Panama Canal Western Access Road. Consequently, the haul sequences for wet and dry materials are as indicated in Figure 7-15 below.

Given the short distance from the Canal to the disposal site, it is expected that materials will be moved and placed using high capacity dump trucks over temporary haul roads, made from the rock obtained from the dredging work.

Figure 7-22: Recommended Materials Transport System for Site T5



System C
Typical Scow/Truck Haul Operation (Wet Excavation Source)



System E
Typical Truck Haul Operation (Dry Excavation Source)

7.6.5 Haul Costs

Based on an average round trip haul distance of 7.0 km, the estimated costs for dry and dredged materials transport to Site T5 are $3.11 per m3 and $4.88 per m3 respectively

7.6.6 Site Restoration

One completion of the filling operations, it is expected that the western sectors of the site would be reforested, with natural re-vegetation over the remainder of the area.

7.6.7 Cost Estimate

Table 7-15 presents the estimated costs for site T5, based on the expectation that UXO survey and clearance will be undertaken over the entire area of the site. Site clearance and restoration costs are relatively high at $77,640 per hectare, or $0.33 per m3 of fill material, while transport costs are also higher than those for sites T1 to T4.

Table 7-15: Summary of Estimated Costs - Site T5

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$189,301**
Archaeological Survey	1	sum	40,000.00	$40,000
UXO Survey & Risk Analysis	29.77	ha	3,000.00	$89,301
Mobilization	1	sum	50,000.00	$50,000
Construct Internal Access Roads	200	m	50.00	$10,000
UXO Clearance				**$1,190,680**
UXO Surface Clearance	14.88	ha	25,000.00	$372,088
Clearance to 60 cm Depth	14.88	ha	55,000.00	$818,593
Site Clearance & Preparation		ha	575.00	**$44,942**
Vegetation Clearance	14.88	ha	500.00	$7,442
Construct Drainage Diversion channels	500	m	75.00	$37,500
Site Restoration				**$488,914**
Site Regrading	24.81	ha	10,000.00	$248,058
Construct Internal Drainage Channels	750	m	125.00	$93,750
Erosion Control Measures	200	m	350.00	$70,000
Top Soil for Reforestation (15 cm)	5.00	ha	7,500.00	$37,500
Import soil for natural Revegetation	3.00	ha	2,500.00	$7,500
Dredged Spoils for Surface cover	16.81	ha	1,000.00	$16,806
Reforestation per ACP guidelines	5.00	ha	3,000.00	$15,000
Selected Natural Revegation	3.00	ha	100.00	$300
Environmental Mitigation				**$187,184**
Mitigation Allowance			0.50%	$187,184
Sub Total				**$2,101,021**
Contingencies			10%	$210,102
Total Estimated Cost of Site Development & Restoration				**$2,311,123**
Equivalent Unit cost of Site Development ($/m3 of capacity)			**$0.33**	
Equivalent Unit cost of Site Development ($/ha)			**$77,640**	
Materials Placement				
Wet Materials Transport to Site	7,279,284	m3	4.88	$35,522,906
Dry Materials Transport to Site	7,279,284	m3	3.11	$22,638,573

Note: Clearance areas based on firing range classification from available records (eg primary, secondary etc)

7.6.8 Value Added Potential

It is most unlikely that the restored site will be used for anything other than Panama Canal support services. It is therefore considered that there is no value added to the site by its selection as a disposal area.

7.6.9 Summary of Findings - Site T5

Site T5 is a severely altered ecosystem, except for an environmentally sensitive forest area to the west of the site. However, large sections of the site are within the primary UXO areas, with a high probability of ordnance over most of the area.

Based on this assessment and the expectation that filling over the UXO sites will be a useful step in the recovery of these dangerous sites, there are no environmental concerns associated with its designation as a fill location.

According to the computations presented in this report, the estimated holding capacity of the site ranges from 2.98 to 7.29 million m3, depending on the fill scenario selected. Estimated costs for site development, filling and restoration are $77,640 per hectare, including the survey and clearance of UXO material. This then equates to some $0.30 per cubic meter of fill, assuming that the site is filled to its maximum capacity. Materials transport costs for dry and wet material from the Gaillard Cut work are estimated to be $3.11 or $4.88 per cubic meter, respectively.

7.7 Site T6 – UXO areas

7.7.1 Evaluation of UXO Risk

A full discussion of UXO Risk assessment and clearance procedures is presented earlier in this report as part of the evaluation of Sites T3 and T5 and will not be repeated here. However, it is important to note that Site T6 is the largest site with UXO problems, and due to its high materials holding capacity, is potentially a critical element in the disposal evaluation for both the Gaillard Cut and Locks excavation projects.

As for Sites T3 and T5, it will be necessary to undertake a risk analysis of the fill areas in order to determine the optimum or acceptable depth of fill that can be applied and to assess the need or otherwise to clear the UXO material prior to the filling operations. However, as indicated earlier, some 63 hectares of the north and east sectors of the site are believed to have been cleared to depths varying from 2.0 to 4.0 ft in 1999 by EOD Technology Inc., with surface clearance of an additional 67 hectares. While the consultants were not able to locate any information on the results or success of this work, it is believed that some documentation exists, either in ACP files or with the Corps of Engineers in the US. This information, if available, could go a long way to clarifying the level of risk from UXO material within this and the other affected sites.

Given the lack of hard data on UXO density and classification, it is assumed in this report that surveys, risk assessment and surface clearance are required prior to any work at site T6. It is also assumed that a minimum fill depth of 10.00 m will be required in order to reduce the UXO hazard to acceptable levels, following the survey and clearance. However, as previously stated, these assumptions simply represent the consultants' opinions at this time, and are not supported by any specialist technical or forensic analysis of conditions within the site.

7.7.2 Materials Holding Capacity

Based on the modified site boundaries to avoid the secondary forest areas identified in the environmental evaluation presented earlier in Volume 2, the fill area covers 305.42 hectares, as shown in Figure 7-23.

As for all the other terrestrial sites, three fill scenarios are proposed, with the resulting volumes as indicated in Table 7-16. Figure 7-24 shows typical cross sections of the three alternative fill scenarios for Site T6.

Table 7-16: Estimated Fill Capacity - Site T6

Scenario	Estimated Fill Capacity (million x m3)
Average depth of 10.00 m over entire site	30.540
Fill to uniform Elevation	77.04
Maximum Site Capacity	115.24

As can be seen from the table, Site T6 has a potentially high fill capacity and could hold all of the material from either the Gaillard Cut work or the Locks excavation, but not both. It is therefore a very important element in the analysis of potential disposal sites for both projects.

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Figure 7-23
Recommended Configuration of Site T6

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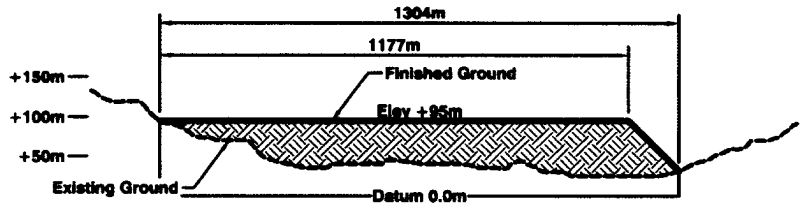
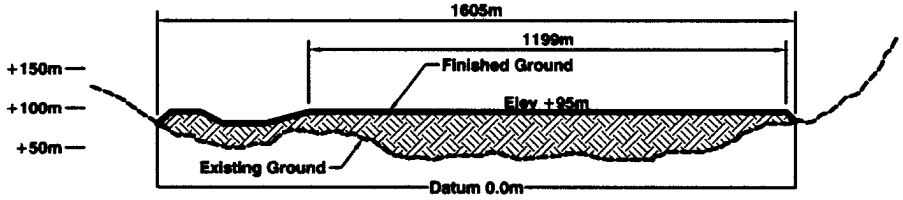
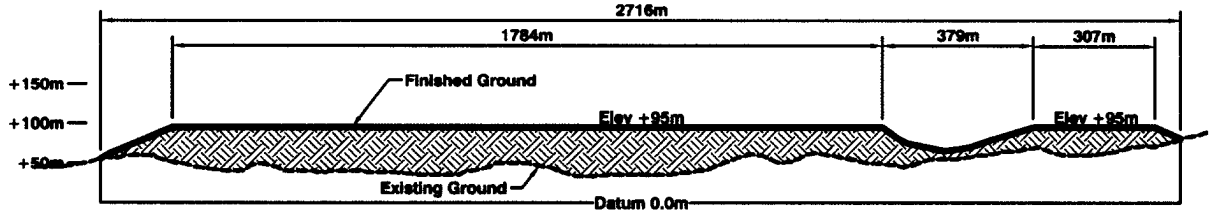
Figure 7-24: Typical Fill Sections - Site T6



Section T6-A (SW-NE)



Section T6-B (NW-SE)



Section T6-C (N-S)

Note: Vertical Exaggeration - 2V:1H

Note: Refer Figure 7-23 for section cut locations.

7.7.3 Drainage Requirements

Results from the drainage model run on the reconfigured site boundaries are shown below in Table 7-17. The minor modifications to the site boundaries did not modify the drainage catchment areas or run-off areas, which were presented earlier in Section 5 of Volume 1.

Table 7-17: Results of Drainage Analysis for Reconfigured Site T6

Site	Watershed Area (hectares)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T6	1008	67	18.08	96.3	50	3.0	28.4

The peak flow and required channel area and width calculated for the 100-yr, 24-hr event for the entire site area is substantial. Therefore, the creation of a diversion channel or channels along site boundaries or internal sub-basin boundaries (depending on filling sequencing and/or ACP preference) of the site may pose some design challenges. Since Site T6 is located near the outlet to the lake of this large watershed and many of the sub-basins are contained within the site itself, it would be nearly impossible to divert offsite flood flows around the site. Given the current system of numerous, complex channels, it would also be more difficult to divert all flows to the site boundaries without substantial filling in a short amount of time. At the same time, the fill process will constantly alter the hydraulic profiles within the site and regular modifications to the channels will be required as the work progresses.

In order to accommodate these changes, it is recommended that a perimeter drain be constructed at the commencement of fill to collect as much of the inflow as possible. All temporary or internal drainage flows would be directed into the main channel and a series of stilling basins until construction is completed. At that time, and assuming that the area is allowed to return to its former forested condition, a final natural drainage flow or stream pattern can be designed and implement for the site.

7.7.4 Site Preparation

Minimal site clearance of the modified area will be required, since most of the area identified for filling has already been cleared of all substantial growth. However UXO survey, assessment and possible ordnance clearance will be necessary.

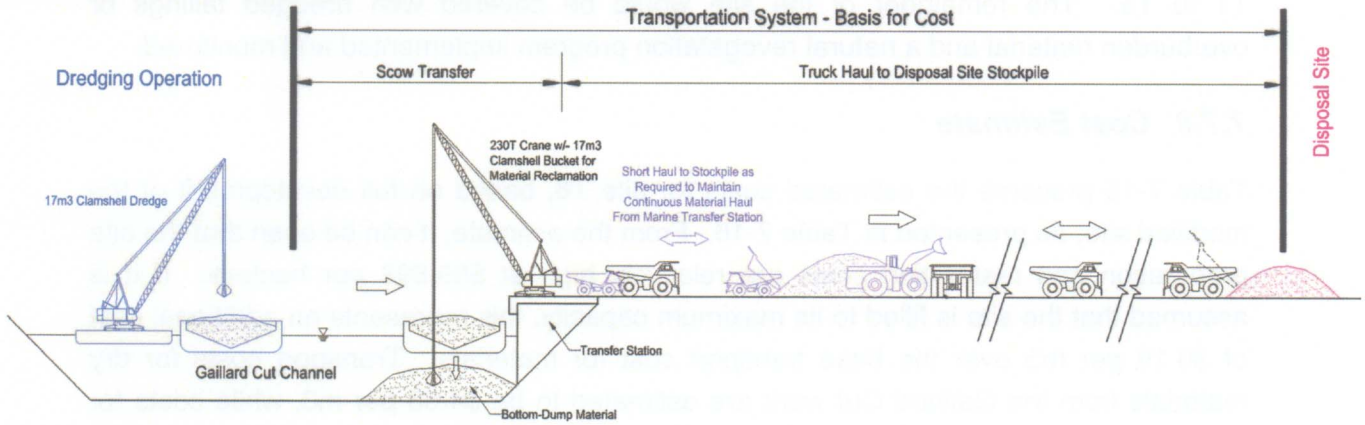
As part of the preparatory work for this site, it will be necessary to obtain technical and cost proposals for the survey, risk assessment and clearance of the UXO material as described in the discussions on Site T3 and T5.

7.7.5 Transportation Analysis

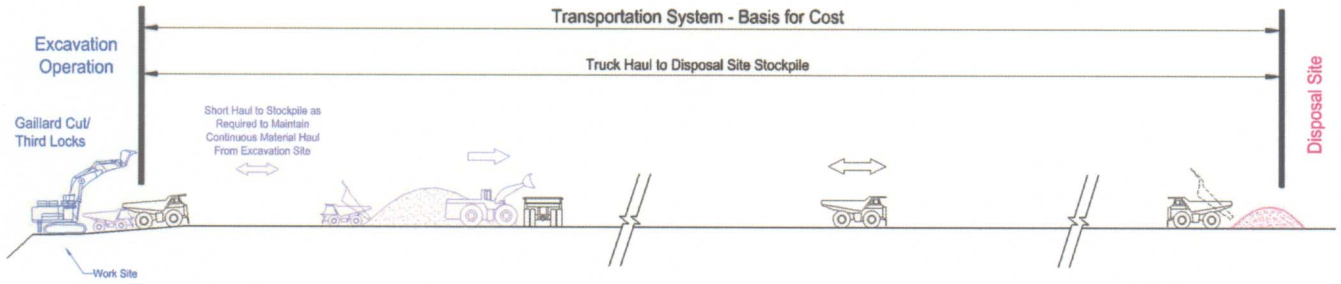
As seen in Figure 7-23, the movement of dredged materials from the Gaillard Cut work to the site would be handled through a transfer station located to the south of the ongoing bridge construction contractors working area, as shown in Figure 7-23 . The haul distance from the transfer station to the center of site T6 will be approximately 2.0 km in length and could partially parallel the existing Panama Canal Western Access Road. Consequently, the haul sequence for the Gaillard Cut work is as indicated in Figure 7-25 below.

Site T6 is also close to the Pacific Side Locks Expansion area and the site could accommodate material from the Locks excavation project, in addition or as an alternative to the Gaillard Cut material. Again, given the short distance from the Canal to the disposal site, it is expected that materials will be moved and placed using high capacity dump trucks over temporary haul roads, using rock obtained from the dredging work, similar to the sequence indicated for dry material indicated in Figure 7-25.

Figure 7-25: Recommended Materials Transport System for Site T6



System C
Typical Scow/Truck Haul Operation (Wet Excavation Source)



System E
Typical Truck Haul Operation (Dry Excavation Source)

7.7.6 Haul Costs

Based on an average round trip truck haul distance of 16.0 km from the centroid of the Gaillard Cut work (dry materials), 4.0 km from the wet materials transfer station and 6.0 km from the Third Locks site, the estimated costs for materials transport to Site T6 are as follows:

Gaillard Cut Material

Wet (dredged) Materials $3.87/m3

Dry Materials $4.66/m3

Third Locks Dry material $3.24/m3

7.7.7 Site Restoration

On completion of the filling operations, it is expected that approximately one third of the area would be re-forested to develop a consistency with the forested areas west of sites T1 to T5. The remainder of the site would be covered with dredged tailings or overburden material and a natural revegetation program implemented and monitored.

7.7.8 Cost Estimate

Table 7-15 presents the estimated costs for site T6, based on full development of the modified site, as presented in Table 7-16. From the estimate, it can be seen that the site preparation and restoration costs are relatively high at $69,898 per hectare. If it is assumed that the site is filled to its maximum capacity, this represents an additional cost of $0.19 per m3 over the base transport cost for materials. Transport costs for dry materials from the Gaillard Cut work are estimated to be $4.66 per m3, while costs for wet materials are $3.87 per m3. Estimated materials transfer costs from the Locks project are $3.24 per m3, assuming dry materials movements only.

Table 7-18: Summary of Estimated Costs - Site T6

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$1,621,200**
Archaeological Survey	1	sum	5,000.00	$5,000
UXO Survey & Risk Analysis	305.40	ha	3,000.00	$916,200
Mobilization	1	sum	500,000.00	$500,000
Construct Internal Access Roads	4,000	m	50.00	$200,000
UXO Clearance				**$10,658,460**
UXO Surface Clearance	204.62	ha	25,000.00	$5,115,450
Clearance to 60 cm Depth	100.78	ha	55,000.00	$5,543,010
Site Clearance & Preparation		ha		**$527,700**
Vegetation Clearance	305.40	ha	500.00	$152,700
Construct Drainage Diversion channels	5,000	m	75.00	$375,000
Site Restoration				**$4,328,475**
Site Regrading	305.40	ha	10,000.00	$3,054,000
Construct Internal Drainage Channels	750	m	125.00	$93,750
Erosion Control Measures	200	m	350.00	$70,000
Top Soil for Reforestation (15 cm)	76.35	ha	7,500.00	$572,625
Import soil for natural Revegetation	50.00	ha	2,500.00	$125,000
Dredged Spoils for Surface cover	179.05	ha	1,000.00	$179,050
Reforestation per ACP guidelines	76.35	ha	3,000.00	$229,050
Selected Natural Revegation	50.00	ha	100.00	$5,000
Environmental Mitigation				**$2,270,307**
Construct Buffer Areas	50.00	ha	15,000.00	$750,000
Mitigation Allowance			0.50%	$1,520,307
Sub Total				**$19,406,142**
Contingencies			10%	$1,940,614
Total Estimated cost of Site Development & Restoration				**$21,346,756**
Equivalent Unit cost of Site Development ($/m3 of capacity)			**$0.19**	
Equivalent Unit cost of Site Development ($/ha)			**$69,898**	
Materials Transport & Placement				
Gaillard Cut Materials				
Wet Materials Transport to Site	34,524,112	m3	3.87	$133,608,313
Dry Materials Transport to Site	32,900,678	m3	4.66	$153,317,159
Third Locks Material				
Dry Materials Transport to Site	90,155,000	m3	3.24	$292,102,200

Note: Clearance areas based on firing range classification from available records (eg primary, secondary etc)

7.7.9 Value Added Potential

Once Site T6 has been cleared of UXO material, filled and restored, the access restrictions can be lifted. However, since the site falls within the area designated as the Canal watershed protection area, it is most unlikely that commercial or other non-Canal related development will ever be permitted. However, restoration of the forests will have a direct benefit to the ecology and may also indirectly enhance the quality of the Canal watershed and the resolution of the UXO dangers are beneficial to the populace of Panama. While it is not possible to quantify the added value of these benefits, it is clear that the clearance, filling and restoration of the UXO sites will be a win-win situation for Panama, ACP and the USA.

7.7.10 Summary of Findings – Site T6

Taking into account the exclusion of the environmentally sensitive areas discussed earlier, Site T6 offers the potential to receive up to 114.5 million m3 of dry or wet material from the Deepening and Widening projects and the Locks Excavation, compared to the anticipated excavation volumes of 80.00 and 90.20 million m3 respectively for the two projects. As such, T6 constitutes a major element of the materials disposal plan for the overall capacity expansion program.

The non-forested areas of Site T6 represent a severely altered ecosystem with the added complication of a high probability of UXO materials over most of the area. There is an environmentally sensitive forest area to the west of the site, and this is also within the UXO area.

Apart from the sensitive areas to the west of the site and the low potential for sites of archaeological interest, there are no serious environmental concerns associated with the filling of Site T6 within the revised site limits shown. The major issue related to the use of this site is the need to fully assess the UXO risk and the requirement to either clear the ordnance or fill over it to a depth that will substantially reduce or eliminate the risk to human life.

Estimated costs for site development and restoration are on the order of $69,000 per hectare, which includes clearance of UXO materials. Transport costs for materials from the Third locks project are relatively low at $3.24 per cubic meter and this makes site T6 an attractive disposal site option, even taking into account the "UXO surcharge", estimated to be $0.19 per cubic meter.

Given the overriding policy of ACP, ARI and the Panama Government to protect all areas within the Canal limits and prohibit any form of commercial or residential development that is not directly related to Canal operations or maintenance, it would seem appropriate for this site to be filled to the maximum depth possible and then

restored by re-forestation or planting of selected species in order to return it to its original condition.

As the largest of the Terrestrial sites, T6 is an important element in the disposal evaluation and offers the potential to resolve a difficult situation over the UXO issues. In terms of cost, the site also represents one of the lowest cost scenarios for disposal, apart from the major unknown element of the UXO clearance.

7.8 Site T7 – Miraflores West Bank

7.8.1 Materials Holding Capacity

As seen in Figure 7-26, this site is closely bounded by the existing canal and the P1 alignment. The most appropriate way to fill in an area bounded by these two alignments would appear to place materials to a uniform depth of approximately 10.00 m above existing grades, with final elevations to be determined as part of the overall grading following the completion of the Locks Project. Based on this assumption the site holding capacity is approximately 4.50 million m3.

7.8.2 Drainage Requirements

The presence of a ridge line through Site T7 naturally divides the site into two drainage areas, requiring separate analyses for each section. The revised watershed areas were calculated to be 57 hectares for sub-basin B1, on the North side of the site and 80 hectares for sub-basin B2 on the South side of the site. The site consists mainly of fair grassland with some work areas. Therefore the SCS Curve Number selected for this watershed was 83. Using the design rainfall depth determined in the rainfall analysis and a number of watershed characteristics calculated from the existing topography, a HEC-HMS model was created to calculate the peak flow from the 100-yr, 24-hr storm. Given the HEC-HMS model results, peak flow and approximate channel characteristics were determined as indicated below.

Table 7-19: Results of Drainage Analysis for Site T7

Site	Watershed Area (hectares)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T7 – B1	57	83	18.21	10.4	2	0.2	6.2
T7 – B2	80	83	18.21	14.7	2	0.3	6.3

As an isolated area that will eventually be incorporated within the New Locks and support areas, it is therefore not practical to prepare a drainage management plan for the site at this time. Drainage of the area would be part of the integrated development plan and final design profiles for the Locks area.

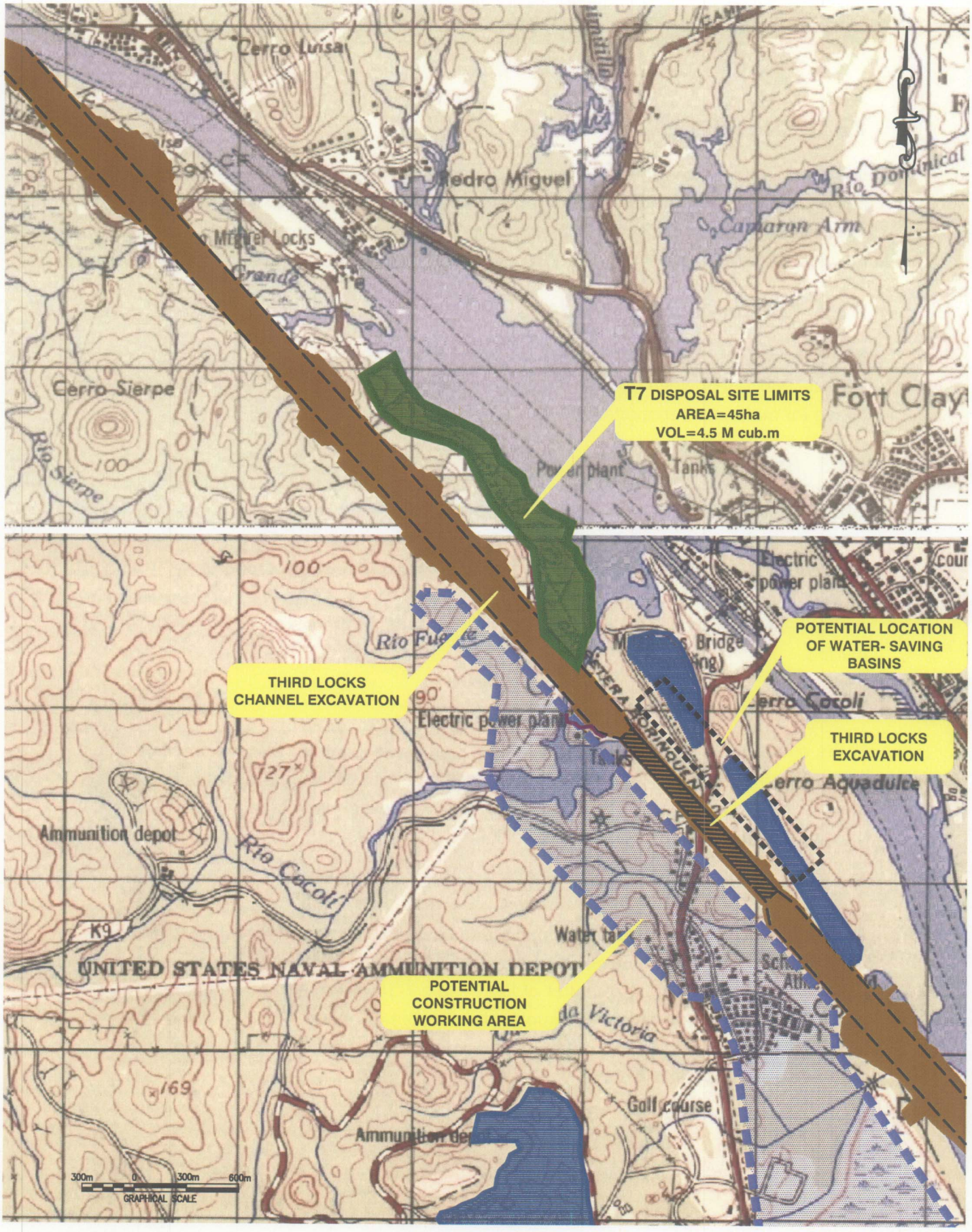


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Figure 7-26
General Location Plan - Site T7

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7.8.3 Site Preparation

It is most probable that this site will be cleared as part of the Pacific Locks excavation. However an allowance for removal of the secondary forests and vegetation cover is included within the cost estimates, since the use of this area for fill could well precede the clearance of the rest of the area for Locks construction and contractor support areas.

7.8.4 Transportation Alternatives

It is assumed that the site would be used to receive material from the Pacific side Locks project. Since it is close to the proposed P1 alignment a truck haul route is the favored option for materials transportation.

7.8.5 Haul Costs

Given the limitations of the existing road, expected elevation of the Locks approach channels and final grading of the area, it is assumed that Site T7 will be filled to an elevation not exceeding 10.00 m above the existing average topography, giving a potential holding capacity of 4.50 million m3. Based on an average round trip haul distance of 5.00 km, the estimated cost for dry materials transport to the site is $ 3.36 per m3.

7.8.6 Site Restoration

In the event that T7 remains as an island or peninsula following the construction of the new locks, it could either be re-forested or used as a locks service area. It is considered that the latter use is more likely and hence no allowance is made in this cost estimate for restoration of the site to its existing condition.

7.8.7 Cost Estimate

As noted earlier, the excavation schedule and quantities of fill material cannot be clearly defined at this stage of the evaluation process. Hence the cost estimates are presented in terms of unit cost per cubic meter of fill. Table 7-15 presents the estimated costs for site T7, based on the capacity assumptions presented above. On the basis of these assumptions, Site T7 represents one of the most cost effective sites for receipt of dry materials from the Locks excavation work.

Table 7-20: Summary of Estimated Costs - Site T7

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$100,000**
Mobilization	1	sum	100,000.00	$100,000
Site Clearance & Preparation		ha		**$60,002**
Vegetation Clearance	45.00	ha	500.00	$22,502
Construct Drainage Diversion channels	500	m	75.00	$37,500
Sub Total				**$160,002**
Contingencies			10%	$16,000
Total Estimated Cost of Site Development & Restoration				**$176,002**
Equivalent Unit cost of Site Development ($/m3 of capacity)			**$0.04**	
Equivalent Unit cost of Site Development ($/ha)			**$3,911**	
Materials Placement				
Dry Materials Transport to Site	4,500,435	m3	3.36	$15,121,462

7.8.8 Value Added Potential

Since the site is currently within the Canal operations area, there is no added value derived from its conversion to a fill disposal area.

7.8.9 Summary of Findings – Site T7

This area includes designated sites for the new Locks alignment, and offers the potential to receive approximately 4.50 million m3 of material. Studies conducted in this area have shown the presence of several species protected by Panamanian laws and endemic plant species. However, mammals and reptile species can be transferred to other areas as part of a mitigation program. The wooded area within the designated parcel of land for the alignment showed some pristine habitats, forested areas in stages of recovery, as well as a rich riverine habitat. Habitats east of the alignment on the side of the Canal are severely altered and consequently the area was categorized as being of low sensitivity.

The main issue related to Site T7 is the final configuration of the Pacific Side locks and approach channels, which could drastically modify its capacity as a disposal site. As such, T7 and also Site T8 cannot be considered to be independent disposal sites in the same fashion as the other terrestrial sites, since their final profiles, use and configuration will be totally dependent on the designs adopted for the Locks and support areas. While

it is quite likely that the two sites will be used for disposal of material from the Locks excavation, it is recommended that environmental and other permitting for both Sites T7 and T8 should be included within the design and submittals for the Locks and support development as part of an integrated package.

7.9 Site T8 - Old Third Locks Excavation Lagoons

7.9.1 Materials Holding Capacity

As shown in Figure 7-27, the disposal plan for site T8 would involve filling the two lagoons and the dredged area south of the Miraflores locks to an elevation that corresponds with the final grading plan for the entrance channels and new Locks. For the purposes of this evaluation, it has been assumed that the P1 alignment will not cross the excavations.

The most appropriate way to fill in the 27.3 hectare area bounded by these two alignments is to fill the underwater portion of the site and then bring the surface to a uniform elevation. Assuming that the final fill elevation is relatively close to the existing ground level, the estimated capacity of the three areas is approximately 5.00 million m3, or 2.99 million m3 for the two enclosed lagoons. As such, the filled site would then serve as a useful working platform for the Third locks construction area or the final permanent support facilities for the Locks. The haul route from the center of the P1 alignment to the center of the disposal site is 2.1 km.

In the event that the P2 alignment is selected or a final alignment crosses the area, it is most probable that this site would fall out of consideration as a disposal site.

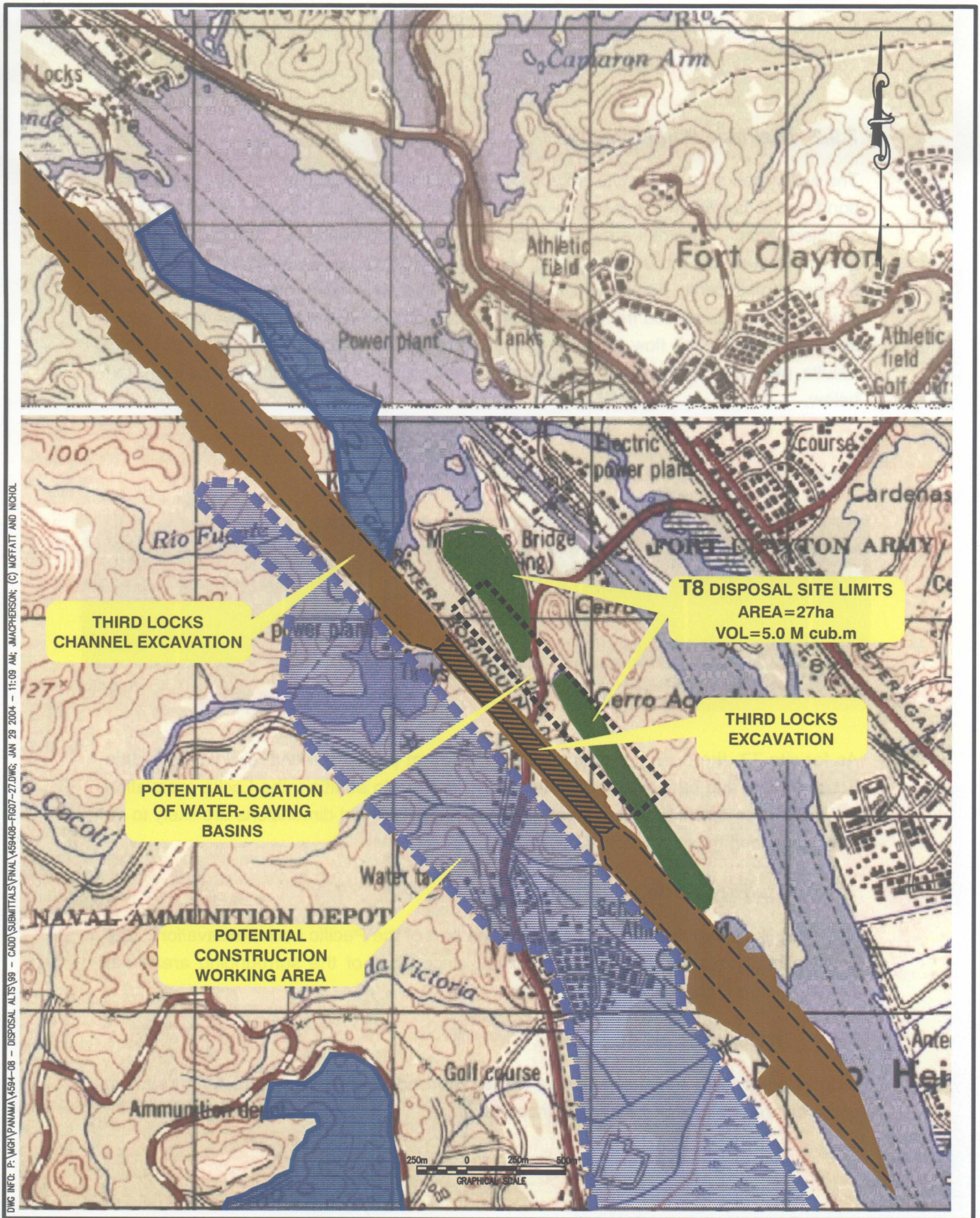

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Figure 7-27
General Location Plan - Site T8

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7.9.2 Drainage Requirements

The watershed area of this site includes the immediate surrounding area for the northern pond and a larger area expanding west around an unnamed tributary draining to the southern pond. The total area was calculated to be 358 hectares. The land cover for this site is currently a brush grassland, yielding an SCS Curve Number of 73. Using the design rainfall depth determined in the rainfall analysis and a number of watershed characteristics calculated from the existing topography, a HEC-HMS model was created to calculate the peak flow from the 100-yr, 24-hr storm. Given the HEC-HMS model results, peak flow and approximate channel characteristics were determined as indicated below.

Table 7-21: Results of Drainage Analysis for Site T8

Site	Watershed Area (hectares)	SCS Curve Number	Precip (cm)	Calculated Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T8	358	73	18.21	31.4	12	1.4	14.2

As for site T7, the drainage of this location will form part of the final civil works for the Locks project and cannot be presented in this report. In addition, the Locks excavation will reduce the catchment area significantly and final channel dimensions are likely to be much less than those indicated above.

7.9.3 Site Preparation

It is most likely that this site will be cleared as part of the Pacific Locks excavation. Site preparation needs for the site are minimal, since most of the surrounding areas are already cleared, partly filled or under water.

7.9.4 Transportation Analysis

Since the site is immediately adjacent to the proposed P1 alignment a truck haul system is the favored option for materials transportation.

7.9.5 Haul Costs

Based on an average round trip haul distance of 4.2 km, the estimated costs for dry materials transport to the site from the Locks excavation is $2.98 per m3.

7.9.6 Site Restoration

Following the construction of the new locks, it is expected that the filled area will be used for service, maintenance or other Canal related activities and no allowance has been made in this cost estimate for restoration of the site to its existing condition.

7.9.7 Cost Estimate

Table 7-15 presents the estimated costs for site T8, based on the capacity assumptions presented earlier.

Table 7-22: Summary of Estimated Costs - Site T8

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$105,000**
Archaeological Survey	1	sum	5,000.00	$5,000
Mobilization	1	sum	100,000.00	$100,000
Sub Total				**$105,000**
Total Estimated Cost of Site Development & Restoration				**$105,000**
Equivalent Unit cost of Site Development ($/m3 of capacity)			**$0.02**	
Equivalent Unit cost of Site Development ($/ha)			**$2,453**	
Materials Placement				
Dry Materials Transport to Site	5,003,136	m3	2.98	$14,909,345

7.9.8 Value Added Potential

Since the site is currently within the Canal operations area, there is no added value to be derived from its conversion to a fill disposal area.

7.9.9 Summary of Findings – Site T8

This area includes designated sites for the new Locks alignment, but offers the potential to receive approximately 5.00 million m3 of fill material. Habitats east of the alignment on the side of the Canal are severely altered and consequently the area was categorized as being of low sensitivity. While the two lagoons have become established and productive aquatic ecosystems, it is most probably that the site will be drastically modified as part of the Locks construction proposals.

The main issue related to Site T8 is the final configuration of the Pacific Side locks and approach channels and it is most probable that the entire area will be cleared and reconfigured as part of the Locks project. In addition, the final alignment could well traverse parts of the two artificial lakes.

As such, Site T8 cannot be considered to be an independent disposal site in the same fashion as the other terrestrial sites, since the final profiles, use and configuration will be totally dependent on the designs adopted for the Locks and support areas. While it is quite likely that the two lakes will be used for disposal of material from the Locks excavation, it is recommended that environmental and other permitting for the site should be included within the design and submittals for the Locks and support development as part of an integrated package. The environmental studies should include the evaluation of existing aquatic communities and mitigation plans. Particular attention should be given to the recently discovered existence of the communities of ostiones noted in section 6.8.1 of Volume 1 of this report.

7.10 Site T9 - Rodman/Technical Evaluation

7.10.1 Materials Holding Capacity

The site shown in Figure 7-28 is approximately 4.0 km from the new locks excavation site. If it assumed that the site is roughly bounded by the 120m contour on the west side and existing roads on all other sides, the computed total area is 146.8 hectares.

Because of the numerous hills and the general slope of the site from 120m to 60m, the estimated capacity of the study area is low, at 5.9 million m^3.

7.10.2 Drainage Requirements

Site T9 is drained by the Velásquez Rv., of 19.4 km2, that always has water along the approximately 8.4 km of length. It has some intermittent tributaries that cross the study area. Velásquez River flows toward the entrance of the Canal in Panama Bay.

The drainage network in this river is dendritical, typical of igneous formations. Rio Velázquez is order 2; water current is very slow and it is possible to observe many almost stagnant pools along the stream.

The watershed area for this site was seen in section 5 of Volume 1 to be 84 hectares. Site T9 has two distinct land use patterns with approximately 50 percent of the watershed exhibiting characteristics similar to the Los Cañones watershed and 50 percent consisting of a fair grassland with work areas. Therefore the weighted SCS Curve Number selected for this watershed was 74. The HEC-HMS model results, peak flow and approximate channel characteristics were determined as indicated in Table 7-23.

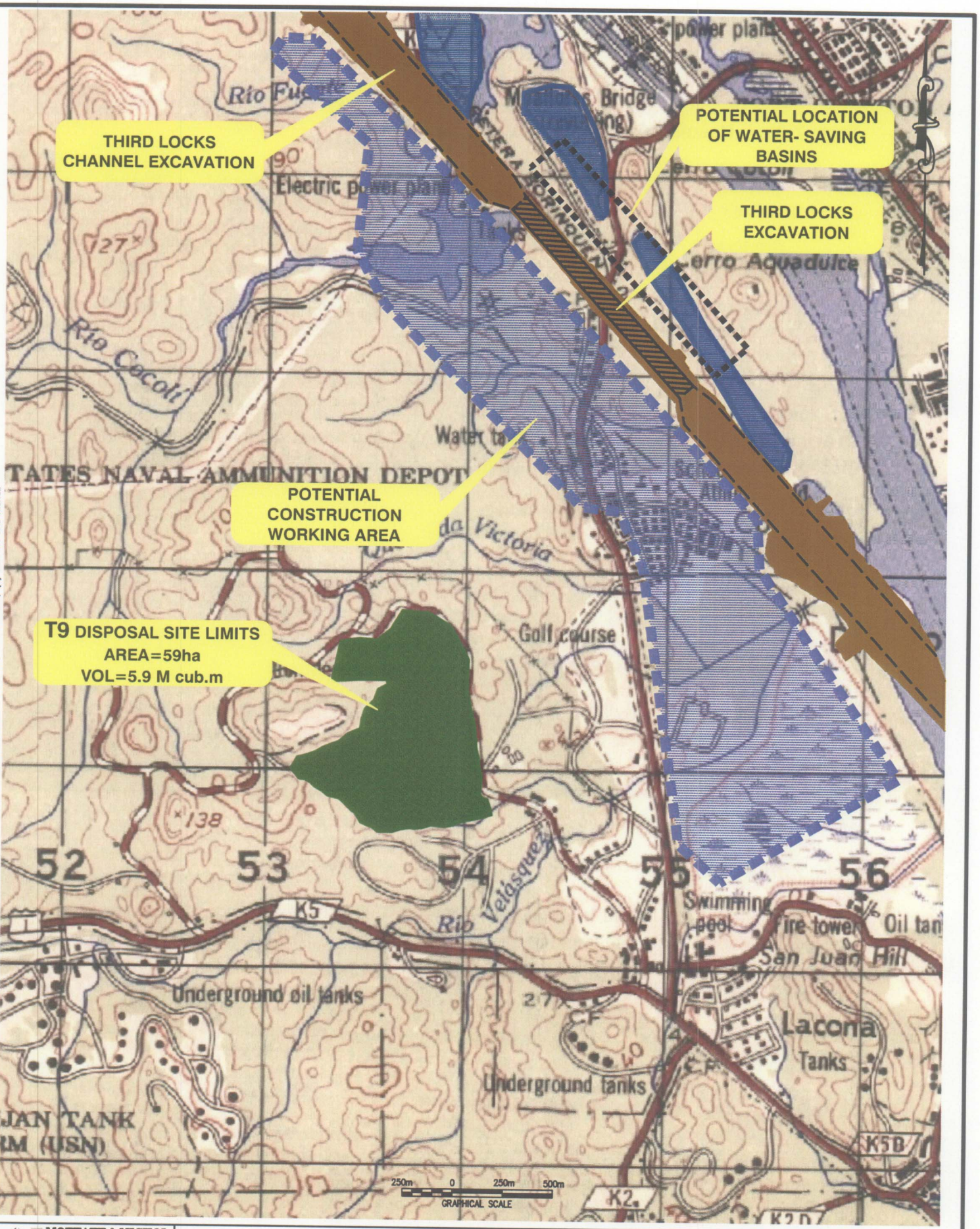

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Figure 7-28
General Location Plan - Site T9

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Table 7-23: Results of Drainage Analysis for Site T9

Site	Watershed Area (hectares)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T9	84	74	18.31	12.1	8	0.4	11.3

As can be seen in Table 7-23, the peak flow and required channel area and width calculated for the 100-yr, 24-hr event are manageable. Therefore, the creation of a diversion channel or channels along site boundaries or internal sub basin boundaries (depending on filling sequencing and/or ACP preference) of the site should pose no significant impediments.

7.10.3 Site Preparation

Site preparation costs for T9 are likely to be high, due to the nature of the topography, presence of old foundations and structures and the heavy tree cover.

7.10.4 Transportation Analysis

Since the site is relatively close to the proposed P1 alignment, and the potential fill volume is limited to some 6.0 million m3, a truck haul system is the favored option for materials transportation. The route of the haul road would cross the existing ACP dredge disposal areas and then parallel the Borinquen highway. Total estimated length of the one way haul is 4.0 km.

7.10.5 Haul Costs

Based on an average round trip haul distance of 8.0 km, the estimated costs for dry materials transport to the site from the Locks excavation site is $3.79 per m3.

7.10.6 Site Restoration

Restoration of the site to its existing condition would be costly, requiring total reforestation and monitoring over a considerable period of time.

7.10.7 Cost Estimate

Table 7-15 presents the estimated costs for site T9, based on the capacity assumptions presented earlier. As noted earlier, the site preparation and restoration costs are high at

an estimated $0.67 per m3 or $57,098 per hectare of fill, always assuming that permission could be obtained from ANAM and ARI for removal of the identified sensitive forest species in the area.

Table 7-24: Summary of Estimated Costs - Site T9

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$340,000**
Archaeological Survey	1	sum	40,000.00	$40,000
Mobilization	1	sum	250,000.00	$250,000
Construct Internal Access Roads	1,000	m	50.00	$50,000
Site Clearance & Preparation		ha		**$307,500**
Vegetation Clearance	50.00	ha	3,000.00	$150,000
Construct Drainage Diversion channels	2,100	m	75.00	$157,500
Site Restoration				**$1,333,750**
Site Regrading	59.00	ha	10,000.00	$590,000
Construct Internal Drainage Channels	750	m	125.00	$93,750
Erosion Control Measures	200	m	350.00	$70,000
Top Soil for Reforestation (15 cm)	54.00	ha	7,500.00	$405,000
Import soil for natural Revegetation	5.00	ha	2,500.00	$12,500
Reforestation per ACP guidelines	54.00	ha	3,000.00	$162,000
Selected Natural Revegation	5.00	ha	100.00	$500
Environmental Mitigation				**$948,125**
Construct Buffer Areas	50.00	ha	15,000.00	$750,000
Mitigation Allowance			10.00%	$198,125
Sub Total				**$2,929,375**
Contingencies			15%	$439,406
Total Estimated cost of Site Development & Restoration				**$3,368,781**
Equivalent Unit cost of Site Development ($/m3 of ca		m3	**$0.67**	
Equivalent Unit cost of Site Development ($/ha)		ha	**$57,098**	
Materials Transport & Placement (Locks Project)				
Dry Materials Transport to Site	5,900,000	m3	3.79	$22,361,000

7.10.8 Value Added Potential

Unless ARI agreed to release the site for development following the fill operations, there is no significant value added to the area from this project.

7.10.9 Summary of Findings – Site T9

Based on the environmental assessments presented in Volume 1 of this report, there is a very high level of environmental sensitivity associated with this site.

This site was classified as pristine of high sensitivity and showed the presence of several protected species, rich forested areas and potential cultural resources sites. Most of the area is forested and not recommended for disposal of excavation material. Even if filling does take place, the estimated capacity of the site is less than 6.0 million m3 and all material from the locks project would need to be trucked along the Borinquen Highway and through the Horoko Golf Club area.

Given the environmental, technical, transport and cost constraints of Site T9, it is recommended that this site should be excluded from consideration as a materials disposal site.

7.11 Site T10 – El Arado

7.11.1 Materials Holding Capacity

As seen in Figure 7-29, El Arado is the largest single terrestrial site reviewed in this report, with an estimated area of 1048.3 ha. If the forested sections are avoided, the total area would reduce to 875.6 hectares. However this would involve filling over all of the pasture and farmed land within the general site boundaries. Due to the rolling hills and the size of this site, a uniform depth of cover is probably the most appropriate fill option. With a uniform fill depth of 10 m, Site T10 would have an available capacity of 87.6 million m3. Assuming an average fill depth of 20 m would indicate a need to provide approximately 440 hectares to accommodate the expected volume of 87.6 million m3 of dry material to be excavated from the Locks project.

Filling to avoid the agricultural areas is not considered an option, since they are generally contiguous and appear to cover approximately 75% of the site. This then implies that it will be necessary to purchase at least 60 to 70 % of the property in private ownership if Site T10 is to be a practical option for material from the Locks excavation, and to provide the necessary access roads and drainage channels around the fill areas.

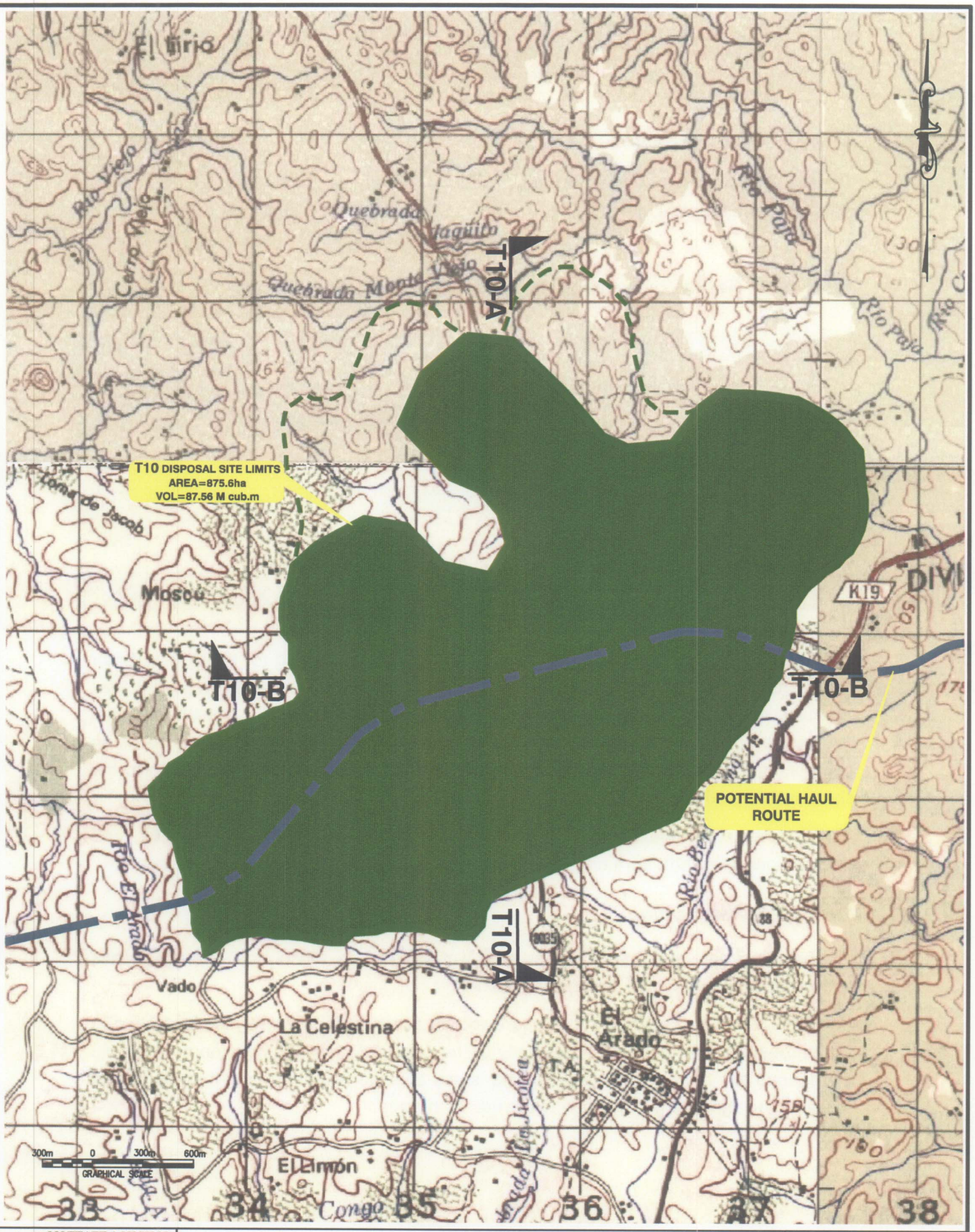

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Figure 7-29
Recommended Configuration for Site T10

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7.11.2 Drainage Analysis

The results from the modified drainage model run are shown below in Table 7-25. The watershed area for this site is shown in Figure 6-44 of Volume 1 of this report.

Table 7-25: Results of Drainage Analysis for Reconfigured Site T10

Site	Watershed Area (hectares.)	SCS Curve Number	Precip (cm)	Calc'd Qp (m^3/s)	Channel Area (m^2)	Channel Bottom Width (m)	Channel Top Width (m)
T10 – B1	267	77	23.95	46.6	26	2.2	20.5
T10 – B2	236	77	23.95	35.2	22	1.9	19.3
T10 – B3	145	77	23.95	28.5	12	1.2	13.9
T10 – B4	376	77	23.95	53.1	25	3.1	20.4

The peak flows and required channel areas and widths calculated for the 100-yr, 24-hr event are substantial. Site T10 is sitting on top of a hydrologic ridge, indicating that diversion of offsite flows away from the individual sub-basins is not a possibility. Given the required sizes of the channels, the creation of a diversion channel or channels along site boundaries or internal sub-basin boundaries is the recommended approach to the short and long term drainage of the area.

As for other sites, the topography will vary considerably during the fill period, and detailed long and short term drainage plans will be required as the work progresses.

7.11.3 Site Preparation

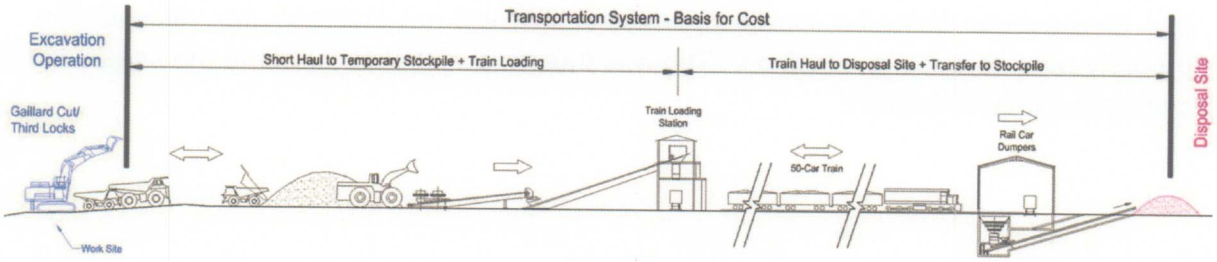
Minimal site clearance of the modified area will be required, since most of the area has already been cleared of all substantial growth.

However, it will be necessary to prepare a land title search, arrange compensation to local property owners and relocate many of the smaller farms and developments within the general site area. This is likely to take some considerable time, and there is almost certain to be significant resistance to the use of this site.

7.11.4 Transportation Analysis

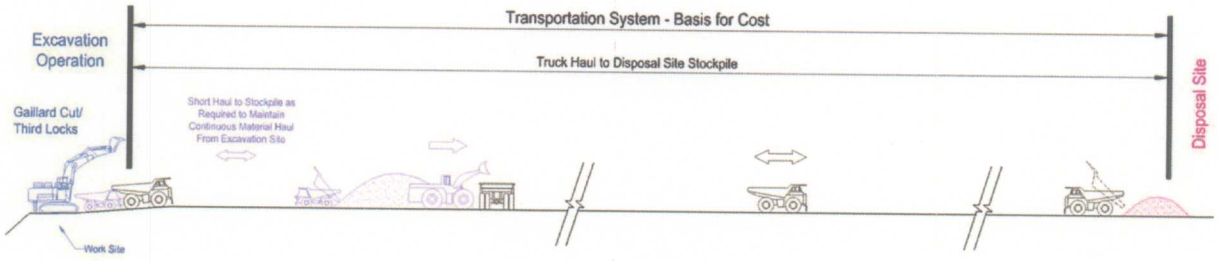
This site is approximately 20.4 km from the new Third locks excavation site. Based on this distance, truck and rail haul routes were tested in order to ascertain the preferred transportation option. According to the analysis of alternative transportation systems presented in Appendix C, a dedicated rail system appears to be the most economical solution for the movement of 90 million m3 of material from the Locks Excavation to site T10.

Figure 7-30: Recommended Materials Transportation Systems for Site T10



System D
Typical Train Haul Operation (Dry Excavation Source)

7.11.5 Haul Costs



System E
Typical Truck Haul Operation (Dry Excavation Source)

Based on an average round trip haul distance of 41 km, the estimated costs for materials transport to Site T10 are $5.42 per m3 or $8.96 for train or truck haul respectively.

7.11.6 Site Restoration

On completion of the filling operations, it is expected that approximately 10% of the site would be reforested, with overburden or local top material placed over the remainder in anticipation of natural re-vegetation growth under a monitored program to eliminate invasive species.

7.11.7 Cost Estimate

Table 7-26 presents the estimated costs for site T10, based on an assumed maximum fill capacity of 90.155 million m3. As can be seen from the table, the site development costs are high, mainly due to a conservative allowance of $25,000 per hectare for purchase of approximately 60% of the total area required for filling. Additional owner compensation and potential mitigation measures are also significant potential costs before filling can take place at this site. These requirements translate to a development cost of $$64,280 per hectare or $0.54 per m3 assuming the site is filled to the maximum volume of approximately 90 million m3.

7.11.8 Value Added Potential

Unlike the other terrestrial sites, T10 is in private ownership and the land must be purchased if it is to be converted to a fill disposal site. While the site would be restored and re-vegetated following the fill operations, this will not increase the value of the property over its existing condition. There is therefore no value added to the site by its conversion to a fill location.

Table 7-26: Summary of Estimated Costs - Site T10

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$30,249,250**
Land Purchase	875.57	ha	25000	$21,889,250
Compensation to displaced land occupiers	500.00	ha	15000	$7,500,000
Archaeological Survey	1	sum	60,000.00	$60,000
Mobilization	1	sum	500,000.00	$500,000
Construct Internal Access Roads	6,000	m	50.00	$300,000
Site Clearance & Preparation		ha		**$1,187,785**
Vegetation Clearance	875.57	ha	500.00	$437,785
Construct Drainage Diversion channels	10,000	m	75.00	$750,000
Site Restoration				**$12,277,182**
Site Regrading	875.57	ha	10,000.00	$8,755,700
Construct Internal Drainage Channels	4,000	m	125.00	$500,000
Erosion Control Measures	1,000	m	350.00	$350,000
Top Soil for Reforestation (15 cm)	50.00	ha	7,500.00	$375,000
Import soil for natural Revegetation	825.57	ha	2,500.00	$2,063,925
Reforestation per ACP guidelines	50.00	ha	3,000.00	$150,000
Selected Natural Revegation	825.57	ha	100.00	$82,557
Environmental Mitigation				**$7,450,716**
Construct Buffer Areas	50.00	ha	15,000.00	$750,000
Mitigation Allowance			0.50%	$6,700,716
Sub Total				**$51,164,933**
Contingencies			10%	$5,116,493
Total Estimated Cost of Site Development & Restoration				**$56,281,426**
Equivalent Unit cost of Site Development ($/m3 of capacity)			**$0.54**	
Equivalent Unit cost of Site Development ($/ha)			**$64,280**	
Materials Placement				
Dry Materials Transport to Site by train	90,155,000	m3	5.42	$488,640,100
Dry Materials Transport to Site by truck	90,155,000	m3	8.96	$807,788,800

7.11.9 Summary of Findings – Site T10

T10 does offer a large area for fill disposal and is not complicated by the UXO issues as are sites T3, T5 and T6. The environmental impacts of conversion of the area for receipt of fill materials are also minimal, since over 90 percent of the area has already be cleared of the original forests. However, it is in private ownership, contains a large number of farms and would be extremely difficult to purchase. There could also be considerable public opposition to the project, based on the loss of livelihood to a large percentage of the residents of the site and neighboring communities.

As can be seen from the cost estimates, the transportation costs are also higher than all of the other terrestrial sites. In addition, the equivalent per hectare cost of UXO clearance and materials transportation to Site T6 is close to the costs of development of site T10, and the resolution of the UXO issue has significant potential benefits for the nation and for ACP.

Finally, the need to acquire the privately owned parcels within the proposed fill area could require government intervention, condemnation procedures and other measures, all of which would take a considerable time and cost effort to accomplish.

Given the weight of the negative socio economic and cost implications generated by the use of Site T10, it is recommended that this site should only be considered for the material from the Third Locks project in the unlikely event that all other terrestrial and marine alternatives have been examined in detail and rejected.

7.12 Site A1 – Trinidad Dam Project

7.12.1 Project Assumptions

The potential construction of a new Dam in the Gatun watershed is under consideration by ACP at this time to increase the capacity of the lake and watershed. Materials from the Gaillard Cut Deepening and Widening project, plus some or all of the material from the Locks Excavation could effectively be used for the construction of the rock dam, thereby reducing project costs and eliminating possible controversy over the filling of certain terrestrial and marine sites presented in this report. At this time, the Trinidad Dam project evaluation is at a preliminary level, and the requirement for this report is to evaluate the potential methods and costs of moving material from the work sites to the dam location.

7.12.2 Materials Transport Options

For the cost evaluation a barge haul and an overland route were selected for comparison. For the overland routes, costs were computed for both train and truck haul.

Interestingly, the most economical overland haul route for the dam project would appear to pass through the El Arado site (T10), and if adopted, would allow both sites to be used in tandem with potential economies in haul costs.

The relevant corridors for both transport options are indicated in Figure 7-31.

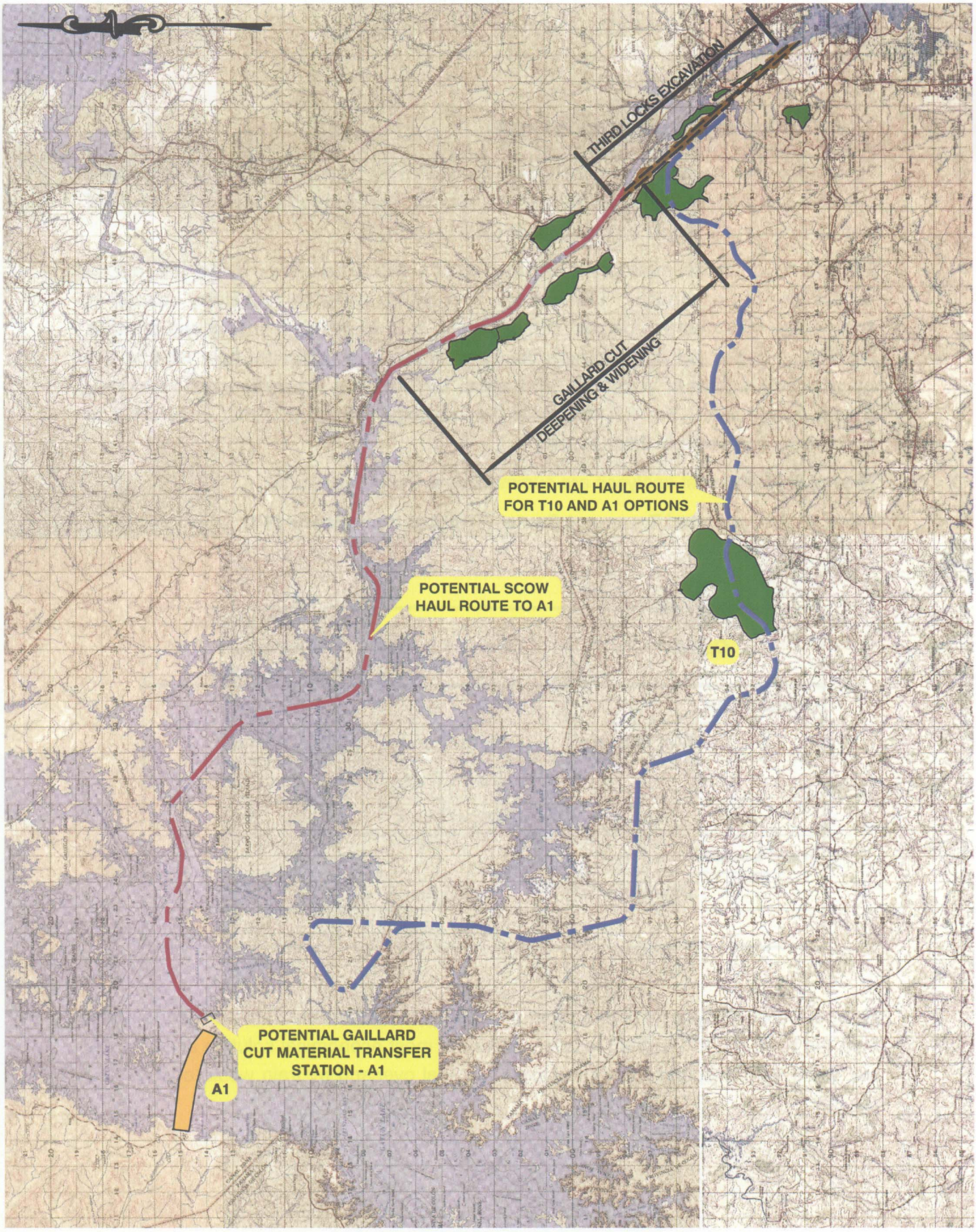


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Figure 7-31
Potential Haul Routes for Trinidad Dam Option (Site A1)

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7.12.3 Materials Transportation Costs

As noted above, transportation costs were computed for material from both the Gaillard Cut work and also for the Locks Excavation material. For all calculations it was assumed that 33.5 million m3 would be required for the Dam project.

Costs for rail transport include the construction of a dedicated rail line to the site, but do not include land acquisition. Construction of receiving areas for temporary storage of material are considered to be part of the working area for the dam project and are also excluded. Truck haul costs include the construction of a dedicated haul road to the specifications shown in Volume 1, and again, exclude land acquisition and temporary storage area costs. For full details of the cost estimates, the reader is referred to Appendix C in Volume 3 of this report.

The results of the cost analyses are summarized in Table 7-27 below.

Table 7-27: Estimated Transport Costs - Trinidad Dam Option (A1)

Option	*Transport System*	*Estimated Transport Cost ($/m3)*
Gaillard Cut		
Wet Material	Barge Haul	4.84
	Barge/Train	13.76
	Barge/Truck	32.46
Third Locks		
Dry Material	Train Haul	12.72
	Truck Haul	26.04

From the cost analysis, it is seen that movement of the Gaillard Cut dredged material from the work site to the Dam location offers the most economical solution at $4.84 per m3, while the transport of the Third locks material overland by train would cost $12.72 per m3.

8 TECHNICAL EVALUATION OF MARINE SITES

As a result of the earlier reports and the findings of the ACP workshops, six marine disposal sites have been identified, as shown in Figure 8-1. Sites M4 and M5 are located west of the Canal entrance, and the remainder are to the east of the Amador Causeway.

The source of material for the marine sites will be the Locks excavation or the Pacific Entrance Channel dredging project. Maximum volume for disposal from both sites combined is therefore expected to be approximately 104 million m3, including an allowance of 30% for bulking of material.

At the request of ACP, the evaluation also includes an assessment of the transportation costs and environmental implications of open water disposal, designated in this report as site M6.

Due to the highly different nature of the marine projects and the entities likely to be involved with the development and use of each site, the level and type of analysis for each site differs considerably. As previously indicated in Volume 1 of this report, the specific work tasks associated with the marine sites are as follows:

- **Site M1 – Panama Bay Fill**
  - Environmental Characterization
  - Preliminary Capacity Assessment
  - Computation of Materials Transport Costs
- **Site M2 – Chorrillo Bay Fill**
  - As for Site M1
- **Site M3 – Amador Causeway Expansion (East)**
  - As for Sites M1 & M2
- **Site M4 – Farfan/Palo Seco Peninsula**
  - Environmental Characterization
  - Environmental Assessment
  - Capacity Assessment
  - Preliminary Concept Evaluation
  - Computation of Materials Transport Costs
  - Land Use assessment
  - Value Added overview
  - Cost Estimate
  - Site Ranking

- **Site M5 – Artificial Island**
    - Environmental Characterization
    - Environmental Assessment
    - Capacity Assessment
    - Preliminary Concept Evaluation
    - Computation of Materials Transport Costs
    - Land Use assessment
    - Value Added overview
    - Cost Estimate
    - Site Ranking

- **Site M6 – Open Water Disposal**
    - Preliminary Concepts
    - Environmental Characterization
    - Computation of Transportation Costs

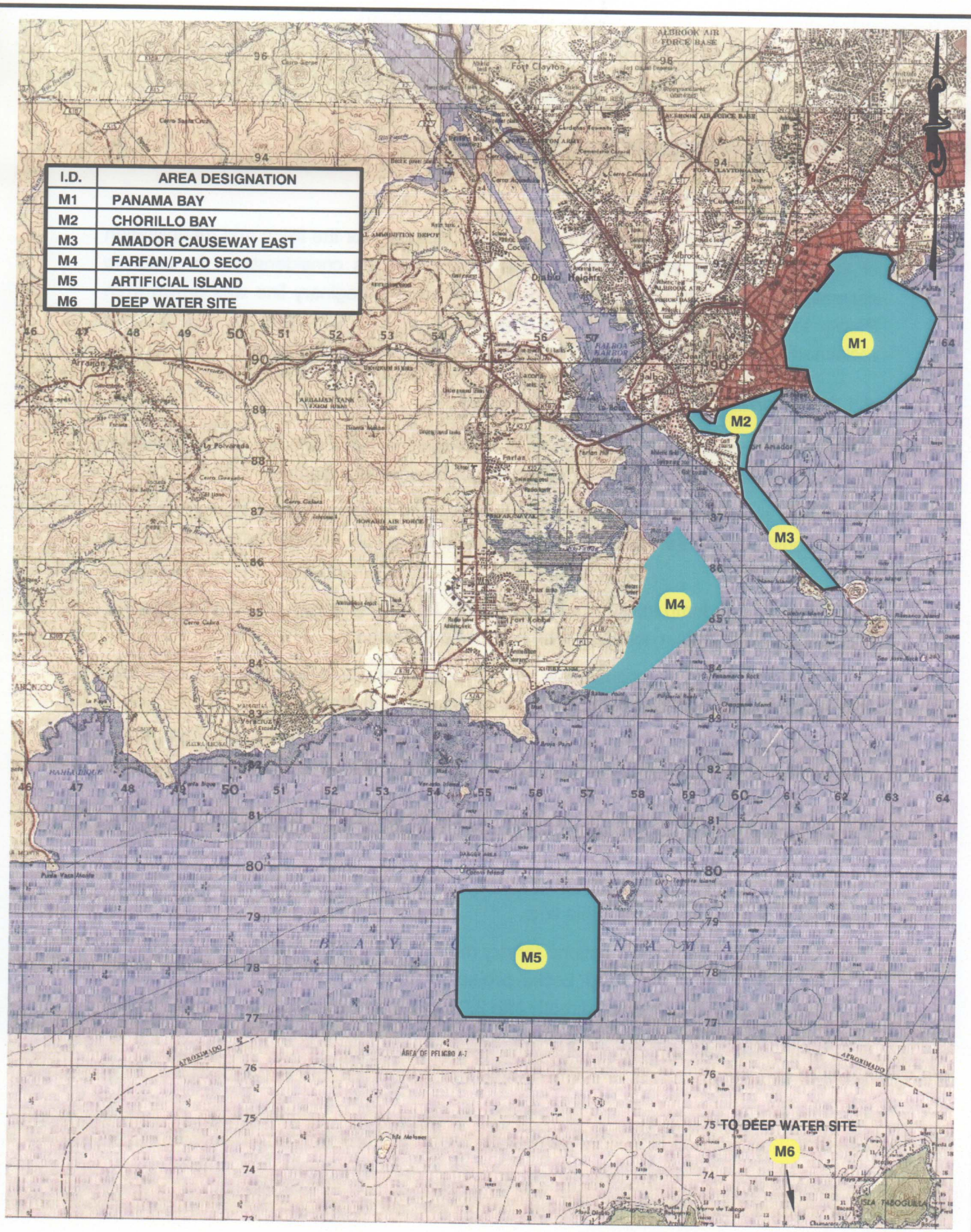

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Figure 8-1
Location of Potential Marine Sites

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8.1 Site M1 - Panama Bay Fill

8.1.1 Site Capacity

As noted above, there are a number of potential concepts for the filling and rehabilitation of the Bay, and the volume of materials required varies considerably. In order to estimate the maximum volume likely to be required, an imaginary line was drawn from Paitilla to Chorrillo Bay as shown in Figure 8-2, which generated some 520 ha of reclaimed land and an estimated fill volume of 61.7 million m3 of material.

8.1.2 Materials Transportation Analyses

There are few options for the movement of materials from the Locks site to the Bay area. Land based transportation can be discounted for a number of reasons:

In order to provide an economical transport system and meet project schedules, the trucks would be off-road vehicles of at least 100 m3 capacity that cannot mix with normal traffic.

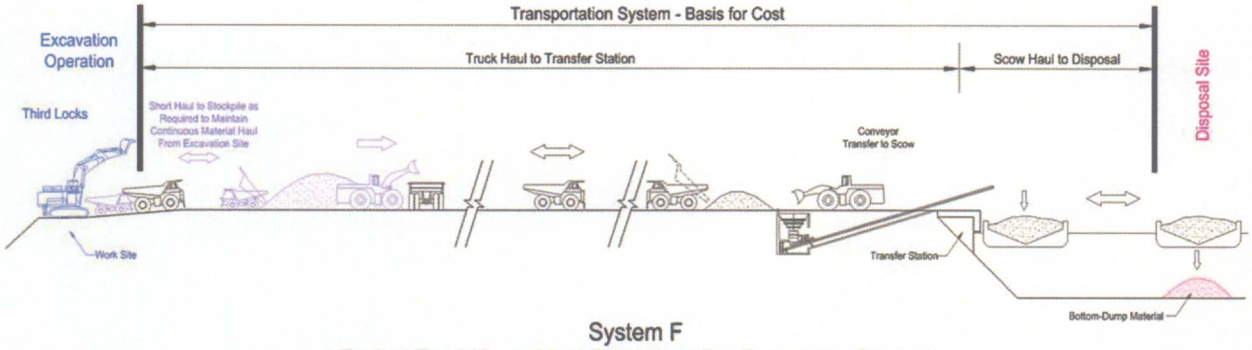
A constant flow of dump trucks would be needed, 24 hours per day, 365 days per year in order to meet the project schedule for the Locks construction.

There are no existing or potential low cost corridors that would enable a dedicated haul road or rail line to link the excavation site with the dumping area.

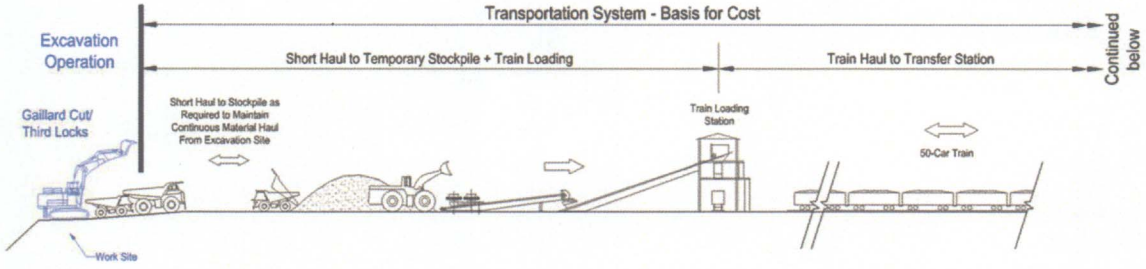
It is therefore considered that the optimum haul system for the M1 site would involve barges with a loading station close to the excavation work face. Alternatively, in the event that multiple sites were adopted at sites M4 or M5, a transfer station could be constructed at the fill locations, where material could be loaded on barges and then moved to the Panama Bay dump areas. The use of any of these options will necessitate that the barge and tug strings cross the Canal at some point, but this is not considered to be a major operational issue at this time.

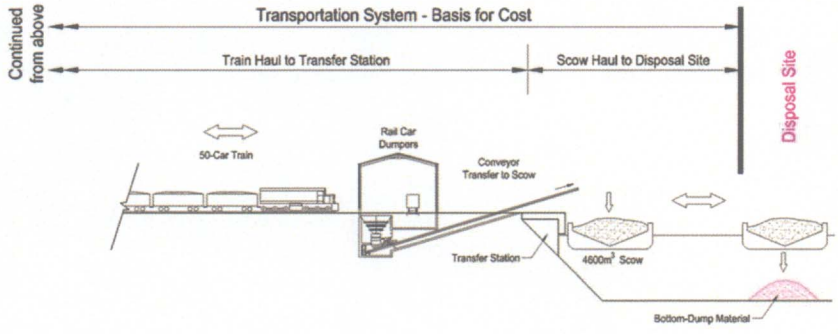
The two alternative transport options for dry materials are illustrated in Figure 8-3. Wet materials from either the Third Locks project or from the Pacific Entrance channel dredging work would be loaded directly into 3,000 cubic yard capacity barges at the work site and moved to the deposition area.

Figure 8-3: Transportation Options for Dry materials movements to Site M1 (Panama Bay Fill)



System F
Typical Truck/Scow Haul Operation (Dry Excavation Source)





System G
Typical Train/Scow Haul Operation (Dry Excavation Source)

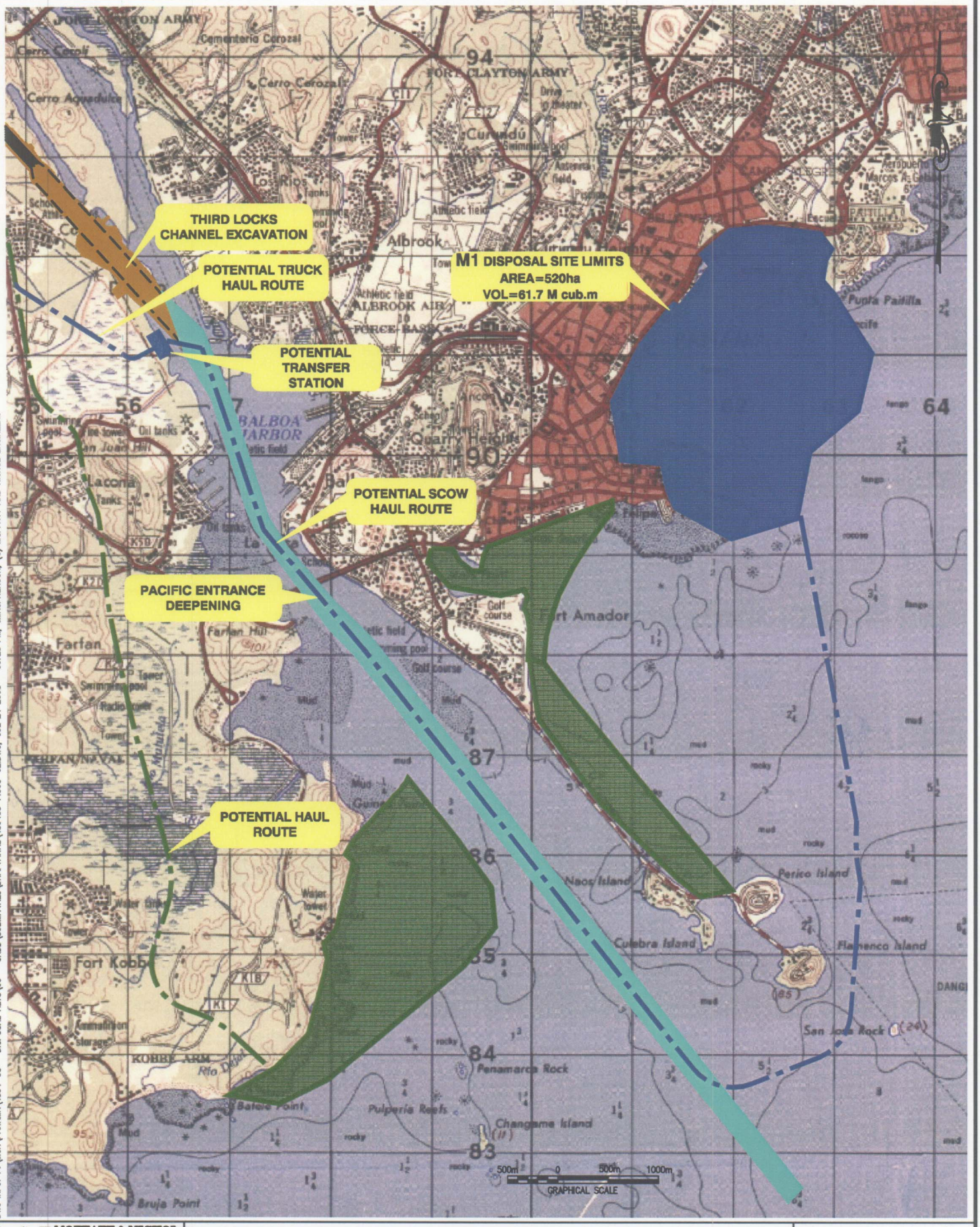


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Figure 8-2
Recommended Configuration of Site M1

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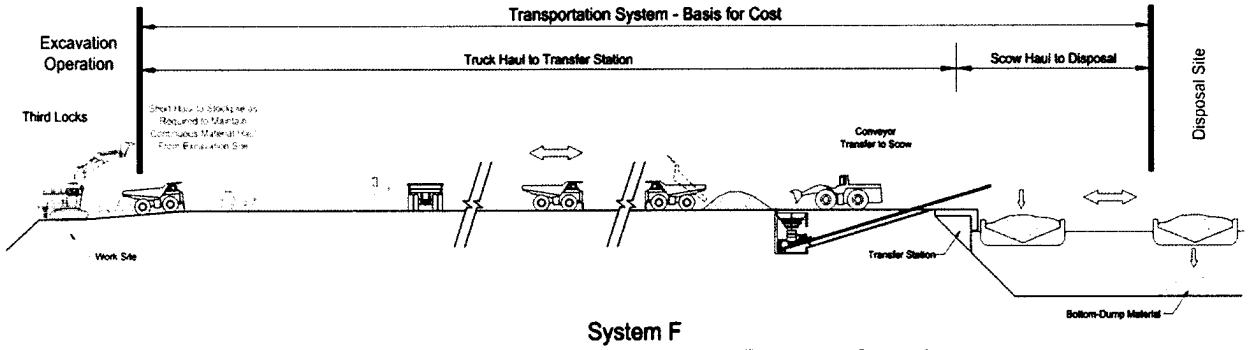
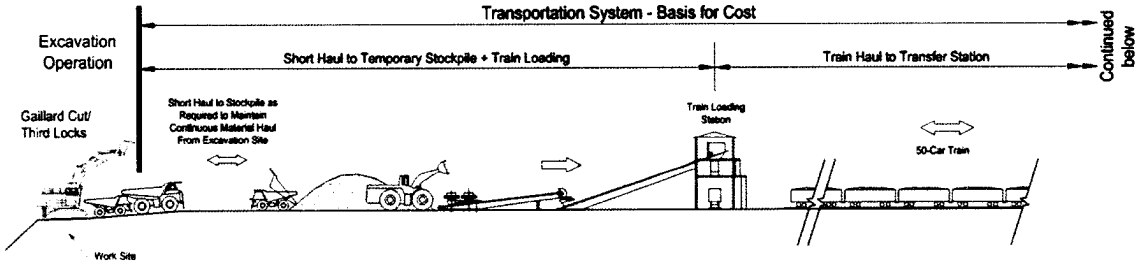
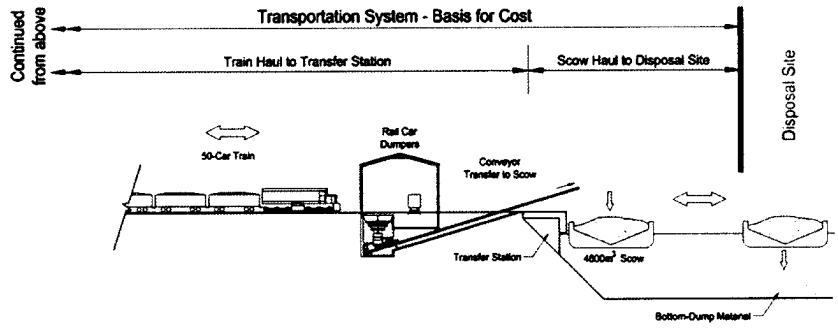
Figure 8-3: Transportation Options for Dry materials movements to Site M1 (Panama Bay Fill)



System F
Typical Truck/Scow Haul Operation (Dry Excavation Source)





System G
Typical Train/Scow Haul Operation (Dry Excavation Source)

8.1.3 Materials Transportation Costs

Transportation costs were computed for the three scenarios indicated above, based on the maximum holding capacity of 61.70 million m3. The resulting costs are:

Barge haul – wet material from Pacific Channel Dredging..... $2.67 per m3

Dump truck to barge load station, barge to Dump Site (System F) ..... $7.33 per m3

Train to barge load station, barge to Dump Site (System G) ..... $6.46 per m3

8.1.4 Summary of Findings – Site M1

As can be seen from Figure 8-2, an ambitious filling program for Panama Bay would accommodate some 61.7 million m3 of material and generate a development area of approximately 520 ha. However, this is less than the total volume of material to be removed from the Locks, mainly due to the relatively shallow water in the Bay, which in turn indicates that another or other sites would be needed to fulfill the project requirements.

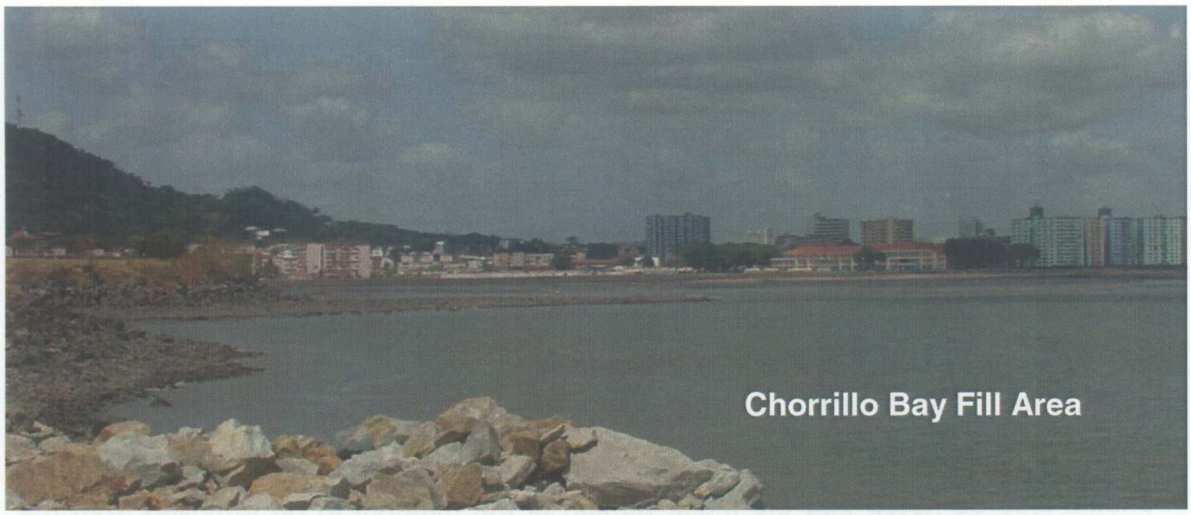
It should also be noted that the major portion of the material to be removed from the Locks excavation will be removed in the dry. This then implies a combination of short haul truck movement to a barge transfer station, before removal to the project site. At the site, the material would be dumped and then transferred to fill locations by dump truck. This multiple handling of dry material results in an estimated cost in excess of $6.00 for the fill, which is high when compared to the cost of traditional hydraulic fill using barges and pumped sand.

Assuming that the P1 alignment is accepted for the new Locks construction, the capacity limitations of the site imply that site M1 can only be considered as part of a multiple site scenario, since it would not offer sufficient capacity to meet the needs of the project. However the selection of the P2 alignment will generate some 35 to 40 million m3 of material, which could readily be accommodated at site M1.

Finally, it is clear that any proposals to fill or restore Panama Bay will be extremely controversial and expensive. Based on recent controversies related to previous attempts to construct small islands in the Punta Paitilla area, It seems unlikely that all of the environmental and community reaction issues related to a major fill project in Panama Bay will be resolved in time to meet the schedule for the Third Locks construction.

8.2 Site M2 - Chorrillo Bay Reclamation

This alternative involves the filling of Chorrillo Bay, which would form part of the tourism development and enhancement plan that would eventually link the Amador Causeway development to the revitalization project for the Casco Viejo sector of the City of Panama. It is hoped that the project shown in Figure 8-4 would also resolve some of the contamination issues within the Chorrillo Bay area.



As for site M1, the filling of Chorrillo Bay would be promoted by the Panamanian Ministry of Tourism (IPAT) or other government or local agency. As such, all concepts, engineering, environmental and project approvals would be the responsibility of others and the potential site capacity presented in this report could be subject to significant change.

8.2.1 Site Capacity

The existing water depth in the Chorrillo Bay area varies from 0.0 to 1.0 m below Mean Low Water Spring tides (MLWS), with many areas drying at low tide, as can be seen in the photograph above. Based on the assumption that fill would be placed behind a gentle curve extended from the Casco Viejo area to the entrance to Amador, the reclamation of Chorrillo Bay would generate some 94 ha of area and hold approximately 6.6 million m3 of material.

Clearly this indicates that site M2 can only be considered as one of a group of multi-sites, regardless of the final alignment of the New Locks project.

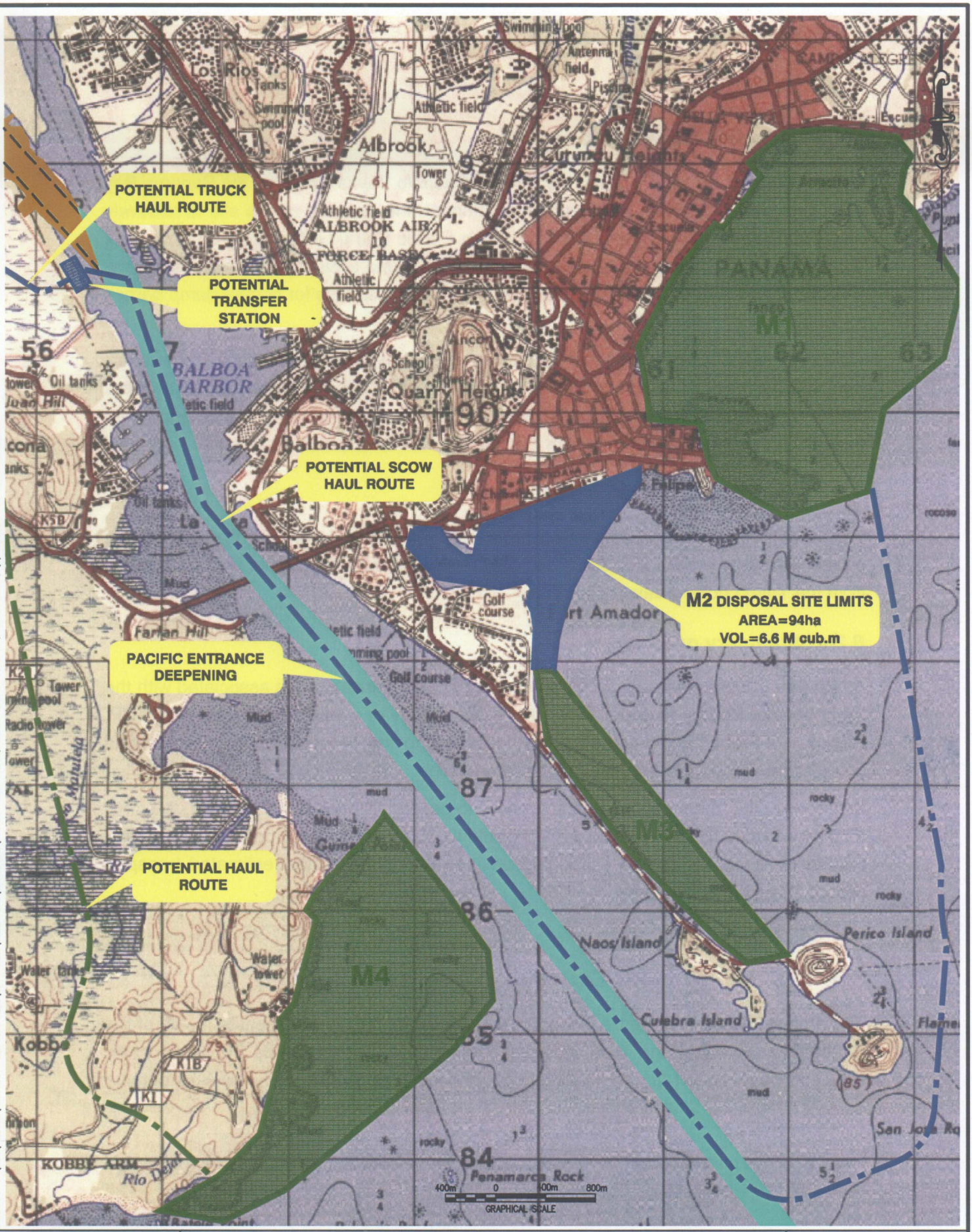


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Figure 8-4
General Location Plan - Site M2

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8.2.2 Materials Transportation System

Although a more recent proposal, the filling of Chorrillo Bay is similar to the Panama Bay fill project with many issues in common. Although the capacity of this site is relatively low, it is expected that material from either the Pacific Entrance Dredging project or the Third locks excavation could be used for this option. One area of concern would be the shallow water in the proposed fill area, that might restrict access for bottom dump barges at certain states of the tides.

As for site M1, it is suggested that barge haul is the only valid option to move materials from either a transfer station or directly from the work face to the dump site, since there are no off-road corridors that could accommodate high capacity dump trucks required to maintain a high level of production for the amount of fill anticipated for this site.

8.2.3 Materials Transport Costs

Estimated materials transportation costs for dredged material from the Pacific Channel entrance dredge project are $2.01 per m3, compared with $7.98[5] per m3 for material from the Third Locks excavation project.

8.2.4 Summary of Findings

As for Site M1, there are a number of potentially controversial issues associated with the filling of Chorrillo Bay that are neither the responsibility or within the jurisdiction of ACP. However, there is considerable interest in extending the recreation and tourist related areas in the vicinity, as discussed in the next section.

In the event that there was a request for ACP to provide fill material for this site, the most economic option for the project sponsor would be to accept suitable dredged spoils from the Pacific Entrance Channel dredging project, at a relatively low estimated transport cost of $2.67 per cubic meter.

8.3 Site M3 - Amador Causeway Expansion (East)

The project indicated in Figure 8-5 would involve the widening of the eastern side of the Amador causeway in the area indicated below, in order to provide improved traffic circulation and added land for recreational and park developments. This is a popular

[5] Assumes that material would be brought by truck to a loading station and then by 3,000 cubic yard scow to the work site.

alternative and would greatly improve the circulation and attractiveness of the Amador Causeway which has become extremely popular following the recent investments of the government and private sector in the area.

While the project would require sponsorship and approvals from ARI other agencies, it would not require significant site preparation work before the placement of materials could be initiated. A number of more modest reclamation efforts have already been initiated along the Causeway and work is now progressing on fill at the connection of the causeway to the mainland close to the recently completed conference and hotel development.

As such, it is entirely possible, that with the proper approvals and support of IPAT and others, that material could be placed to the east of the Causeway, in advance of any final development options for the additional land created by the fill material.

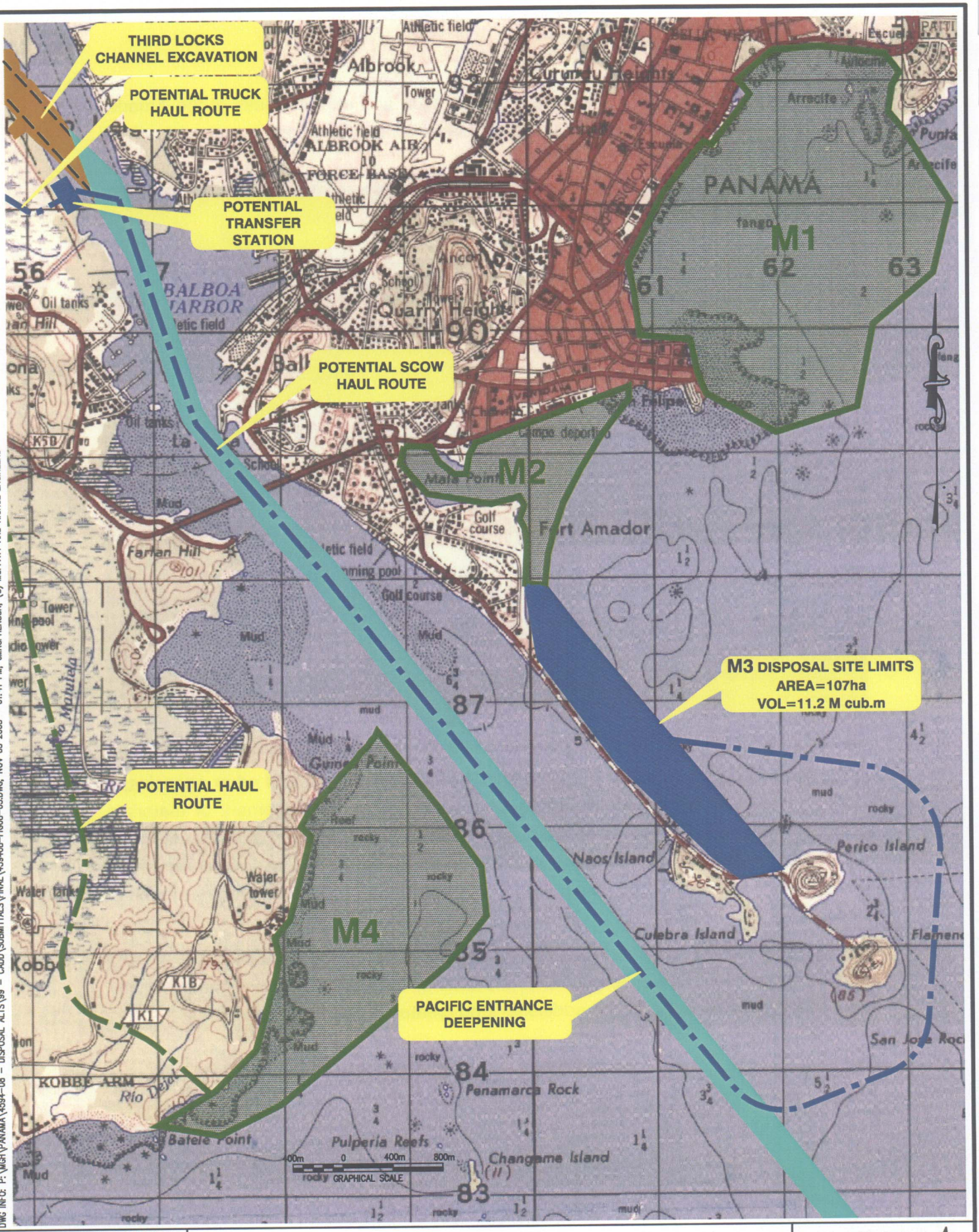

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Figure 8-5
General Location Plan - Site M3

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8.3.1 Development Concepts

As noted earlier, any development concepts for this project would be generated by ARI or the appropriate agency or private entity responsible for the master planning of the Causeway area. However, based on the consultant's knowledge of the area, it would appear that the creation of a relatively wide causeway would permit the construction of a traffic circulation system recreational areas and separation of vehicular traffic from pedestrians and other recreational users of this popular area. At the same time, the construction of a wide platform also offers the opportunity to incorporate recreational parks, concert arenas or other public access facilities that would enhance the general attractiveness of the area.

Based on this very general approach, it is considered that increase in the width of the Causeway of somewhere between 50 and 500 m would offer an exciting opportunity for a well designed and attractive park area with good separation between vehicular and pedestrian traffic.

For the purposes of this initial analysis, all calculations have been based on a simplistic fill configuration of no more than 500 m, although it is recognized that no formal approvals or support has been given to the suggested fill extents and configuration.

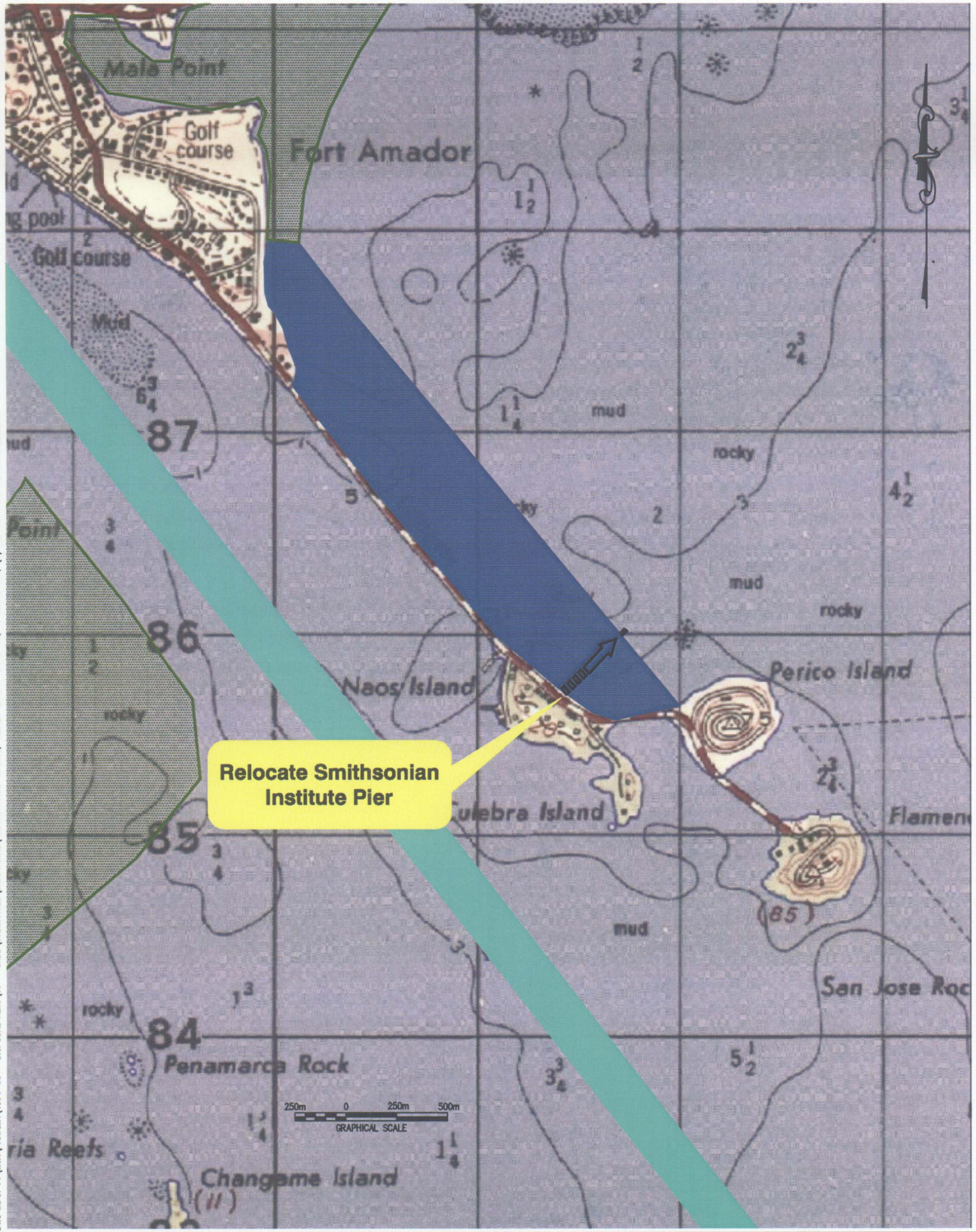

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Figure 8-6
General Concept for Expansion of Amador Causeway

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8.3.2 Materials Holding Capacity

The existing water depth east of the Amador Causeway varies from 1.0 to 2.0 m below Mean Low Water Spring tides (MLWS). In order to provide an estimate of the potential fill quantities required to meet a range of expansion options, Table 8-1 shows the estimated volume of material that would be required to meet expansion widths of 50 to 500 m.

Table 8-1: Estimated Fill quantities for Amador Causeway Expansion Options

Causeway Expansion Width (m)	Estimated Materials Requirement (Million m3)
50	0.67
100	1.61
200	3.80
300	6.24
400	8.68
500	11.23

It would appear that the expansion project is unlikely to hold all of the material from the Entrance Channel Dredging project. However, preliminary estimates[6] of the dredged materials characteristics indicate that a significant percentage[7] of the material could be soft silts, which would be unsuitable for filling at the Causeway, unless retaining dikes were constructed to hold the material and prevent high turbidity or sedimentation. It is also possible that this project would be combined with the Chorrillo Bay fill to present an integrated development plan for the combined areas.

Under either of these scenarios, soft material could be deposited at existing ACP disposal site and the excavated hard material used for fill at the Causeway, with the final volumes to be determined following more detailed examination of the characteristics and volumes of material in the proposed dredging area.

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[6] Preliminary Seismic Profiles of the Pacific Entrance, Coastal and Inland Marine Services Inc. for ACP, November 1999

[7] Tentative estimates indicate that 20 to 50% of the dredge material may be soft silts or sands. However, there is insufficient site information at this time to confirm or refine this figure.

In the event that the Causeway was increased in width by some 500 m, as shown in Figure 8-6, the site would accommodate approximately 11.23 million m3 and provide 107 ha of new land for development.

The estimated fill volume is close to the 14.30 million m3 of (bulked) material to be removed from the Pacific Entrance channel dredging project, which is also close to the suggested disposal site. Since a large percentage of this material will also be rock, it would make excellent fill for the Causeway extension. Should the configuration of the fill area be modified slightly, or the Chorrillo Bay project included in the overall concept, the full amount of the material from the Pacific Entrance dredging project can be easily accommodated.

8.3.3 Transportation Alternatives

As for sites M1 and M2, it is considered that barge haul is the only realistic transportation method for site M3. In the event that the site is to receive material from the Locks Excavation, transportation would be via transfer stations either at the excavation site or combined with one of the west side marine disposal sites (M4 or M5). However, it is clear that the simplest option is to designate the site as the preferred option for dredged material from the Pacific Entrance channel dredging, which would not involve any multiple handling of the material.

During the preparation of this report, ACP officials noted that work on the Pacific Entrance Dredging project could start as early as 2003 with the dredging of some 3.0 million m3 of material. In this case, an early start could be made on the expansion project, assuming the necessary support of ARI and the public to the proposals.

8.3.4 Transportation Costs

As seen below, transportation costs for wet material from the Pacific Entrance dredging project are the most economic option for Site M3. However the site can also accommodate modest amounts of dredged material from the Locks excavation at relatively economic costs.

Barge haul – wet material from Third Locks Excavation (System A)..... $2.42 per m3

Barge haul – wet material from Pacific Entrance Dredging (System A) ..... $2.01 per m3

These unit rates are relatively independent of the final volume to be placed, since the material would be loaded directly to barges at the dredge site and bottom dumped at the Causeway. It should be noted that the final recovery of the bottom dumped material and filling of the site to final elevations is not included in the unit rates, since it is assumed to be the responsibility of the project sponsor.

8.3.5 Site Preparation Costs

Filling the area would necessitate the displacement and relocation of the Smithsonian pier and installations and the restaurant owners at the entrance to Naos island might require relocation of the informal boat landing ramps close to the parking areas. The responsibility for these costs may not fall on ACP, since ACP would probably provide the fill material at an attractive cost. However, in the event that ACP decided to underwrite the expenses shown in Table 8-2 the site preparation work will add another $0.11 per cubic meter to the materials transport costs. This is not considered to be a major obstacle to the use of this site.

Table 8-2: Estimated Site Preparation Costs - Site M3 (Amador Causeway East)

Description	Amount (US$)
Preliminaries and Relocation of Existing	**$1,050,000**
Mobilization	$50,000
Relocate Smithsonian Pier	$750,000
Relocate Ramp at Isla Perico Embayment	$250,000
Site Preparation	**$12,500**
Dredge Soft Materials	$12,500
Environmental Mitigation	**$258,439**
Mitigation Allowance	$258,439
Sub Total	**$1,320,939**
Contingencies	$132,094
Total Estimated Cost of Site Preparation	**$1,453,033**
Equivalent Unit cost of Site Development ($/m3 of ca	**$0.11**
Equivalent Unit cost of Site Development ($/ha)	**$13,580**

8.3.6 Value Added Potential

Clearly the expansion of the Causeway will provide significant benefits to the community, in that it will reduce traffic congestion and risk of automobile accidents and also expand the recreational opportunities for users of this popular area. It might be also possible to construct additional commercial developments in the filled area, but this would necessarily form part of a Master Plan to be prepared by ARI or other agencies responsible for the development of the area.

The expansion of recreational opportunities may not provide direct financial benefits to the project sponsors. However the use of dredged material at this site offers a significant possibility of added economic value to the community and is considered to be a highly beneficial use.

8.3.7 Summary of Findings

It is considered that the site represents an ideal site for disposal of dredged material from the Pacific Channel entrance dredging if ARI or the other agencies involved in the management and development of the Amador Causeway support the proposal. Fill can be placed over a period of time without disruption of the existing activities on the Causeway and development of the reclaimed area would follow the preparation of an updated Master Plan for the site. The cost of transport is low, at $2.01 per m3 if dredged spoils are used for the fill, and it is likely that the material will contain a high percentage of good rock for dike construction and general fill.

The suggested expansion width of 500 m is an extremely flexible number and interested parties in the project have suggested that the expansion should not exceed 100m. Given the proximity of the Chorrillo Bay project, it would appear logical that the planning for the area consider both Chorrillo Bay and Amador East expansion as a single unit, with the configuration of the fill and distribution of materials computed to serve both.

8.4 Site M4 - Farfan/Palo Seco Peninsula

The waterfront area along the Farfan shoreline is relatively shallow, and does not permit the passage of even small craft. There are also numerous rock outcrops along the shoreline. The rock is covered with a layer of soft silt which varies in thickness[8] from 0 to 2.00 m. The shoreline is mainly rocky, with extensive tree cover and vegetation to the waters edge. There are some small pocket beaches within the embayments along the Palo Seco shoreline. The water depth in front of the shoreline is relatively shallow, reaching some 2.0 m below MLWS at a distance of 2 to 3 km from the shoreline.

On the land side, the western limits of the site can be considered to be Kobbe Beach, which is being reserved for tourist related development that may involve the construction of a new resort. The existing access road from the Inter American highway to Kobbe and Veracruz passes along the shoreline area of Site M4. While this is not considered to be a major conflict, clearly the impacts of the new development on the access to the west must be taken into consideration.

8.4.1 Development Concepts

The Farfan/Palo Seco area offers an interesting combination of development options immediately west of the Canal entrance channel. There have been a number of proposals to construct a Container Port in the Farfan area, and other prospective developers have suggested the construction of a reclamation area to offer commercial, residential or tourism related development in this area.

As a relatively unlimited site, it was initially assumed that the Farfan/Palo Seco site could accommodate the full amount of materials to be removed from the Locks Excavation and Pacific Entrance Channel dredging. However, the area in front of the shoreline is extremely shallow, and the deposition of the full amount of the Locks and Pacific Channel entrance dredging materials would require the construction of a land mass covering some 920 hectares, extending south to Isla Changame and blocking the westward looking view from the Amador Causeway.

A second alternative would be to consider the site as a multi-site and limit the intrusion on the view from Amador to the Punta Bruja headland. This would create the smaller landfill extension shown in Figure 8-7 covering approximately 324 hectares.

[8] Interim results of Geophysical Surveys by ACP & Golder Associates, January 2003.

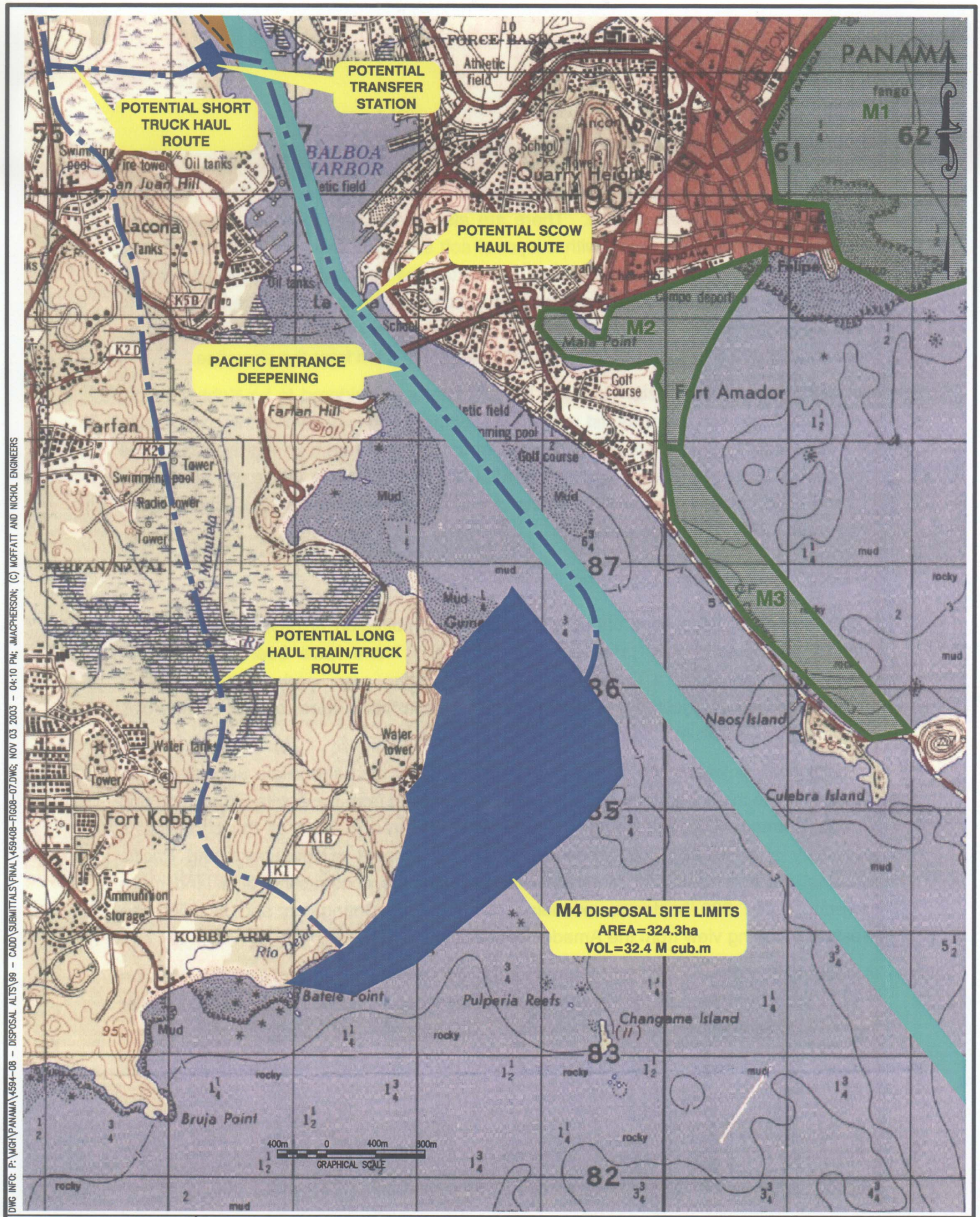

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Figure 8-7
Recommended Configuration for Site M4

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The extent of fill that can be placed at this location is also limited by the existence of the sensitive inter-tidal area at the Rodman/Bridge of the Americas shoreline, which is used by migrating birds as described in Volume 1. It is understood that there are contamination concerns at the bird migration site and the construction of a peninsular development at Farfan might offer an opportunity to build an intertidal habitat in an uncontaminated area. However, for the purposes of this evaluation, it is assumed that the existing mudflats would be left undisturbed by any filling in this area.

8.4.2 Materials Holding Capacity

The fill configuration indicated in Figure 8-7 and discussed above would have an approximate capacity of 32.40 million m3. As a result of the findings of the environmental assessments, it is recommended that minimum intrusion be inflicted on the landside areas, due to the highly sensitive nature of the dry forest areas and existing habitats.

8.4.3 Materials Transport

Earlier work [9]on the potential to construct an artificial island offshore of Venado island concluded that the most economic transportation system would be to construct a rail line from the excavation site to the reclamation area. The preferred rail alignment passed some 1,000 m west of the shoreline of site M4 and could readily be adjusted to service this location. Alternatively, materials could be moved by tuck, barge or conveyor.

8.4.4 Transportation Costs

Based on the expectation that fill at Site M4 would be limited to 32.40 million m3, costs were computed for both a truck and a rail haul for the dry material from the Locks excavation and a barge haul for the dredged material. The transportation cost model indicates that a truck haul option, will cost $6.62 per m3 compared to $7.06 per m3 for the rail haul if M4 is considered as a stand alone marine site. In the event that M4 was combined with the artificial island (M5) or any of the other marine sites by using a shared landside transportation system, the unit cost of materials transport by train would be reduced to $4.20 per m3, similar to that of site M5.

Unit costs for each transportation alternative are indicated below:

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[9] Preliminary Study of Island Development at the Pacific Entrance to the Panama Canal, Moffatt & Nichol, December 2001.

Barge haul – wet material from Pacific Entrance Dredging (System A) ..... $1.96 per m3

Dry Material from Locks excavation by train, stand alone site (System D). $7.06 per m3

Dry Material from Locks excavation by train, in conjunction with other site $4.20 per m3

Dry Material from Locks excavation by truck haul (System E) ..... $6.62 per m3

8.4.5 Land Use Concepts

Recent geophysical survey of the areas between the shoreline and Taboga Island indicated that the depth to rock on the Canal entrance side of the disposal area is at an elevation of -20.00 m below mean low water (MLLW), rising sharply to the surface on a north south orientation close to the former isolation hospital.

This would permit the dredging of a deep water navigation channel from the Canal entrance to the site in the event that it was to be used for maritime purposes, with a relatively high level of interest in its potential as a container terminal.

The land created could also be used for a variety of development options, included residential or commercial real estate, port activities, resort development, public parks, tourism, ecological reserves or a combination of uses.

It is not the purpose of this report to make any recommendations on the preferred use, and ACP would work closely with ARI and other authorities before any final decision was made.

However, for the purposes of cost comparison and value added assessment, Figure 8-8 and Figure 8-9 present two potential configurations for the fill area. It should be noted that both options avoid the sensitive intertidal habitats on the Rodman foreshore and south of the Bridge of the Americas.

In the event that total separation of the land fill was required from the landside, the development could take the form of an island, connected to the shore by short open piled trestles of some 50 to 100 m in length.

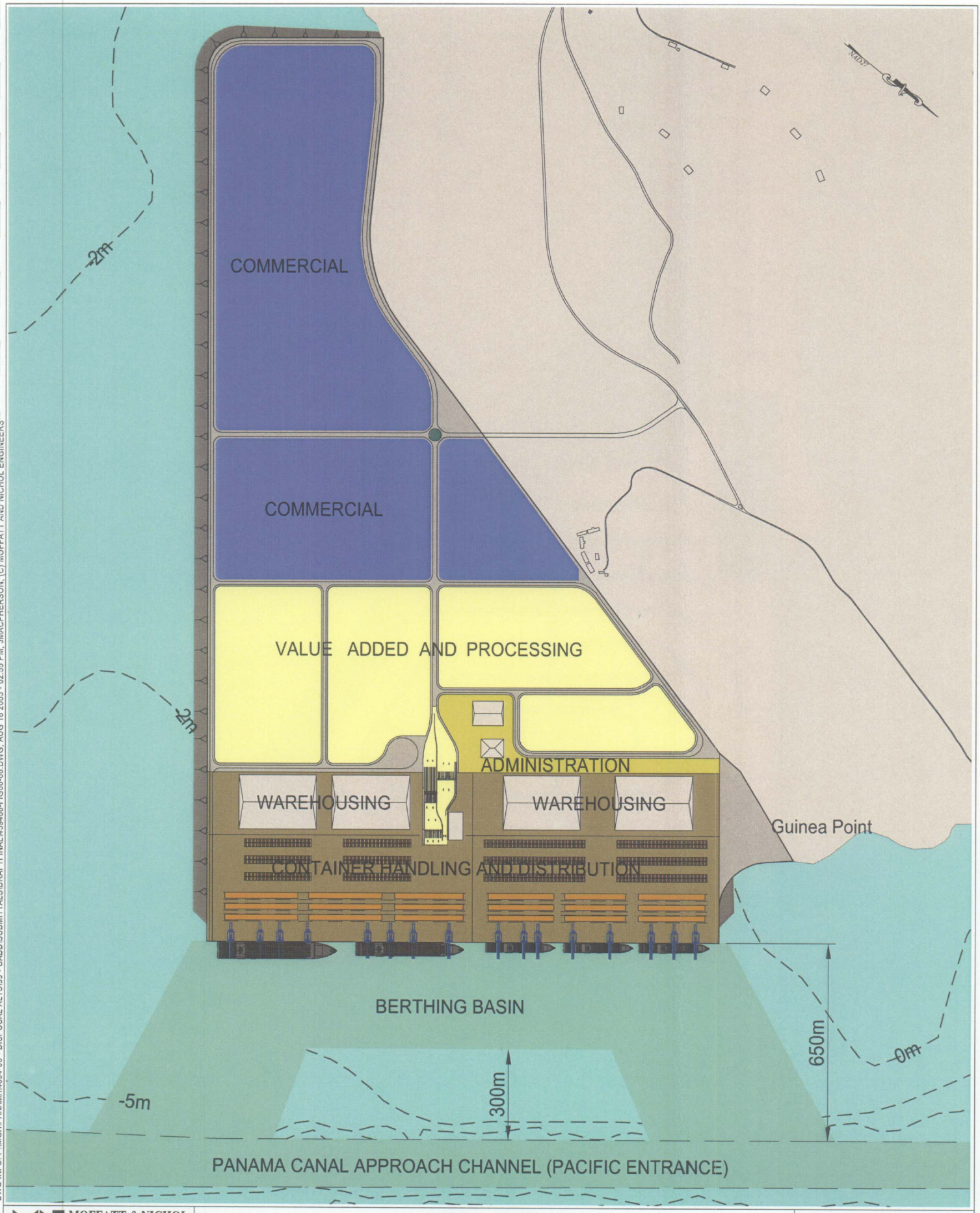

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Figure 8-8
Potential Layout of M4 as Maritime-Use Development

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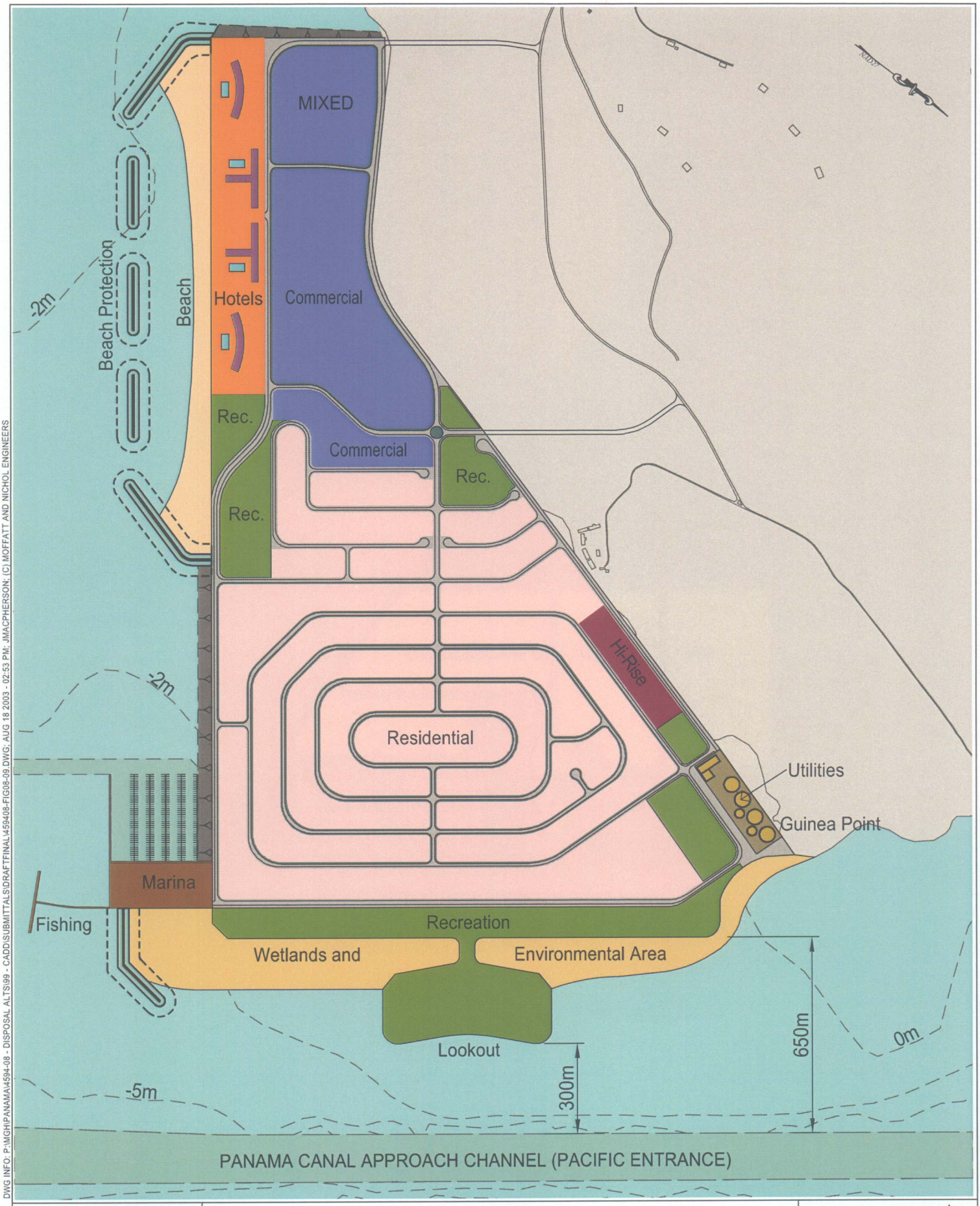

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Figure 8-9
Potential Layout of M4 as Mixed-Use Development

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8.4.6 Cost estimates

As for the other marine sites, there are few site preparation elements associated with this disposal site. Estimated costs are presented in Table 8-3 and it should be noted that the relatively low cost per hectare is also a function of the fact that no site restoration allowance is included for this site, since it is assume that the filled site would be developed for commercial or other uses, as indicated above, at the expense of a private developer or project sponsor.

Table 8-3 : Estimated Site Preparation Costs - Site M4

Description	Quantity	Unit Cost (US$)	Amount (US$)
Preliminaries			**$3,425,000**
Archaeological Survey	1	25,000.00	$25,000
Mobilization	1	150,000.00	$150,000
Relocate long term stay hospital	1	3,250,000.00	$3,250,000
Site Preparation			**$5,000,000**
Dredge Soft Materials	1,250,000	4.00	$5,000,000
Environmental Mitigation			**$1,671,848**
Mitigation Allowance		0.75%	$1,671,848
Sub Total			**$10,096,848**
Contingencies		10%	$1,009,685
Total Estimated Cost of Site Preparation			**$11,106,532**
Equivalent Unit cost of Site Development ($/m3 of capacity)			**$0.37**
Equivalent Unit cost of Site Development ($/ha)			**$37,146**
Materials Placement			
Dry Materials Transport to Site (truck haul)	32,400,000	6.62	$214,488,000
Wet Materials by scow (Pac Ent. Dredging)	14,315,000	1.49	$21,329,350

Note: Dry materials volume is estimated maximum site capacity, but less than total volume generated by Third Locks project. Wet materials volume and unit costs assume site receives wet materials from either Pacific Entrance dredging project.

8.4.7 Value Added Potential

It is considered that both of the two development concepts would generate significant added value for site M4. An estimated competitive lease rate for the permanent installations for a state of the art container terminal on a major trade route can be on the order of $200,000 per ha per year, and a 150 ha terminal could therefore be expected to

generate some $30.00 million in annual revenue if there is a high level of demand for container capacity in the area. However, this income estimate is predicated on the existence of the approach channels, berths, pavements, utilities and other permanent container terminal installations, the cost of which must be taken into account in assessing the net value added potential for the site.

Significant expansion of the Balboa container terminals is also underway at this time, which should meet capacity needs for at least the short term. However, given the long lead time for the Locks and fill projects, the market conditions could well be favorable for additional port facilities close to the Canal by the time fill project is initiated.

In the event that it was decided that the site should be designated for residential, commercial or other non – maritime related development, it is most probable that proposals would be requested from private sector developers for the purchase, lease or concession for the created waterfront lands. Estimates of potential value added by this approach vary widely, but it would seem reasonable to expect an equivalent land value of $300,000 to $1,000,000 per developable[10] hectare.

8.4.8 Summary of Findings

The environmental evaluation of this site has to take into consideration the close relationship between the terrestrial and marine components of the peninsula. The flora and biota, described in the following sections, contains both marine and terrestrial components and it is unique in its national representation. The highly diverse benthic environment, the presence of potentially reach productive waters, the rich coastal fauna and flora, and the presence of protected species, were important factors that assisted in the classification of the terrestrial area and shorelines bordering site M4 as an "exclusion zone".

This then implies that any development along the waterfront at Farfan/Palo Seco should be connected to the existing access roads via a clearly defined corridor. The surrounding areas would then be classified as protected areas in order to prevent ancillary development that might be expected to follow the exploitation of the newly gained waterfront area along the foreshore. It might also be necessary to separate the fill from the shoreline and connect to the fill area by a short causeway or jetty, according to the final environmental evaluation of the site and development project.

However, in terms of potential added value, the site offers the possibility to create a world class residential, commercial or maritime related development alongside the Canal. Public reaction to the project will be a key issue and any serious opposition to

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[10] Developable land would vary from 30 to 65% of total area, depending on type of development planned, area dedicated to public access or recreation facilities etc.

the project would probably eliminate it from serious consideration. The reaction of the existing investors in the Amador Causeway projects would also be an important factor in the evaluation of the opposition or support for the use of M4 for commercial, residential or maritime related facilities.

8.5 Site M5 - Artificial Island

This alternative involves the construction of an artificial island using part or all of the material from the Third Locks excavation and possibly from the Pacific Entrance Channel Dredging projects. Development of the created land could include port facilities, residential or commercial real estate, industrial development, resort development, public parks, tourism, ecological reserves or a combination of uses.

8.5.1 Materials Holding Capacity

According to the earlier study work, updated by the interim results of the recent geophysical survey, there are a number of alternative locations for the artificial island, as indicated in Figure 8-10, with the preferred option being very much dependent on the selected use for the newly created land area.

For the purposes of this initial environmental assessment and technical evaluation, the potential impacts and costs of all of the alternative locations are relatively similar and do not impact the general findings of this study.

It is also assumed that the maximum holding capacity of the artificial island is on the order of 100 million m3, in order to accommodate all of the material from the Locks excavation and also from the Pacific entrance channel dredging if necessary. This would yield an island of approximately 350 hectares if located in 10 m of water.[11] In general terms, the cost effectiveness of the island improves at its maximum size, due to the significant investment required to link the island to the mainland and provide the basic infrastructure for development, maritime use or other activities. However, once the basic causeway and infrastructure are in place, there are no significant size limitations to the island, and its capacity can readily exceed or be much less than the maximum amount of material to be produced by the Locks excavation projects.

[11] Below MLWS

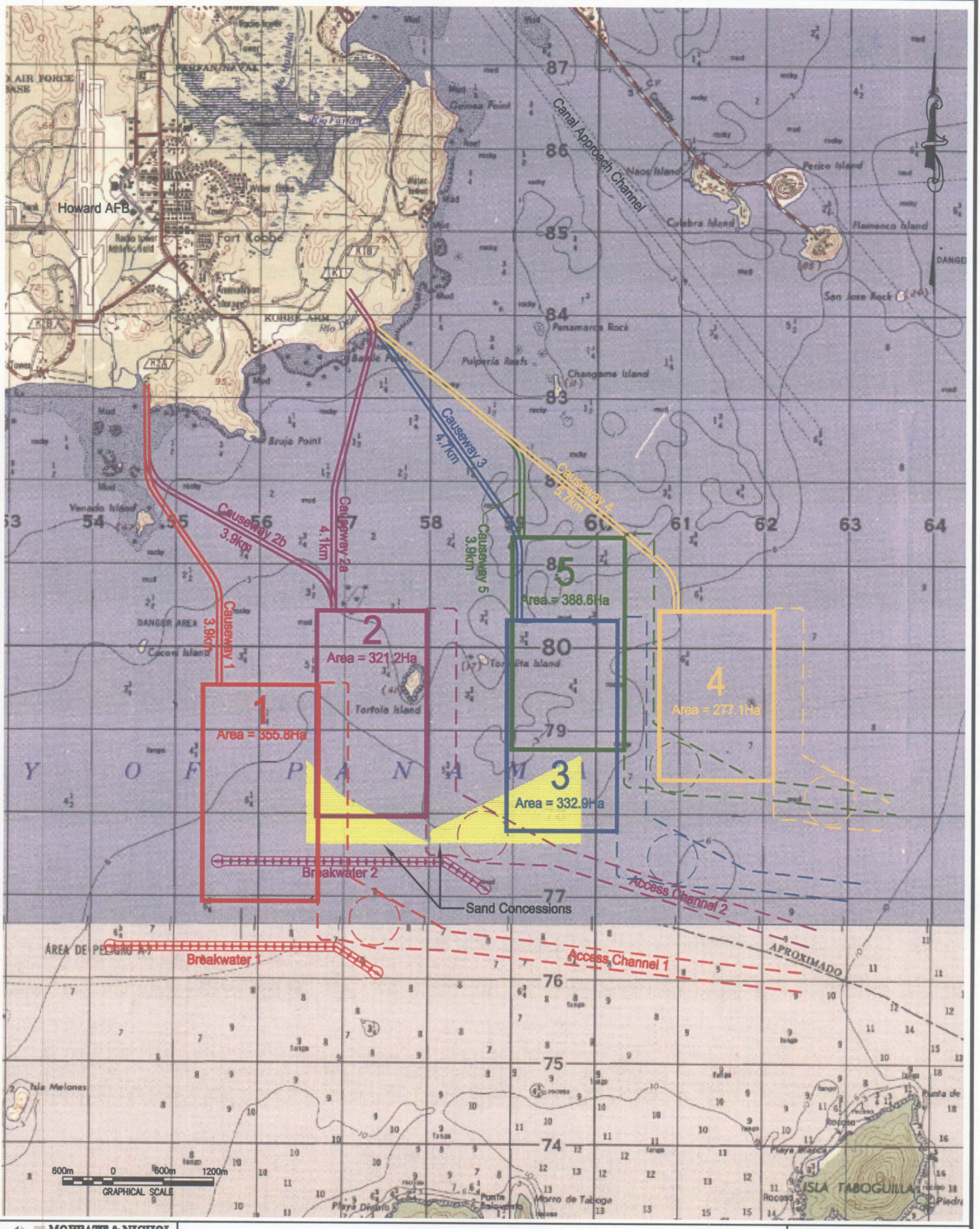

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Figure 8-10
Potential Alternative Locations for Site M5 (Artificial Island)

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However, based on an initial target holding capacity of some 100 million m3, it is estimated that the island would provide approximately 350 – 425 ha of land for development, depending on the fill configuration and elevations, width of causeway required and the need or otherwise for an offshore breakwater.

8.5.2 Potential Land Use

As for site M4, there are two fundamental development alternatives for the artificial island. The first would be to develop a maritime center that would have container cargo transfer facilities, an intermodal cargo distribution center and support services, together with public access areas. The second would be a mixed use commercial, residential and public access development, that could be combined with wetlands areas, a new marina and essentially create a small township on the island. Table 8-4 shows a tentative listing of potential development options and areas that might be created within the artificial island if used for commercial or residential development. Figure 8-11 shows a preliminary development concept as a container port and Figure 8-12 shows a tentative layout of the island as a commercial or residential development project.

Both of these alternatives would be connected to the foreshore via a causeway, with the width of the structure being wider for the Port city than for the commercial residential development, in order to accommodate the higher volume of traffic and a potential rail link to the bascule bridge crossing the Miraflores Locks. It is quite probable that the connecting structure for the mixed use development island could be an open piled trestle, similar to the Corredor Sur highway, while the additional width of the access for the Port island would almost certainly dictate the construction of a rubble mound causeway, with sections of open trestle to permit water flow and sediment transport.

These options are being developed in more detail as part of an ongoing feasibility study of the artificial island and are introduced here to demonstrate the wide range of options, potential uses, locations and configurations of the disposal site.

Table 8-4 : Potential Allocation of Land created at Site M5 (Artificial Island)

Potential Land Use	Quantity	Unit	Area (ha)	Total area (ha)
golf course & club	1	each	65.00	65
marina landside	1	each	10.00	10
hi -rise residential (apartments)	2000	units	0.03	67
single family homes (upscale)	200	units	0.15	30
stores/commercial	50	each	0.09	5
park & recreational	4	each	10.00	40
restaurants	10	each	0.50	5
police/govt	1	each	0.50	1
churches	2	each	1.00	2
hotels/resorts	4	each	10.00	40
utilities etc	2	each	2.00	4
beach	1	each	5.00	5
wetlands/environmental zones	1	each	20.00	20
			Sub Total	293
allowance for roads			30.00%	86
pubic parking/bus terminal	2000	spaces	0.0021	4
		Total Area (ha)		**383**

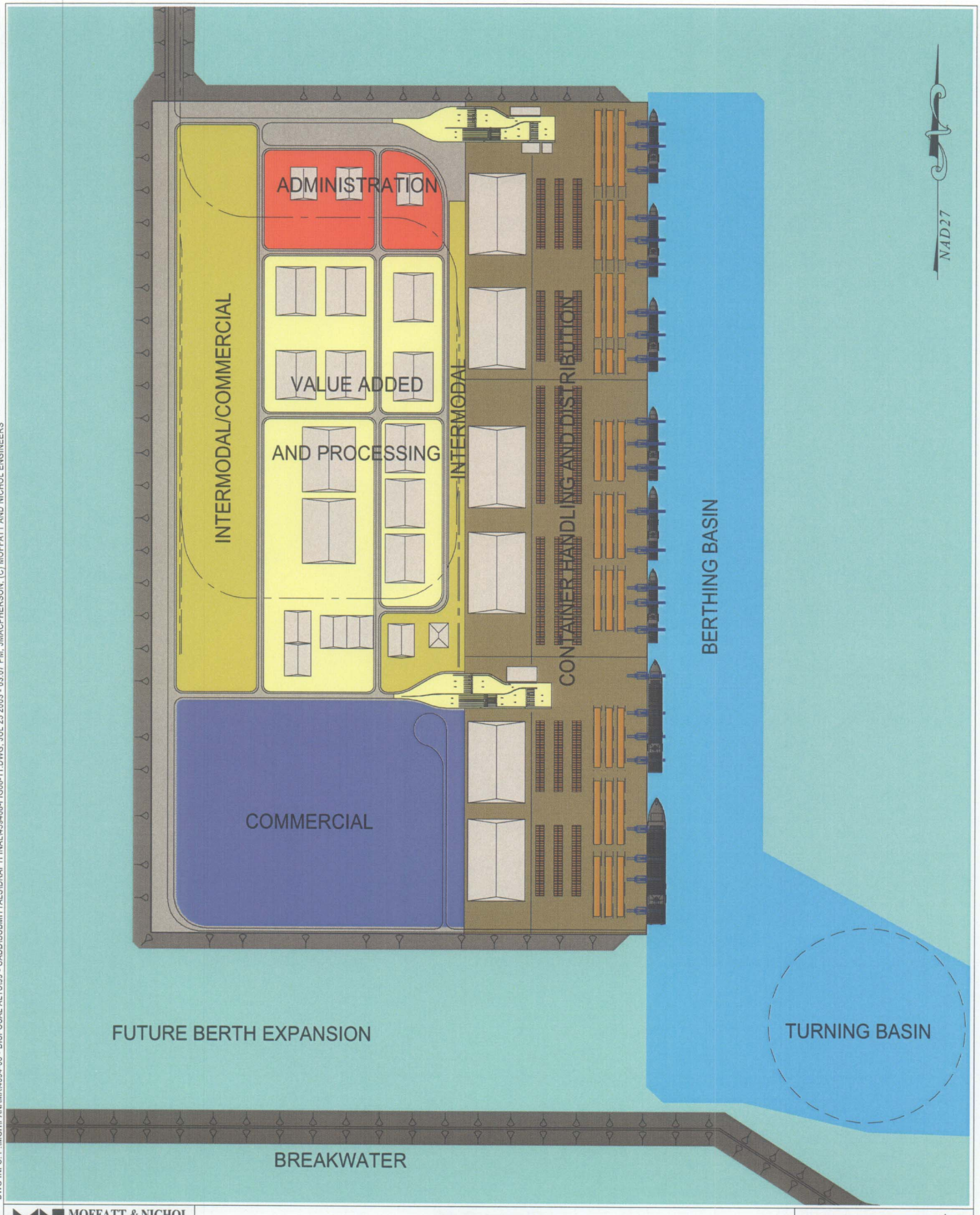

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Figure 8-11
Potential Layout of M5 as Maritime-Use Development

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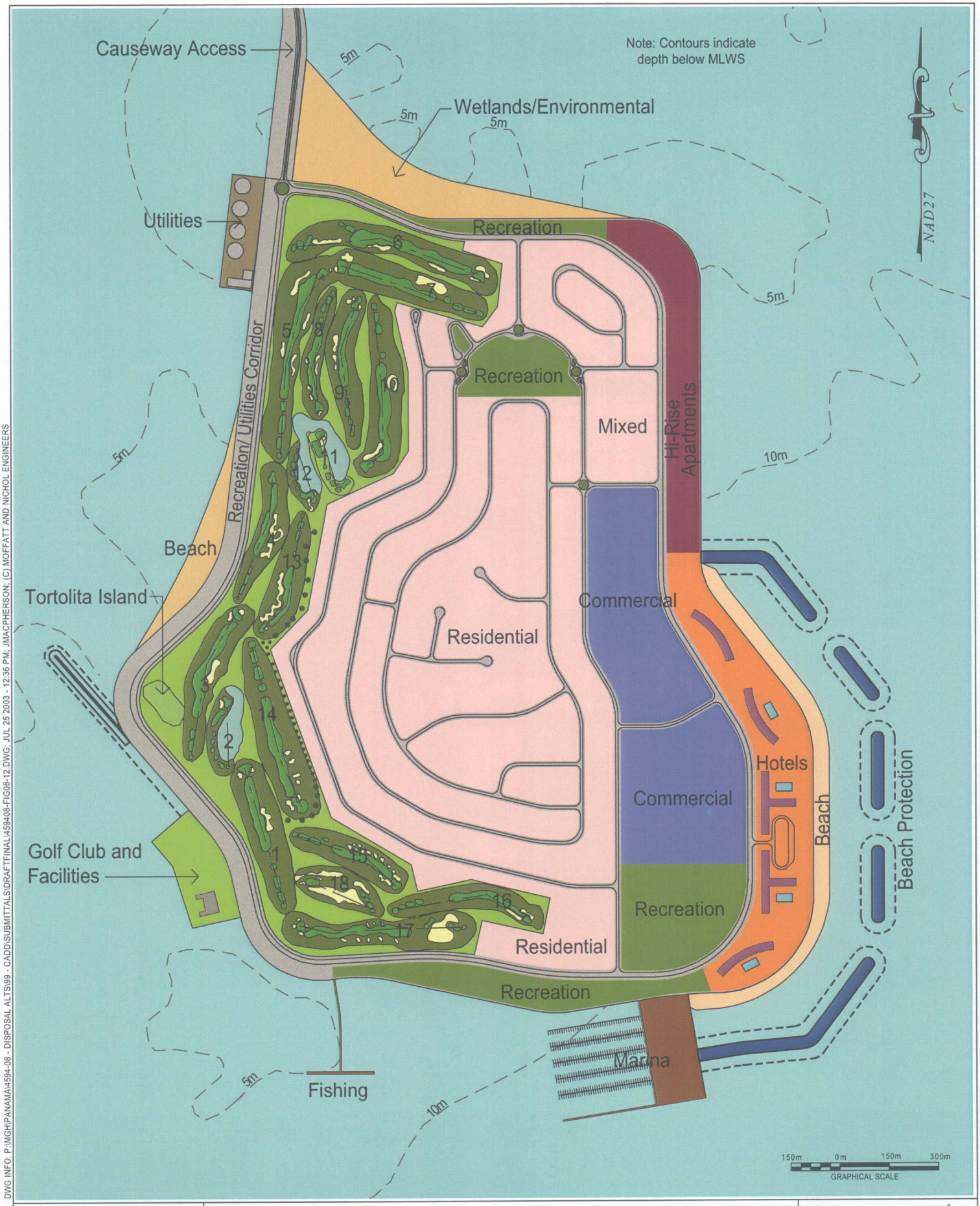

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Figure 8-12
Potential Layout of M5 as Mixed Use Development

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One of the key concerns for the island option may be the impact of the connecting causeway on marine habitats, siltation and the Veracruz beaches. While the hydrodynamic models prepared as part of the feasibility study indicate that the causeway will not cause any significant levels of siltation or increase the contamination of the area, public agencies or special interest groups could present opposition to the project based on perceived concerns.

If opposition to the use of M5 as a development project was strong, a third option for the island would be to create a nature reserve or habitat creation zone accessible only by water. Clearly this would be a relatively expensive project due to the high cost of transportation, but it would meet objections to the causeway construction and provide sufficient volume to accommodate the full amount of the Locks excavation material.

As such, the island would be considered a near shore disposal site with no added value, at least in the short term.

8.5.3 Materials Transport

Transportation options evaluated for the island project include:

- Rail
- Truck
- Truck to transfer station then barge to disposal site
- Barge Haul (For Pacific Entrance Dredging only)
- Conveyor systems

Each system was evaluated on the basis of the maximum amount of material generated by the source project. For the Third Locks project, the total volume of dry material generated was assumed to be 90.16 million m3, some 90% of the total amount to be excavated, while the Pacific entrance project is assumed to generate 14.3 million m3 of wet material that would be moved by barge. Estimated total capacity of the island footprint as shown in Figure 8-10 is 100.4 million m3, which would vary according to location and final configuration adopted for the project.

8.5.4 Transportation Costs

As part of the earlier study work, the use of a conveyor system was rejected due to the coast implications of the need to break large rock pieces down to a size that would be within acceptable maintenance levels for the conveyor idlers and equipment[12]. Detailed costs were then computed for both a truck and a rail haul for the dry material from the Locks excavation and a barge haul for the dredged material, as indicated below. In each case, the costs include the infrastructure and equipment required to support the system, such as haul corridor preparation, rail lines, locomotives, primary movers etc. For rail costs, it was assumed that no residual value would apply to the locomotives and rolling stock at the end of the project. Truck haul costs were based on industry standards for the required equipment, which include replacement after a given number of working hours. Given that there are a number of alternative locations still under evaluation for the artificial island, the location indicated in was adopted to serve as the basis for the transportation cost computations.

The resulting unit transportation costs were:

Third Locks Material

Dry materials moved by train .....$4.20 per m3

Dry material by truck .....$6.87 per m3

Dry material by truck to transfer station then by barge .....$5.35 per m3

Pacific Entrance Material

Dredged Material by barge.....$2.15 per m3

[12] Conveyor systems are being evaluated in more detail as part of the ongoing Artificial Island Study. Early indications are that it is technical viable to use conveyors for the movement of rock, but costs are likely to exceed the rail option.

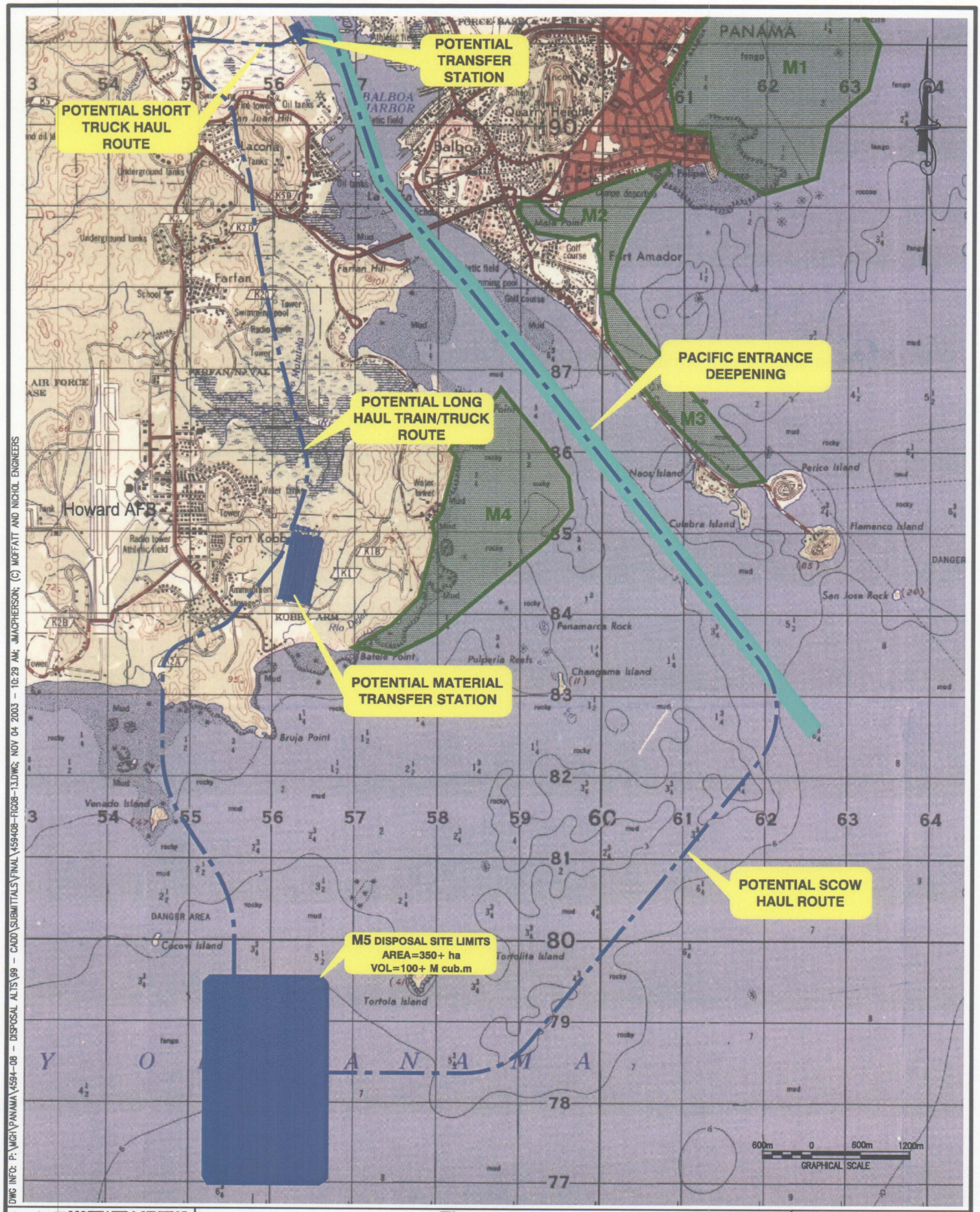

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Figure 8-13
Potential Location & Haul Routes for Site M5 (Artificial Island)

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8.5.5 Cost Estimates

As for the other marine sites, preparation costs for the placement of fill at the island are relatively low. It is acknowledged that a transport corridor and system must be constructed before any filling can take place, but this element and the connecting causeway construction cost have been built into the transportation unit costs presented in earlier discussions.

Table 8-5 therefore represents those costs that are related to the construction of the island and the preparation of the sub soils to receive fill material. No allowance is made for dredged channels, infrastructure or rehabilitation of the site after filling, since it is assumed that this will be a developer cost to be set against the added value of the created land areas.

Table 8-5 : Estimated Site Preparation Costs - Site M5 (Artificial Island)

Description	Quantity	Unit	Unit Cost (US$)	Amount (US$)
Preliminaries				**$280,000**
Archaeological Survey	1	sum	30,000.00	$30,000
Mobilization	1	sum	250,000.00	$250,000
Site Preparation				**$1,562,500**
Dredge Soft Materials	50.00	ha	31,250.00	$1,562,500
Environmental Mitigation				**$2,853,701**
Mitigation Allowance			0.75%	$2,853,701
Sub Total				**$4,696,201**
Contingencies			10%	$469,620
Total Estimated Cost of Site Preparation				**$5,165,821**
Equivalent Unit cost of Site Development ($/m3 of capacity)			**$0.05**	
Equivalent Unit cost of Site Development ($/ha)			**$14,759**	
Materials Transport Costs				
Dry Materials by train	90,155,000	m3	4.20	$378,651,000
et materials from Pac channel, by barge	14,315,000	m3	2.15	$30,777,250

Note: Most economic costs are shown for materials transport

8.5.6 Summary of Findings

The artificial island is the only marine site capable of receiving the full volume of materials from the Locks Excavation and the Pacific Entrance Dredging projects, unless open water disposal is adopted. Train transportation and site preparation costs are relatively lower than the other marine sites, due to the very high volume of material to be moved. The establishment of a rail corridor to the island also offers important multi-modal opportunities for the island and the Howard area developments, in the event that it is decided that the island can be used as a maritime center for container handling and other cargoes.

Environmental concerns over the island and any other major offshore fill in this area require careful consideration and it is certain that additional sampling and analytical work will be needed before the project could be approved by ANAM and other agencies. However, initial work on the hydrodynamic impact of the island indicates that the size of the island should not cause any major negative impacts on the existing shoreline or local hydrodynamic regime, since the study area is not subject to strong tidal currents. The habitat value of the soft silts in the proposed construction area is also relatively low.

These two factors indicate that a reduction in the size of the island is unlikely to cause a significant reduction in the environmental impacts of the project.

However, it is clear that the construction of an extended rubble mound causeway from the shoreline to the site will block the currents in the area and also have an effect on small boat traffic and local fishing grounds. These concerns can be addressed by including one or more breaches or bridges in the causeway, with the location and size of the breaches to be determined following more detailed hydrodynamic modeling of alternatives. However, as a result of the ongoing feasibility work on the island project, there is now a substantial data base available on the bathymetry, sub bottom conditions, waves and currents and water quality in the study area.

The mixed use development option shown in Figure 8-12 offers some very interesting possibilities for use of the island. In particular, it has the following advantages over the Port option:

- Connection to the landside by an open piled causeway is probably economically viable and would resolve concerns over sediment passage and environmental impacts
- The location of the island is not critical
- The island can have a more natural footprint than the rectangular flat features of the Port Terminals
- The topography can be designed to offer a more natural profile and fit the development planning for the island
- Use of the island for mixed development would avoid the need for an offshore breakwater and reduce development costs.

8.6 Site M6 - Open Water Disposal

This alternative involves the underwater deposition (below surface) of excavation material and/or dredge material offshore. As noted earlier, the disposal of material in deep water would not provide any significant added value, except perhaps for community benefits from fisheries enhancements that might follow if the material was used to created artificial reefs. However, the computation of transportations costs provides a benchmark for comparison with other alternatives. An environmental evaluation is also presented, in order to assess the potential impacts in the unlikely event that this option is selected for part or all of the material.

8.6.1 Disposal Site Selection Criteria

Although no value added benefits would be derived from the disposal of the material from the Pacific Entrance dredging and possibly the Locks excavation using traditional open water dumping, the cost of this option sets a benchmark for the financial assessment of other marine disposal options.

As noted, there are two groups of material which could practically be disposed of in this manner:

- Pacific Entrance Channel Dredged material (11.00 million m3, before bulking)
- Locks Excavation with or without Pacific Entrance Channel Material (69.5 to 80.5 million m3)

In addition to the environmental criteria, selection of a suitable site for the placement of materials from these two options should take into consideration the following:

- Avoidance of hazards to commercial shipping
- Avoidance of impacts on local current and sedimentation regimes

Based on the expectation that the new Locks would accommodate vessels of up to 15.2 m draft[13], an additional 3 m of under keel clearance would be advisable to ensure that a fully loaded vessel would have ample depth of water under all weather conditions expected in the Panama approaches.

This would then indicate that filling should not reduce the depth of navigable waters to less than approximately 20 m. Selection of a site closer to shore would also be practical, if navigation by larger vessels was precluded due to the natural depths of water. However, for the purposes of this preliminary evaluation, it is suggested that the deep water disposal evaluation be based on a requirement to maintain at least 20 m of water.

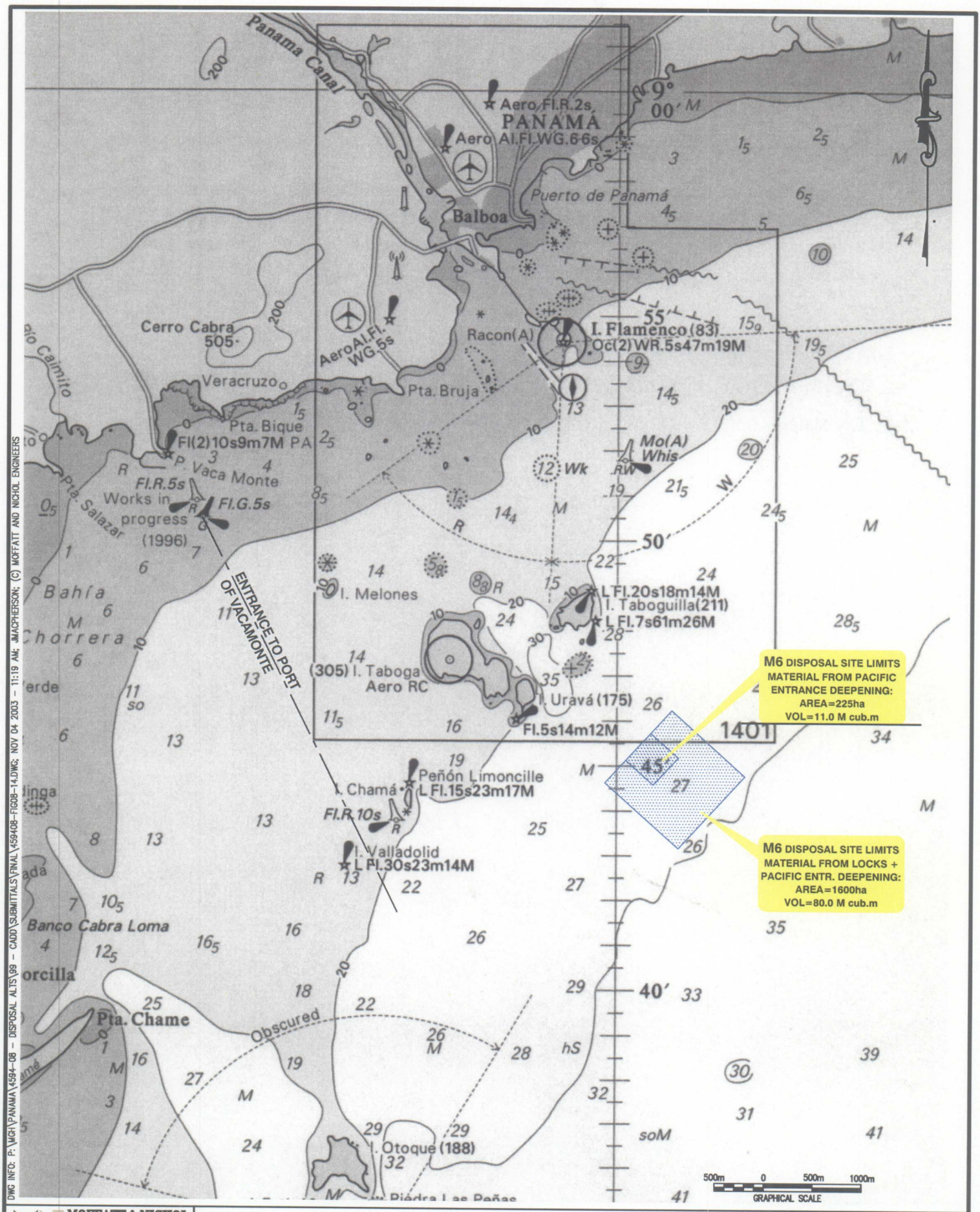
In order to avoid conflicts with the Panama Canal anchorages and the navigation channels to the Port of Vacamonte, it would appear that the general area south of Taboga shown in Figure 8-14 would be the most practical location for the disposal site. Depending on the quantity deposited, an area of between 2.5 and 18 km2 would be required to accommodate the range of materials volume indicated earlier, based on an assumption that the depth of fill would not exceed 5.00 m.

[13] Terms of Reference – Pacific Locks Concept Studies, 2001

8.6.2 Materials Transport Alternatives

Given the high volume of material to be removed from the Locks, a barge haul directly from the working face is not considered to be a valid transportation option, due to the high level of interference with the regular Panama Canal traffic and the risk involved.

Consequently, costs were computed for the Locks excavation material, based on an assumption that the dry material would be moved from the locks site to a transfer station at Farfan or some similar location, then stockpiled and transferred to barges for dumping at the open water site. Any material from the Pacific Entrance Dredging work would be loaded directly into barges in conventional fashion at the work face for transport to the dump site.



DWG INFO: P:\WGH\PANAMA\4594-08 – DISPOSAL ALTS\99 – CADD\SUBMITTALS\FINAL\459408-FIG08-14.DWG; NOV 04 2003 – 11:19 AM; JMACPHERSON; (C) MOFFATT AND NICHOL ENGINEERS

MOFFATT & NICHOL ENGINEERS
LOUIS BERGER GROUP INC.

Figure 8-14
Potential Location for Deep Water Disposal Site (M6)

ACP AUTORIDAD DEL CANAL DE PANAMÁ

8.6.3 Materials Transport costs

Transport costs were computed for the three alternatives above. From the assessment presented below, it can be clearly seen that the direct haul of material from the Pacific Entrance Channel dredging is relatively economic, but costs more than disposal at Farfan, the Artificial island or the Amador Causeway project area.

Wet material from Pacific Entrance Dredging ..... $2.15 per m3

Dry Material from Third Locks (train haul/transfer station/barge haul)..... $6.36 per m3

Dry Material from Third Locks (truck haul/transfer station/barge haul)..... $5.08 per m3

9 REVIEW OF FINDINGS

Based on the site visits, field tests, environmental assessments and technical analyses presented in this report, a number of conclusions and recommendations are developed for the candidate disposal sites.

9.1 Summary of Disposal Site Capacities

Assuming the reconfiguration of the sites as discussed earlier, the adjusted materials holding capacities for the study sites are as indicated in Table 9-1, below.

Table 9-1: Summary of Disposal Sites Capacities

Site Ref.	Designation	Area (ha)	Generated Excavation Volume (million m3)	Estimated Maximum Capacity (million m3)
Gaillard Cut Materials Sites			**79.98**	
T1	Rio Mandinga	149.20		60.72
T2	Rio Camacho	88.90		32.35
T3	Gaillard Cut North	115.00		28.13
T4	Gaillard Cut East (west bank dry matl)	105.56	12.56	12.56
T5	Gaillard Cut South	29.76		7.28
T6	UXO Area	305.40		115.24
A1	Trinidad Dam Project	n/a		33.50
	Total Available in Group	**793.82**		**289.78**
Third Locks Excavation Sites			**90.17**	
A1	Trinidad Dam Project	n/a		33.50
T6	UXO Area	305.40		115.24
T7	Miraflores West Bank	45.00		4.50
T8	1939 Third Locks Excavation	27.30		5.00
T9	Rodman/Horoko	59.00		5.90
T10	El Arado	875.60		87.56
M1	Panama Bay Fill	520.00		61.68
M2	Chorrillo Bay Fill	94.00		6.56
M3	Amador East	107.00		11.23
M4	Farfan/Palo Seco	324.00		32.43
M5	Artificial Island	350.00		110.40
	Total Available in Group	**2,707.30**		**474.00**
Pacific Entrance Channel Dredging Sites			**14.30**	
M1	Panama Bay Fill	520.00		61.68
M2	Chorrillo Bay Fill	94.00		6.56
M3	Amador East	107.00		11.23
M4	Farfan/Palo Seco	324.00		32.43
M5	Artificial Island	350.00		110.40
	Total Available in Group	**1,395.00**		**222.30**

9.2 Terrestrial Sites

9.2.1 Site T1 – Rio Mandinga

On the basis of the high ecological value of the areas around this site, with a diversity of flora and fauna and the potential for eco-tourism, it is strongly recommended that the extents of fill be limited to un-forested areas east of the Mandinga River watershed.

This effectively reduces the area available for fill to approximately 150 ha, which offers the capacity to receive up to 61 million m3 of fill, depending on the fill profile and configuration selected. Based on this revised configuration, there are no significant objections to the use of this fill from an environmental standpoint.

Based on the range of full options, the estimated cost of materials transportation for site T1 is on the order of $2.06 per m3 for dry materials excavated from the west banks of the Gaillard Cut for the Canal widening project, or $3.85 per m3 for dredged material for the deepening and widening projects. Site preparation and site restoration costs are estimated to be $31,600 per hectare or $4.71 million for the fully developed site.

In spite of the environmental restrictions on the areas west of the proposed fill area, Site T1 is an important element of the Widening and Deepening project due to its relatively high potential capacity and economic transportation and development costs.

9.2.2 Site T2 – Rio Camacho

Based on the initial environmental assessment, the forested areas within the original configuration of Site T2 have been excluded from consideration for materials disposal. This reduces the effective area for fill to 90 ha, or a maximum capacity of 32.35 million m3.

The estimated cost of materials transport for Site T2 are similar to those at T1, indicating a unit cost of $2.64 per m3 for dry material and $4.39 per m3 for dredged material. Site preparation and site restoration costs are $28,537 per hectare, which is similar to the costs applicable to Site T1.

9.2.3 Site T3 – Gaillard Cut North

The area within the designated site limits will offer some 115 hectares for receipt of fill materials and a maximum holding capacity of 28.13 million m3.

There are no significant environmental concerns associated with its use as a disposal site. However, parts of site T3 are within the areas classified as potentially having Unexploded Ordnance (UXO) and little is known of the danger posed by unexploded ordnance over the study area.

According to the work already undertaken in the area, it is likely that clearance to depths ranging from 60 cm to 1.20 m will be required to provide the necessary level of confidence that the danger from UXO presence has been reduced to an acceptable level.

The estimated costs for materials transport to Site T3 area are $3.35.m3 for dry material and $3.86 per m3 for wet or dredged material respectively and the cost of site preparation and restoration is relatively high at $73,012 per hectare, due to the need for UXO survey and clearance. However, Site T3 represents a useful disposal site option, even when the need for clearance of the UXO materials is taken into consideration.

9.2.4 Site T4 – Gaillard Cut East

T4 is the only site being evaluated on the east side of the Gaillard Cut. It is recommended that the site should be reserved for the receipt of dry materials from the east side of the widening work, which primarily involve slope reconfiguration for stability purposes. The estimated total of dry excavation from the work on the east bank of the Canal is 12.56 million m3, which the site can readily accommodate.

Based on the information collected through site reconnaissance and studied transects, the use of this site is not expected to cause significant adverse effects on critical biota.

The estimated cost of site preparation and restoration is relatively low at $9,767 per hectare and the fill transport costs are also low at an estimated $3.32 per m3. Hence, Site T4 is one of the more economical sites to develop, place materials and restore.

9.2.5 Site T5 – Gaillard Cut South

The area within the site limits offers approximately 29.76 hectares for receipt of fill materials and a maximum capacity of 7.28 million m3. The new bridge over the Panama Canal is also under construction in this area and it is understood that the access corridor to the new bridge crosses the northern limits of the proposed disposal area.

The site falls within the UXO hazard area and clearance will be required before filling can take place.

Based on the information collected through site reconnaissance and studied transects, the use of this site is not expected to cause significant adverse effects on critical biota.

The estimated costs for dry and dredged materials transport from the Gaillard Cut work to Site T5 are $3.11 per m3 and $4.88 per m3 respectively. Site preparation and restoration costs are high at $77,640 per hectare, mainly due to the expectation of significant efforts to survey and clear the UXO materials.

9.2.6 Site T6 – UXO Area

Based on the modified site boundaries to avoid the secondary forest areas identified in the environmental evaluations, the proposed fill area covers 305.42 hectares and has a maximum capacity of 115.24 million m3, sufficient to hold all of the material from either the Gaillard Cut work or the Locks excavation, but not both.

Site T6 is the largest site with UXO problems and due to its potentially high fill capacity, is also a critical element in the disposal evaluation for both the Gaillard Cut and Locks excavation projects. However, at maximum capacity, the fill material would be approximately 30 m deep, which should substantially reduce or eliminate the concerns of UXO risk.

Apart from the sensitive areas to the west of the site and the low potential for sites of archaeological interest, there are no serious environmental concerns associated with the filling of Site T6 within the revised site limits shown.

The estimated costs for dry materials transport to Site T6 vary from $3.24 per m3 for material from the Third Locks Excavation to $4.66 per m3 from the Gaillard Cut work. Movement of dredged materials from Gaillard Cut will cost on the order of $3.87 per m3. Site preparation and restoration costs are relatively high at $69,898 per hectare, due to the UXO concerns.

As the largest of the terrestrial sites, T6 is an important element in the disposal evaluation and offers the potential to resolve a difficult situation over the UXO issues. In terms of cost, the site also represents one of the lower cost scenarios for disposal, apart from the major unknown element of the UXO clearance.

9.2.7 Site T7 – Miraflores Locks West Bank

The site is closely bounded by the existing canal and the P1 alignment and will be significantly altered by the new Locks construction project, regardless of whether it is used as a disposal site or not. The most appropriate way to fill in an area bounded by these two alignments would appear to place materials to a uniform depth of 10 m, giving a capacity of approximately 4.50 million m3.

No significant environmental concerns are associated with the use of this site.

Based on an average round trip haul distance of 5.00 km, the estimated cost for dry materials transport to the site is $ 3.36 per m3. Site preparation costs are low at $3,911 per hectare

The main issue related to Site T7 is the final configuration of the Pacific Side locks and approach channels, which could drastically modify its capacity as a disposal site. It is recommended that environmental and preliminary designs for both Sites T7 and T8

should be included within the design and submittals for the Locks and support development as part of an integrated package.

9.2.8 Site T8 – 1939 Third Locks Lagoons

The disposal plan for site T8 would involve filling the two lagoons and the dredged area south of the Miraflores locks to an elevation that corresponds with the final grading plan for the entrance channels and new Locks. The most appropriate approach would be to bring the surface of this area to a uniform elevation. Assuming that the final fill elevation is relatively close to the existing ground level, the estimated capacity of the three areas is approximately 5.00 million m3.

There were no environmental restrictions observed for the utilization of this site for the deposition of excavation material, except for fauna mitigation measures discussed earlier.

Based on an average round trip haul distance of 4.2 km, the estimated costs for dry materials transport to the site from the Locks excavation is $2.98 per m3. Site preparation costs are minimal, at an estimated $2,453 per hectare.

The main issue related to Site T8 is the final configuration of the Pacific Side locks and approach channels and it is most probable that the entire area will be cleared and reconfigured as part of the Locks project. In addition, the final alignment could well traverse parts of the two artificial lakes. As for site T7, it is therefore recommended that any decisions relative to the use and configuration of filling in these two areas should be part of the overall planning and design of the Third Locks project and development area.

9.2.9 Site T9 – Rodman/Horoko

This site is adjacent to areas administered by ARI and adjacent areas administered by ARI and ACP, and with the inter-American highway. It was formerly used by the US military for the storage of ammunition and it contains numerous bunkers that are currently empty.

Because of the numerous hills and the general slope of the site from 120m to 60m, the estimated capacity of the study area is low, at 5.9 million m^3.

There is a very high level of environmental sensitivity associated with this site, and taking into account its relatively low capacity, it is recommended that the entire area be eliminated from consideration as a disposal site.

In the event that filling is proposed for this site, the estimated transport costs for dry material from the Locks project are $3.79 per m3, with site preparation and restoration costs estimated at $57,098. This latter figure is based on an assumption that total reforestation would be required by ARI and ANAM in the unlikely event that approvals were obtained for materials disposal at this location.

9.2.10 Site T10 – El Arado

The total un-forested area of 875.6 hectares would have an available capacity of from 87.6 million m3, assuming an average fill depth of 10 m.

The estimated costs for materials transport to Site T10 are $5.42 per m3 or $8.96 for train or truck haul respectively. Site development costs are high, at $64,280 per hectare, mainly due to an allowance of $25,000 per hectare for purchase of the land required for filling. Additional owner compensation and potential mitigation measures are also significant potential costs before filling can take place at this site.

T10 offers a large area for fill disposal and is not complicated by the UXO issues as are sites T3, T5 and T6. The environmental impacts are also minimal, since over 90 percent of the area has already been cleared of the original forests. However, all of the land is in private ownership, contains a large number of farms and would be difficult to purchase. There could also be considerable public opposition to the project, based on the loss of livelihood to a large percentage of the residents of the site and neighboring communities.

Given the weight of the negative socio economic and cost implications generated by the use of Site T10, it is recommended that this site should only be considered for the material from the Third Locks project in the unlikely event that all other terrestrial and marine alternatives have been examined in detail and rejected.

9.2.11 Site A1 (Trinidad Dam Option)

Evaluation of this option is limited to selection of preferred land and water based corridors and computation of alternative transport costs.

From the cost analysis, it is seen that movement of the Gaillard Cut dredged material from the work site to the Dam location offers the most economical solution at $4.84 per m3, while the transport of the Third locks material overland by train would cost $12.72 per m3.

9.3 Marine Sites

9.3.1 Site M1 – Panama Bay Fill

An ambitious filling program for Panama Bay could accommodate some 61.7 million m3 of material and generate a development area of approximately 520 ha. This is less than the total volume of material to be removed from the Locks, mainly due to the relatively shallow water in the Bay. Hence, Site M1 can not be considered as a single solution for the receipt of material from the Locks project.

The major portion of the material to be removed from the Locks excavation will be removed in the dry, which requires a combination of short haul truck movement to a barge transfer station, before removal to the project site. This multiple handling of dry material results in an estimated cost in excess of $6.46 for the fill, which is high when compared to the cost of traditional imported hydraulic fill.

Finally, it is clear that any proposals to fill or restore Panama Bay will be extremely controversial and expensive. Based on recent controversies related to previous attempts to construct small islands in the Punta Paitilla area, it seems unlikely that all of the environmental and community reaction issues related to a major fill project in Panama Bay will be resolved in time to meet the schedule for the Third Locks construction.

9.3.2 Site M2 - Chorrillo Bay

This alternative involves the filling of Chorrillo Bay. Based on the assumption that fill would be placed behind a gentle curve extended from the Casco Viejo area to the entrance to Amador, the reclamation of Chorrillo Bay would generate some 94 ha of area and hold approximately 6.6 million m3 of material.

As for site M1, it is suggested that barge haul is the only valid option to move materials from either a transfer station or directly from the work face to the dump site, since there are no off-road corridors that could accommodate high capacity dump trucks required to maintain a high level of production for the amount of fill anticipated for this site.

Estimated materials transportation costs for dredged material from the Pacific Channel entrance dredge project are $2.01 per m3, compared with $7.98 per m3 for the movement of dry materials by truck and scow. It is assumed that the filling of Chorrillo Bay would be promoted by the Panamanian Ministry of Tourism (IPAT), ARI or other government or local agency. As such, all concepts, engineering, environmental and project approvals would be the responsibility of others and the potential site capacity presented in this report could be subject to significant change.

9.3.3 Site M3 – Amador Causeway East

The final width of the expansion of the causeway will depend on the concept developed for the project by ARI or the sponsoring group. However, in terms of volume calculations, it is most unlikely the increase would exceed 500 m, in which case the project could absorb approximately 11.23 million m3 of material and providing 107 ha of new land for development.

It would appear that the expansion project is unlikely to hold all of the material from the Entrance Channel Dredging project. In addition, a significant percentage of the material

could be soft silts, which would be unsuitable for filling at the Causeway, unless retaining dikes were constructed to hold the material and prevent high turbidity or sedimentation. It is also possible that this project would be combined with the Chorrillo Bay fill to present an integrated development plan for the combined areas.

Under either of these scenarios, soft material could be deposited at existing ACP disposal site and the excavated hard material used for fill at the Causeway site, with the final volumes to be determined following more detailed examination of the characteristics and volumes of material in the proposed dredging area.

Transportation costs for wet material from the Pacific Entrance dredging project are the most economic option for Site M3 at $2.01 per m3. The site can also accommodate dredged material from the Locks excavation at approximately $2.42 per3 m3.

Filling the area would necessitate the displacement and relocation of the Smithsonian pier and installations and the restaurant owners at the entrance to Naos Island might require relocation of the informal boat landing ramps close to the parking areas[14]. The responsibility for these costs may or may not fall with ACP. If they are included in the cost estimate for preparation of this site, this would add approximately $0.11 per m3 to the base transport cost, assuming that all of the Pacific entrance channel material is used.

The Chorrillo Bay and Amador East expansion sites represent an economic and beneficial use for dredged material from the Pacific Channel entrance dredging, assuming that ARI or the other agencies involved in the management and development of the Amador Causeway support the proposal. Fill can be placed over a period of time without disruption of the existing activities on the Causeway and development of the reclaimed area would follow the preparation of an updated Master Plan for the site.

9.3.4 Site M4 – Farfan/Palo Seco

The optimum fill configuration for this location would have an approximate capacity of 32.40 million m3. However, the environmental evaluation of this site has to take into consideration the close relationship between the terrestrial and marine components of the peninsula. The flora and biota, contains both marine and terrestrial components and it is unique in its national representation. The highly diverse benthic environment, the presence of potentially reach productive waters, the rich coastal fauna and flora, and the presence of protected species, were important factors that assisted in the classification of the terrestrial area and shorelines bordering site M4 as an "exclusion zone".

Based on the expectation that fill at Site M4 (marine area) would be limited to 32.4 million m3, truck haul appears to be the most economical transport method at $6.62 per

[14] Filling using imported material was observed at this location in November 2003.

m3, unless the site was combined with other options to increase the total volume moved to the Farfan area, in which case, rail transport would probably be more economical at approximately $4.20 per m3.

In terms of potential added value, the site offers the possibility to create a world class residential, commercial or maritime related development alongside the Canal. Either of the two development concepts could generate significant added value for site M4.

In the event that it was decided that the site should be used for residential, commercial or other non – maritime related development, it is most probable that proposals would be requested from private sector developers for the purchase, lease or concession for the created waterfront lands.

Public reaction to the project will be a key issue and any serious opposition to the project would probably eliminate it from serious consideration. The reaction of the existing investors in the Amador Causeway projects would also be an important factor in the evaluation of the opposition or support for the use of M4 as a disposal Site.

9.3.5 Site M5 – Artificial Island

This alternative involves the construction of an artificial island using part or all of the material from the Third Locks excavation and possibly from the Pacific Entrance Channel Dredging projects. Development of the created land could include port facilities, residential or commercial real estate, industrial development, resort development, public parks, tourism, ecological reserves or a combination of uses.

If all of the material from the Third locks project was taken to Site M5, this would yield an area of approximately 350 hectares.

There are two fundamental development alternatives for the artificial island. The first would be to develop a maritime center that would have container facilities, potentially a cargo distribution center and support services, together with public access areas. The second would be a mixed use commercial, residential and public access development, that could be combined with wetlands areas, a new marina and essentially create a small township on the island.

A transport corridor and system must be constructed before any filling can take place and the costs are included in an estimated unit rate of $4.25 per m3 from the Third Locks Project. No allowance is included in this cost for dredged channels, infrastructure or rehabilitation of the site after filling, since it is assumed that this will be a developer cost to be set against the added value of the created land areas. However, the above cost does include an allowance for the removal of soft material from the disposal area before filling, in order to reduce long term settlement of the filled areas.

One of the key concerns for the island option may be the impact of the connecting causeway on marine habitats, siltation and the Veracruz beaches. While the

hydrodynamic models prepared as part of the feasibility study indicate that the causeway will not cause any significant levels of siltation or increase the contamination of the area, public agencies or special interest groups could present opposition to the project based on perceived concerns.

A major advantage of the mixed use option is that it offers considerable flexibility in location, configuration and elevational profiles that cannot be offered for the marine related development option. In addition, the landside access requirements are more modest, which in turn suggests that an open piled causeway could be economically used to connect the island to the shore side, thereby removing any potential concerns on the environmental impacts of the larger rubble mound causeway that is required for the Port option.

If opposition to the use of M5 for either one of the two development options was strong, a third alternative for the island would be to create a nature reserve or habitat creation zone accessible only by water. Clearly this would be a relatively expensive project due to the high cost of transportation, but it would meet objections to the causeway construction and provide sufficient volume to accommodate the full amount of the Locks excavation material in the event that another site or combination of sites could not be approved. It is interesting to note that the combined transport and site development costs of Site T6 (UXO area) are estimated to be $3.43 per m3, compared to $4.25 per m3 for the artificial island.

It therefore follows that a careful evaluation of the UXO issues at site T6 and the environmental and value added issues at the artificial island will be important factors in the selection process for the preferred disposal site.

9.3.6 Site M6 - Open water Disposal

Although no value added benefits would be derived from the disposal of the material from the Pacific Entrance dredging and possibly the Locks excavation using traditional open water dumping, the cost of this option sets a benchmark for the financial assessment of other marine disposal options.

In selecting an optimum location for Open water disposal, it was considered that the crest of any underwater fill should not interfere with the passage of deep draft vessels in the anchorages, Canal approaches or open water areas. Shallow water sites were not considered, since they are essentially the same as the other candidate sites discussed in this report. For the purposes of this preliminary evaluation, it is suggested that the deep water disposal evaluation be based on a requirement to maintain at least 20 m of water.

In order to avoid conflicts with the Panama Canal anchorages and the navigation channels to the Port of Vacamonte, the general area south of Taboga was considered to the most practical location for the disposal site.

Costs were computed for the Locks excavation material, based on an assumption that the dry material would be moved from the locks site to a transfer station at Farfan or some similar location, then stockpiled and transferred to barges for dumping at the open water site. Any material from the Pacific Entrance Dredging work would be loaded directly into barges in conventional fashion at the work face for transport to the dump site.

From the assessment presented below, it can be clearly seen that the direct haul of material from the Pacific Entrance Channel dredging is relatively economic, but costs more than disposal at Farfan, the Artificial island or the Amador Causeway project area.

Wet material from Pacific Entrance Dredging ..... $2.15 per m3

Dry Material from Third Locks (train haul/transfer station/barge haul) ..... $6.36 per m3

Dry Material from Third Locks (truck haul/transfer station/barge haul) ..... $5.08 per m3

10 CLASSIFICATION OF DISPOSAL SITES

As noted earlier, the sites were initially assessed on the basis of identified environmental sensitivities and potential loss of critical habitats in the area originally designated for fill. The technical evaluation of each site then took these initial recommendations into account and reconfigured site boundaries or recommended elimination of a number of the sites.

The classifications that now follow therefore represent the revised or updated environmental concerns, based on these modifications.

Classification of the Sites is based on the following assessment categories:

- Socio Economic Impact
- Environmental Impact
- Site Preparation, Restoration and Materials Transport Costs
- Value Added Potential
- Institutional or Project Approval Considerations

It is important to note that the classification of the individual sites must be presented within the context of the three excavation or dredging projects that will be the source of materials. For example, the classification of site T1 (Rio Mandinga) is irrelevant to the findings of site M5 (Artificial Island) since the material from the Gaillard Cut project cannot be taken to site M5, and the Pacific Entrance Channel material will not be placed at Site T1.

The following site classifications are presented in terms of the source material project, with some overlap for those sites that can accommodate materials from one or more of the excavation projects.

It is also important to note that the relative importance of the five classification categories will vary according to the particular interest of an interested party and there are no defendable numerical techniques that can be used to place a weighting on the criteria that would be acceptable to all.

Finally, it is clear from the outcome of the work tasks, that many of the differences between sites under the above classifications are relatively minor. In order to reflect this concentration of results, the classification of each site is based on a ten point system, with low scores indicating the most favorable outcome. However, due to the inherent defects in any weighting system, no attempt is made in this study to place any emphasis on any of the evaluation categories noted above[15].

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[15] Combined score was simply the sum of the socioeconomic, environmental, value added, etc., scores.

10.1 Socio Economic Impact Assessment

10.1.1 Ranking Criteria

For every disposal site considered, a list of potential affected communities and economic areas was made.

Four criteria were selected in order to determine the degree of socioeconomic impact that communities or economic sectors may suffer. The degree of negative impact per criterion and community or economic sector, was defined at the quantitative level according to four different values, each one corresponding to a qualitative category: 0=Null, 1=Low, 2=Medium, and 3=High.

The four evaluation criteria selected are:

A. Physical impact

B. Direct economic impact

C. Indirect economic impact

D. Hedonic Value

Next, every variable was weighted, giving a higher value to criteria Physical Impact and Direct Economic Impacts with a weighted value of 33.33% -, than to Indirect Economic Impact and Hedonic or (Property Value), which were – weighted at 16.7% . This approach is taken since any impact on the first two criteria will affect the other two, but not the opposite. Therefore, A) and B) are the most determinant criteria, with C) and D) being of secondary importance.

The following process was applied for potentially affected community or economic sector: first, it was considered in what degree each variable would be affected and a quantitative value was assigned (either 0, 1, 2 or 3). The weighting factor considered for each variable was applied and an average established for all impacted communities.

A socioeconomic index (ISE) was elaborated, aiming at measuring the level of socioeconomic impact that would be originated in a certain community or economic sector. An average ISE per disposal site option was obtained out of the ISE values for the communities or economic sectors involved.

Finally, the ISE values are converted to a ten point system, for consistency with the other classification criteria noted earlier.

Table 10-1: Index used for Socio Economic Classification

ISE value	Level of Impact	Ten point Classification
0	Nil	0
0.01 - 1	Low	2
1.01 - 2	Medium	6
2.01 - 3	High	10

10.1.2 Socio Economic Ranking

Sites T1, T2, T3, T5, T6, T7, T8, T9

All of these sites are within areas controlled by ACP with no development permitted, apart from Panama Canal maintenance and support activities. Consequently there are no Socio economic considerations related to their potential use as disposal sites.

Site T4: Gaillard Cut East

This use of this site results in a nil negative impact, as the communities of Pedro Miguel and Paraiso are located at enough distance of the potential site, and none of the variables considered would be affected.

Site T10: El Arado

This site is very close to the Rio Congo community and, the selection of this disposal site would cause a strong negative physical impact in the area, as well as a negative impact on the existing livestock activities. However, it is considered that a low negative impact will be generated on the other communities in the area, such as Nuevo Emperador, Nuevo Chorrillo and La Chorrera, that are all located far away from the disposal site. The ISE value is 1.88, expressing a medium level of negative impact. Positive impacts deriving from the commercial use of rock deposits or urbanization development could also arise from this option.

Site M1 – Panama Bay Fill

The evaluation of the socio-economic impacts of this option is outside the scope of this study, due to the unknown nature of the development concepts for the fill project.

Site M2 - El Chorrillo

The communities of El Chorrillo and San Felipe, would be affected at a medium level (1.33). The former because is directly connected to the potential disposal site, which would be affecting the activities of artisan fishermen organized in the Cooperativa de Pescadores de El Chorrillo, who would have to be relocated in similar or improved conditions. The relationship between these fishermen and El Chorrillo community is strong as they belong to the community.

Site M3 - Amador Causeway East Expansion

The Amador (causeway) option consists of improving existing access road infrastructure and use of the extracted material for urban expansion; it should not imply any physical negative impact, except during construction, nor should it have any negative economic impact on real estate values. It is expected that the improvement to the basic infrastructure would mean a potential increase of opportunities to develop commercial, and tourism activities. Therefore, the ISE value is zero (nil negative impact).

Site M4 - Palo Seco

This site would affect the Veracruz community with a low level of impact, as it has tourism attraction. Calzada de Amador, on the contrary, would be highly affected, as the disposal site would be located right in front of this commerce and tourism services area. The general ISE value for this site is 2.33, expressing a high impact degree.

Site M5 - Artificial Island

Given the three options presented earlier, the construction of the artificial island could have a range of socio economic impacts varying from nil to significant.

This potential disposal site would highly affect the Taboga community, La Playita de Bique and the economic sector of Calzada de Amador. The Veracruz community would be affected at a medium level. Taboga would suffer the alteration of the surrounding scenery, possibly creating a decline in the value of real estate and projected tourism development. On the other hand, La Playita de Bique could also be highly impacted in their marine ecosystems, which provide species of economic benefit to the community. The Calzada de Amador would be affected because of the change in the surrounding landscape, causing a decline of real estate value, a negative impact of the current and projected tourism activities.

Based on these expectations and the preliminary concepts suggested for the island, the resulting ISE values for the three different development options for the island are:

- Port or Maritime Development Center ..... 2.08 (High)
- Mixed Use Development ..... 1.08 (Medium)
- Non inhabited nature reserve ..... 0.17 (Low)

Site M6 – Open water Disposal

While there may be some concerns from residents of Taboga as a result of the barge traffic and any potential impacts on the area fisheries, it is not expected that the open water disposal option is likely to generate any significant socio economic issues.

Table 10-2 and Table 10-3 summarize the potential socio economic impacts for the terrestrial and marine sites indicated above.

Table 10-2: Socio Economic Impacts of Terrestrial Sites

Site	Description	Affected Community	Weight factors								ISE	Level of Impact	Ten point Classification
			Physical 33.33%		Dir. Economic 33.33%		Ind. Economic 16.67%		Property Val. 16.67%				
			Impact	Score	Impact	Score	Impact	Score	Impact	Score			
T1	Rio Mandinga	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T2	Rio Camacho	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T3	Gaillard Cut North	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T4	Gaillard Cut East	Paraiso, Pedro Miguel	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T5	Gaillard Cut South	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T6	UXO area	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T7	Miraflores West Bank	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T8	1939 Locks Excavations	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T9	Rodman/Horoko	None	0	0.00	0	0.00	0	0.00	0	0.00	0.00	Nil	0
T10	El Arado	Ave. - all Communities		0.58		0.50		0.25		0.17	1.50	Medium	6
		Río Congo	*3*	*1.00*	*3*	*1.00*	*3*	*0.50*	*1*	*0.17*	*2.67*	*High*	
		Nuevo Emperador	*2*	*0.67*	*1*	*0.33*	*1*	*0.17*	*1*	*0.17*	*1.33*	*Medium*	
		Nuevo Chorrillo	*1*	*0.33*	*1*	*0.33*	*1*	*0.17*	*1*	*0.17*	*1.00*	*Low*	
		Ciudad de la Chorrera	*1*	*0.33*	*1*	*0.33*	*1*	*0.17*	*1*	*0.17*	*1.00*	*Low*	

Note: Socio economic impact assessments were not required for sites not shown in this Table.

Table 10-3: Socio Economic Impacts of Marine Sites

Site	Description	Affected Community	Weight factors								ISE	Level of Impact	Ten point Classification
			Physical		Dir. Economic		Ind. Economic		Property Val.				
			33.33%		33.33%		16.67%		16.67%				
			Impact	Score	Impact	Score	Impact	Score	Impact	Score			
M2	**Chorrillo Bay Fill**	**Ave. - all Communities**		**0.67**		**0.33**		**0.17**		**0.17**	**1.33**	**Medium**	**6**
		El Chorillo	*2*	*0.67*	*1*	*0.33*	*1*	*0.17*	*1*	*0.17*	*1.33*	*Medium*	
		San Felipe	*2*	*0.67*	*1*	*0.33*	*1*	*0.17*	*1*	*0.17*	*1.33*	*Medium*	
M3	**Amador East**	**Calzador de Amador**	**1**	**0.33**	**0**	**0.00**	**1**	**0.17**	**0**	**0.00**	**0.50**	**Low**	**2**
M4	**Farfan/Palo Seco**	**Ave. - all Communities**		**0.67**		**0.67**		**0.17**		**0.50**	**2.00**	**Medium**	**6**
		Veracruz	*1*	*0.33*	*1*	*0.33*	*1*	*0.17*	*3*	*0.50*	*1.33*	*Medium*	
		Calzador de Amador	*3*	*1.00*	*3*	*1.00*	*1*	*0.17*	*3*	*0.50*	*2.67*	*High*	
M5	**Artificial Island**												
M5-1	**Maritime Center**	**Ave. - all Communities**		**0.83**		**0.67**		**0.17**		**0.42**	**2.08**	**High**	**10**
		Taboga	*3*	*1.00*	*2*	*0.67*	*1*	*0.17*	*3*	*0.50*	*2.33*	*High*	
		Playita Bique	*3*	*1.00*	*2*	*0.67*	*1*	*0.17*	*1*	*0.17*	*2.00*	*High*	
		Veracruz	*1*	*0.33*	*1*	*0.33*	*1*	*0.17*	*3*	*0.50*	*1.33*	*Medium*	
		Calzada de Amador	*3*	*1.00*	*3*	*1.00*	*1*	*0.17*	*3*	*0.50*	*2.67*	*High*	
M5-2	**Mixed Use**	**Ave. - all Communities**		**0.33**		**0.42**		**0.21**		**0.13**	**1.08**	**Medium**	**6**
	Development	*Taboga*	*2*	*0.67*	*1*	*0.33*	*1*	*0.17*	*1*	*0.17*	*1.33*	*Medium*	
		Playita Bique	*1*	*0.33*	*1*	*0.33*	*1*	*0.17*	*0*	*0.00*	*0.83*	*Low*	
		Veracruz	*1*	*0.33*	*1*	*0.33*	*1*	*0.17*	*0*	*0.00*	*0.83*	*Low*	
		Calzada de Amador	*0*	*0.00*	*2*	*0.67*	*2*	*0.33*	*2*	*0.33*	*1.33*	*Medium*	
M5-3	**Nature Reserve**	**Ave. - all Communities**		**0.17**		**0.00**		**0.00**		**0.00**	**0.17**	**Low**	**2**
		Taboga	*1*	*0.33*	*0*	*0.00*	*0*	*0.00*	*0*	*0.00*	*0.33*	*Low*	
		Playita Bique	*0*	*0.00*	*0*	*0.00*	*0*	*0.00*	*0*	*0.00*	*0.00*	*Nil*	
		Veracruz	*1*	*0.33*	*0*	*0.00*	*0*	*0.00*	*0*	*0.00*	*0.33*	*Low*	
		Calzada de Amador	*0*	*0.00*	*0*	*0.00*	*0*	*0.00*	*0*	*0.00*	*0.00*	*Nil*	

Note: Socio economic impact assessments were not required for sites not shown in this Table.

10.2 Environmental Impact

Following the initial environmental assessment and modification of the impacted sites to respond to ecological or other concerns, each site was again reviewed on the basis of the recommended site limits and configurations. Because the environmental assessment is based on the modified sites, it assumes that sensitive areas will be avoided to the extent possible. Any deviation from the areas specified could result in significant increases in the negative impacts of spoil disposal. From the environmental standpoint, impacts on aquatic, terrestrial and cultural factors were assessed for each site.

As the archaeological model utilized does not predict the actual existence of significantly valuable sites, the consideration of the cultural aspects was omitted. However, where the model predicted the possibility of the existence of areas of archaeological importance, recommendations were made to perform more in depth investigations prior to final exploitation of the sites for fill materials.

Impact significance was assessed using ANAM's (Vicente Conesa Fernández – Vitora[16]) recommended methodology based on the preparation of a Significance Matrix using a multi criteria approach. Elements that constitute the matrix include the following:

- Sign (+/-)
- Degree of Perturbation (DP)
- Risk of occurrence (RO)
- Extension (EX)
- Duration (D)
- Reversibility (RV)

Sign (+/-): Impact sign refers to the beneficial or prejudicial character of the different Project actions on environmental elements.

Degree of Perturbation (DP): Refers to the degree of disturb the action causes over a particular environmental factor in the specific field of occurrence. It ranges between 1-12 where 12 correspond to a total destruction situation and 1 is a minimal effect.

Risk of Occurrence (RO): Refers to the frequency of the effect, whether cyclical or recurrent, unpredictable or constant along time. Continuous effects are assigned a value of 4, periodical is 2, and 1 to those of irregular or discontinuous occurrence.

Extension (EX): Refers to the theoretical area of influence of the impact related to the Project overall area (% of impacted area). If the action produces a spot effect, the impact

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[16] "Guía Metodológica para la Evaluación del Impacto Ambiental", 2nd. Ed. Madrid, 1995", by Vicente Conesa F.

is considered localized (1). If, on the contrary, it has a generalized influence over the project, the impact shall be considered total (8); intermediate situations correspond to partial impacts (2) and extensive impacts (4).

Duration (D): Refers to the period the effect remains and after which the affected environmental factor would return to the initial condition either by natural or corrective measures. If the effect lasts less than one year, it is considered that the action produces a short effect (1); between 1 and 10 years, it is considered permanent (4).

Reversibility (RV): Refers to the possibility of reconstitution of the affected element, that is, the possibility to return to the initial conditions previous to the action, by natural means, once the former stops acting over the affected media. A short term is assigned a value of 1; mid term is 2, and irreversible effects are assigned a value of 4.

The significance of the impact results from the following equation:

IS = + / - (PD+RO+EX+D+RV)

For situations in which no significant impacts were identified, a nil condition (zero value) was adopted. Table 10-4 shows the Impact Significance Ranking system.

Among the six criteria indicated in the environmental impact assessment methodology, only the Degree of Perturbation and the Extension were considered variable. The Risk of Occurrence was invariably considered continuous (rank of 4); in terms of duration, impacts were considered permanent (value 4), and regarding Reversibility, all impacts were considered as irreversible (value of 4). Potential impacts were assessed over three media: aquatic, terrestrial and cultural. As previously indicated, a first round of analysis considered the situation in each site as originally proposed, that is, regardless of the vegetative cover and river alteration; impacts over the cultural environment (archeological / historical) were assessed based on the amount of potential archeological sites determined with the PASM methodology. During this first round, impacts on the aquatic environment were assessed based on the length of 3rd (or higher) stream order reaches affected, using Strahler criteria; impacts on the terrestrial environment were evaluated based on the percentage of forested area impacted by the disposal.

As a consequence of the significance high results obtained, a recommendation was made to avoid intervention of all forested areas and provide a buffer corridor for all three-order or higher water stream. Impacts were then re-evaluated based on the following premises:

Degree of Perturbation (for terrestrial media): Where no forest, river or potentially archeological interest areas were left after the exclusion criteria, a nil impact significance was considered. Nevertheless, if the surroundings of the site included highly valuable forest areas, some perturbation will still occur over the fauna (circadian rhythm alteration due to noise, illumination, human presence, changes in traversing paths, etc.). Therefore, a value of 2 (medium) was considered for DP in most sites. Regarding the aquatic

environment, the buffer corridors were included as part of the mitigation measures and the forest areas excluded, the drainage patterns will still be modified fill the fill contouring; DP was then adopted equal to 2. In the cultural environment, the DP factor was adjusted based on the number of potential sites remaining within the adjusted polygons.

Extension: Values were adjusted considering that surrounding forests will still be spot or partially intruded. As per the aquatic, some 3rd order reaches remained in the impacted area; therefore, a partial (2) extension factor was considered. As for the cultural analysis, as in the DP consideration, the extension factor was adjusted based on the number of potential sites remaining within the adjusted polygons.

Table 10-4: Environmental Impact Significance Classifications

SIGN		**DEGREE OF PERTURBATION (DP)**	
Beneficial Impacts	+	Low	1
Negative Impacts	-	Medium	2
		High	4
		Very high	8
		Total	12
EXTENSION (EX)		**DURATION (D)**	
Spot	1	Brief	1
Partial	2	Temporary	2
Extensive	4	Permanent	4
Total	8		
Critical	12		
RISK OF OCCURRENCE (RO)		**IMPACT SIGNIFICANCE (IS)**	
Irregular or discontinued	1	The significance of the impact varies between 5 and 36. Scores between 29 and 36 are considered very high; high between 23 and 28; medium between 17 y 22; low between 11 and 16, and very low between 5 and 10.	
Periodical	2		
Continuous	4		
REVERSIBILITY (RV)			
Short term	1		
Middle term	2		
Long term	4		

As a result, an average environmental condition within Conesa's five categories was derived for each site.

As with the Socio Economic classifications, the resulting impact levels are then converted to a ten point basis, for comparison with other primary classification criteria. The translation of the levels to a point system is as follows:

- Nil 0
- Very Low 1
- Low 3
- Medium 5
- High 8
- Very High 10

Table 10-5 and Table 10-6 show the revised environmental impact ratings for the terrestrial sites. The results for the marine sites are presented in Table 10-7. Classifications, based on the ten-point system, are presented in Table 10-8.

Table 10-5: Summary of Environmental Impact Assessments - Terrestrial Sites T1 to T5

Site	Description	Potential Impacts	Impact Significance							
			Sign	DP	RO	EX	D	RV	Total	Impact
T1	Rio Mandinga	Aquatic: Affected hydrology and associated habitat	-1	2	4	1	4	4	-15	Low
		Terrestrial: Loss of: habitat, biodiversity, protected species and temporary residence for migratory birds	-1	2	4	1	4	4	-15	Low
		Potential for archaeological findings (0 sites)							0	Very Low
		Average							**-10**	**Very Low**
T2	Rio Camacho	Aquatic: Affected hydrology and associated habitat	-1	2	4	2	4	4	-16	Low
		Terrestrial: Loss of: habitat, protected and endemic species and temporary residence for migratory birds	-1	2	4	2	4	4	-16	Low
		Potential for archaeological findings (0 sites)							0	Very Low
		Average							**-11**	**Low**
T3	Gaillard Cut North	Aquatic: Affected hydrology and associated habitat	-1	2	4	1	4	4	-15	Low
		Terrestrial							0	None
		Potential for archaeological findings (0 sites)							0	Very Low
		Average							**-5**	**Very Low**
T4	Gaillard Cut East	Aquatic							0	None
		Terrestrial: Loss of: habitat, protected species	-1	2	4	2	4	4	-16	Low
		Potential for archaeological findings (12 sites)	-1	1	1	1	4	4	-11	Low
		Average							**-9**	**Very Low**
T5	Gaillard Cut South	Aquatic							0	None
		Terrestrial							0	None
		Potential for archaeological findings (12 sites)	-1	1	1	1	4	4	-11	Low
		Average							**-4**	**Very Low**

Source: Prepared by LBG, 2003

DP – Degree of Perturbation, RO – Risk of Occurrence, EX – Extension, D – Duration of Impact, RV – Reversibility.

Table 10-6: Summary of Environmental Impact Assessments - Terrestrial Sites T6 to T10

Site	Description	Potential Impacts	Impact Significance							
			Sign	DP	RO	EX	D	RV	Total	Impact
T6	UXO Area (Assumed, entry to site not possible)	Aquatic							0	None
		Terrestrial: Loss of: habitat, protected speciesand temporary residence for migratory birds	-1	2	4	2	4	4	-16	Low
		Potential for archaeological findings (6 sites)	-1	4	1	1	4	4	-14	Low
		Average							**-10**	**Very Low**
T7	Miraflores West Bank	Aquatic: Affected hydrology and associated habitat	-1	2	4	2	4	4	-16	Low
		Terrestrial							0	None
		Cultural							0	None
		Average							**-5**	**Very Low**
T8	1939 Locks Excavations	Aquatic: Loss of the outfall segment of Cocoli Rv.	-1	2	4	2	4	4	-16	Low
		Terrestrial: Loss of habitat, protected species, and support for migratory birds	-1	2	4	2	4	4	-16	Low
		Cultural	-1	6	4	4	4	4	-22	Medium
		Average							**-18**	**Medium**
T9	Rodman Horoko	Aquatic: Affected hydrology and associated habitat	-1	8	4	4	4	4	-24	High
		Terrestrial: Loss of habitat, protected and endemic species, and support for migratory birds	-1	12	4	8	4	4	-32	Very High
		Potential for archaeological findings (1 site)	-1	4	1	1	4	4	-14	Low
		Average							**-23**	**High**
T10	El Arado	Aquatic: Affected hydrology and associated habitat	-1	2	4	4	4	4	-18	Medium
		Terrestrial:Loss of habitat	-1	2	4	2	4	4	-16	Low
		Potential for archaeological findings (12 sites)	-1	8	1	1	4	4	-18	Medium
		Average							**-17**	**Medium**

Source: Prepared by LBG, 2003

DP – Degree of Perturbation, RO – Risk of Occurrence, EX – Extension, D – Duration of Impact, RV – Reversibility.

Table 10-7: Summary of Environmental Impacts - Marine Sites

Site	Description	Potential Impacts	Impact Significance						
			DP	RO	EX	D	RV	Total	Impact
M1	Panama Bay Fill	Water Quality Deterioration	-1	-4	-4	-4	-1	-14	Low
		Habitat Loss	-1	-4	-4	-2	-4	-15	Low
		Biota Loss	-2	-4	-4	-2	-1	-13	Low
		Hydrodynamic Modification	-4	-4	-8	-4	-4	-24	High
		Average						**-16.5**	**Low**
M2	Chorrillo Bay	Water Quality Deterioration	-1	-4	-1	-4	-1	-11	Low
		Habitat Loss	-1	-4	-1	-4	-4	-14	Low
		Biota Loss	-2	-4	-1	-2	-1	-10	Very Low
		Hydrodynamic Modification	-1	-4	-1	-4	-4	-14	Low
		Average						**-12.25**	**Low**
M3	Amador East	Water Quality Deterioration	-1	-4	-4	-4	-1	-14	Low
		Habitat Loss	-1	-4	-4	-1	-1	-11	Low
		Biota Loss	-2	-4	-4	-2	-1	-13	Low
		Hydrodynamic Modification	-1	-4	-4	-4	-4	-17	Medium
		Average						**-13.75**	**Low**
M4	Farfan - Palo Seco	Water Quality Deterioration	-2	-4	-4	-2	-1	-13	Low
		Habitat Loss	-8	-4	-8	-4	-4	-28	High
		Biota Loss	-8	-4	-8	-4	-4	-28	High
		Hydrodynamic Modification	-4	-4	-4	-4	-4	-20	Medium
		Average						**-22.25**	**Medium**
M5-1	Artificial Island - Maritime Center	Water Quality Deterioration	-8	-4	-4	-2	-4	-22	Medium
		Habitat Loss	-8	-4	-4	-4	-4	-24	High
		Biota Loss	-4	-4	-4	-4	-4	-20	Medium
		Hydrodynamic Modification	-8	-4	-4	-12	-4	-32	Very High
		Average						**-24.5**	**High**
M5-2	Artificial Island - Mixed use development	Water Quality Deterioration	-2	-4	-4	-2	-1	-13	Low
		Habitat Loss	-8	-4	-4	-4	-4	-24	High
		Biota Loss	-4	-4	-4	-4	-4	-20	Medium
		Hydrodynamic Modification	-4	-4	-4	-4	-4	-20	Medium
		Average						**-19.25**	**Medium**
M5-3	Artificial Island - Nature Reserve	Water Quality Deterioration	-2	-4	-4	-2	-1	-13	Low
		Habitat Loss	-6	-4	-4	-4	-4	-22	Medium
		Biota Loss	-2	-4	-4	-2	-1	-13	Low
		Hydrodynamic Modification	-2	-2	-2	-2	-2	-10	Very Low
		Average						**-14.5**	**Low**
M6	Deep Water Disposal	Water Quality Deterioration	-8	-4	-4	-4	-2	-22	Medium
		Habitat Loss	-8	-4	-4	-4	-2	-22	Medium
		Biota Loss	-4	-4	-2	-2	-2	-14	Low
		Hydrodynamic Modification	0	0	0	0	0	0	None
		Average						**-14.5**	**Low**

DP – Degree of Perturbation, RO – Risk of Occurrence, EX – Extension, D – Duration of Impact, RV – Reversibility.

Table 10-8: Environmental Classification of Modified Sites

Site Ref.	Designation	Impact	10-point Classification
Gaillard Cut Materials Sites			
T1	Rio Mandinga	Very Low	1
T2	Rio Camacho	Low	3
T3	Gaillard Cut North	Very Low	1
T4	Gaillard Cut East	Very Low	1
T5	Gaillard Cut South	Very Low	1
T6	UXO Area	Low	3
A1	Trinidad Dam Project	n/a	n/a
Third Locks Excavation Sites			
A1	Trinidad Dam Project	n/a	
T6	UXO Area	Low	3
T7	Miraflores West Bank	Very Low	1
T8	1939 Third Locks Excavation	Low	3
T9	Rodman/Horoko	High	8
T10	El Arado	Medium	5
M1	Panama Bay Fill	Low	3
M2	Chorrillo Bay Fill	Low	3
M3	Amador East	Low	3
M4	Farfan/Palo Seco	Medium	5
M5-1	Artificial Island - Maritime Center	High	8
M5-2	Artificial Island - Mixed Use Development	Medium	5
M5-3	Artificial Island - Nature Reserve	Low	3
M6	Deep water Disposal	Low	3
Pacific Entrance Channel Dredging Sites			
M1	Panama Bay Fill	Low	3
M2	Chorrillo Bay Fill	Low	3
M3	Amador East	Low	3
M4	Farfan/Palo Seco	Medium	5
M5	Artificial Island	High	8
M6	Open Water Disposal	Medium	5

10.3 Site Preparation, Restoration and Materials Transport Costs

Costs were computed for site preparation, restoration and mitigation and materials transport to each location.

Since there are a number of alternative transportation methods, volumes, characteristics and sources for the materials to be moved to the fill sites, these costs are presented independently of the other cost components associated with each of the disposal sites.

Materials transport costs, with the notable exception of train haul costs, are relatively independent of the volume of material to be moved, and can be quoted as a unit cost per cubic meter. However, site preparation and restoration costs presented on the same basis will vary widely if the depth or volume of fill to be placed varies from the amount assumed for the unit rate computation. For this reason, it is considered that ranking of these elements of costs is best presented on the basis of unit cost per hectare.

Unfortunately, this then prevents the presentation of a single cost ranking for each site. However, an attempt to make this comparison is presented in Table 10-9, based on the assumption that each site would be filled to its maximum capacity. The reader is cautioned that this global cost ranking is suspect, since the total system capacity exceeds the total volume of material generated by the three projects, which in turn negates the assumption of maximum fill volume at each site. It is also quite likely that several sites may be used as primary disposal areas, and feed minor locations, which again will distort the global cost rankings.

Table 10-9: Cost Comparisons for all Disposal Sites

Site	Description	Area (ha)	Maximum Site Capacity (m3)	Site Preparation & Restoration		Transport Costs ($/m3)		Total Cost ($/m3) at max capacity	
				$/ha	$/m3	Dry Material	Wet Material	Dry Material	Wet Material
Gaillard Cut Disposal Sites									
T1	Rio Mandinga	149	60 072 000	$31 600	$0.07	$2.06	$3.85	$2.13	$3.92
T2	Rio Camacho	89	32 350 000	$28 537	$0.09	$2.64	$4.39	$2.73	$4.48
T3	Gaillard Cut North	115	28 130 000	$73 012	$0.30	$3.35	$3.86	$3.65	$4.16
T4	Gaillard Cut East /1	106	12 560 000	$9 767	$0.08	$3.32		$3.40	
T5	Gaillard Cut South	30	7 280 000	$77 640	$0.33	$3.11	$4.88	$3.44	$5.21
T6	UXO Sites	305	115 240 000	$69 898	$0.19	$4.66	$3.87	$4.85	$4.06
A1	Trinidad Dam		33 500 000				$4.84		$4.84
Third Locks Excavation Disposal Sites									
A1	Trinidad Dam		33 500 000				$12.72		$12.72
T6	UXO Sites	305	115 240 000	$69 898	$0.19	$3.24		$3.43	
T7	Miraflores Locks West Bank	45	4 500 000	$3 911	$0.04	$3.36		$3.40	
T8	1939 Locks Excavation Lagoons	27	5 000 000	$2 453	$0.02	$2.98		$3.00	
T9	Rodman/Horoko /2	59	5 900 000	$57 098	$0.67	$3.79		$4.46	
T10	El Arado	876	87 560 000	$64 280	$0.54	$5.42		$5.96	
M1	Panama Bay Fill /3	520	61 680 000	n/a		$6.46		$6.46	
M2	Chorrillo Bay /3	94	6 560 000	n/a		$7.98	$2.42	$7.98	$2.42
M3	Amador Causeway East Expansion	107	11 230 000	$13 580	$0.11	$7.98	$2.42	$8.09	$2.53
M4	Farfan/Palo Seco Reclamation	324	32 430 000	$37 146	$0.37	$6.62		$6.99	
M5	Artificial Island	350	110 400 000	$14 759	$0.05	$4.20		$4.25	
M6	Open Water Disposal	1 800	110 000 000	n/a		$5.08		$5.08	
Pacific Entrance Channel Disposal Sites									
M1	Panama Bay Fill /3	520	61 680 000	n/a			$2.67		$2.67
M2	Chorrillo Bay /3	94	6 560 000	n/a			$2.01		$2.01
M3	Amador Causeway East Expansion	107	11 230 000	$13 580	$0.11		$2.01		$2.12
M4	Farfan/Palo Seco Reclamation	324	32 430 000	$37 146	$0.37		$1.96		$2.33
M5	Artificial Island	350	110 400 000	$14 759	$0.05		$2.15		$2.20

Notes: 1 Site T4 to be used for dry material from East Bank widening.

2 Rodman Horoko has severe environmental constraints.

3 Development costs for Panama Bay and Chorrillo Bay projects not in scope of study.

4 Total costs assume site is filled to maximum capacity

10.4 Value Added Potential

The scope of this study does not extend to computations of value added forecasts for each of the candidate disposal sites. Using the ten point system indicated earlier, classification of the sites is therefore based on the following categories:

- Significant Financial Added Value (i.e. sale or land rental income)..... 0
- Significant Community and Economic Benefits..... 4
- Potential Economic or Intrinsic Benefits to Panama..... 6
- Nominal or modest financial or economic benefits..... 8
- No Added Value or Benefits..... 10

It should be noted that it might be argued that Site T10 (El Arado) has negative added value since the land must first be purchased before filling, after which it would be restored to its original state. However, in this study, the costs of land acquisition and compensation have been included in the site preparation cost estimates presented in the previous section, in order that a cost comparison can be made for all sites. It is therefore not appropriate to also penalize this option on the basis of its negative added value.

The results of this analysis are presented in Table 10-10, below:

10.4 Value Added Potential

The scope of this study does not extend to computations of value added forecasts for each of the candidate disposal sites. Using the ten point system indicated earlier, classification of the sites is therefore based on the following categories:

- Significant Financial Added Value (i.e. sale or land rental income) 0
- Significant Community and Economic Benefits 4
- Potential Economic or Intrinsic Benefits to Panama 6
- Nominal or modest financial or economic benefits 8
- No Added Value or Benefits 10

It should be noted that it might be argued that Site T10 (El Arado) has negative added value since the land must first be purchased before filling, after which it would be restored to its original state. However, in this study, the costs of land acquisition and compensation have been included in the site preparation cost estimates presented in the previous section, in order that a cost comparison can be made for all sites. It is therefore not appropriate to also penalize this option on the basis of its negative added value.

The results of this analysis are presented in Table 10-10, below:

Table 10-10: Sites Classification based on Value Added Potential

Site Ref.	Designation	Value Added Potential (10-point Classification)		Ranking
Gaillard Cut Materials Sites				
T1	Rio Mandinga	None	10	**4**
T2	Rio Camacho	None	10	**4**
T3	Gaillard Cut North	None	10	**4**
T4	Gaillard Cut East	Nominal Community Benefits	8	**2**
T5	Gaillard Cut South	None	10	**4**
T6	UXO Area	Nominal Community Benefits	8	**2**
A1	Trinidad Dam Project	Potential Economic	6	**1**
Third Locks Excavation Sites				
T6	UXO Area	Nominal Community Benefits	8	**6**
T7	Miraflores West Bank	None	10	**7**
T8	1939 Third Locks Excavation	None	10	**7**
T9	Rodman/Horoko	None	10	**7**
T10	El Arado	None	10	**7**
M1	Panama Bay Fill	Significant Financial	0	**1**
M2	Chorrillo Bay Fill	Significant Community/Economic	4	**4**
M3	Amador East	Significant Community/Economic	4	**4**
M4	Farfan/Palo Seco	Significant Financial	0	**1**
M5	Artificial Island	Significant Financial	0	**1**
Pacific Entrance Channel Dredging Sites				
M1	Panama Bay Fill	Significant Financial	0	**1**
M2	Chorrillo Bay Fill	Significant Community/Economic	4	**4**
M3	Amador East	Significant Community/Economic	4	**4**
M4	Farfan/Palo Seco	Significant Financial	0	**1**
M5	Artificial Island	Significant Financial	0	**1**
M6	Open Water Disposal	None	10	**6**

10.5 Institutional or Project Approval Considerations

This section examines the institutional and approval aspects of each site and attempts to classify each site on the basis of the time, level of effort required and cost of securing the necessary approvals or public support to move ahead with the project.

10.5.1 Introduction

There are some elements that should be considered at the moment in which decision is being taken for the use of the sites. These elements - or variables - include social, legal, institutional or development sectors which may have some type of relation with the marine sites and have to be taken in consideration before the future use of any of the sites.

10.5.2 Terrestrial Sites

Social

For the purpose of this evaluation a social variable is:

- The impact on a population or individual families or livestock and agrarian developers that have to be transfer from its original settlement or land to other ones because the area is going to be used as disposition site.
- Health risks that persons or individuals may have because of the use of any particular site.
- The negative way in which public and private terrestrial transport users may be affected because of the roads used for the transportation of excavated material to the disposal sites.

Legal

The legal aspects that should be consider when a site is being selected are those that constitute the framework of natural resources which may be affected or those that may be have a different use as designated by a law.

The legal framework for natural resources encompasses: the forestry legislation, the rules that regulate water resources, the protection of wildlife, and the Code of Mineral Resources.

Other legal aspects that should be taken into consideration are:

- Law 21 of July 2, 1997, by which the Regional Plan for the Development of the Interoceanic Region and General Plan for the Use, Conservation and Development of the Canal Area are approved.
- The Agrarian Code, 1962
- The Panama Canal Treaty (Torrijos-Carter) September 7, 1977.

Institutional

At the moment in which a disposal site is being selected it is necessary to know which governmental institution has jurisdiction over that particular site, or the institution that has jurisdiction over a specific sector that may be affected by the selection of a site.

Institutions that should be taken into consideration at the moment of site selection are:

- The Interoceanic Region Authority (Autoridad de la Región Interoceánica, ARI)
- The National Environmental Authority (Autoridad Nacional del Ambiente, ANAM)
- The Ministry of Public Works (Ministerio de Obras Públicas, MOP)
- The Ministry of Health (Ministerio de Salud, MINSA)
- The Ministry of Livestock and Agrarian Development (Ministerio de Desarrollo Agropecuario, MIDA)
- Ministry of Housing (Ministerio de la Vivienda, MIVI)
- The Ministry of Foreign Affairs (Ministerio de Relaciones Exteriores, MINREX)

Developmental Sectors

The development sectors include different productive national sectors which may be affected with the selection by the selection of a site that is being use by another national sector. Among the sectors that should be considered are:

- Livestock and agricultural development
- Transportation
- Tourism
- Industrial
- Natural Resources (sub sector of protected natural areas)

Site T1 – Rio Mandinga

This site has no social or institutional issues. Legal interaction falls under Law 21 of July 2, 1997 by which the Regional Plan for the Development of the Interoceanic Region and General Plan for the Use, Conservation and Development of the Canal Area are approved. Part of the site is considered as Native Protected Area (Área Silvestre Protegida). Protection Forest. West Bank of the Canal (Bosque Protector. West Bank of Canal.)

Site T2 – Rio Camacho

No social or institutional issues. The legal issues are similar to Site T1 and the site is also protected as for T1.

Site T3 – Gaillard Cut North.

The use of sites T3, T5 and T6 as shooting ranges by the United States may be a health risk to persons or individuals. Legal interaction is similar to other locations within the Canal area of jurisdiction.

These sites are designated as impact areas and dangerous materials site under Law 21 of July 1997. (Ärea de uso diferido – Area de impacto y materiales peligrosos). The objective of this category is to temporarily limit any type of development base on potential dangerous conditions.

Besides the legal implications there are political implications due to the fact that the Republic of Panama has requested that the United States Government complies with Article IV Use of Defense Sites (Usos de los Sitios de Defensa) number 4, of the application of Article III of the Panama Canal Treaty related to the removal from the sites all menace to the life, health and human securities ("*que toda amenaza a la vida salud y seguridad sea removida de cualquier sitio de defensa, area de coordinación militar, o porción del mismo...*"

Site T4 – Gaillard Cut East

This site presents no legal or institutional issues of note. Users of the Trans isthmian Highway (Panama-Colon) may be affected because of the road could be used for the transportation of excavated material to the disposition site. Hence the use of this site may affect the Transportation Sector.

Site T5 – Gaillard Cut South

Institutional issues for this site are similar to those at T3 and T6.

Site T6 – UXO Area

Institutional issues for this site are similar to those at T3 and T5, with the exception that the area covered by T6 is much larger and likely to be more controversial.

Site T7 – Miraflores West Bank

This site presents no significant institutional issues.

Site T8 – 1939 Locks Excavation Sites

This site presents no significant institutional issues.

Site T9 – Rodman- Horoko

This site is under the jurisdiction of the Authority of the Interoceanic Region (ARI). The sector interaction means that the area has been transfer from the public to the private sector, particularly to the industrial sector.

Site10 – El Arado

The use of the site will have an impact on the population or individual families that have to be transfer from its original settlement or land to other ones because the area is going to be used as disposition site. The legal interaction means that land tenure of settlers may

be under the regulation of the Agrarian Code. The sector interaction means that the area is used for livestock and agricultural production.

The following table presents an assessment of the social, legal, institutional and development considerations for each of the marine disposal sites. The word "yes" means that there is an interaction between a variable and a specific site. On the other hand, the word "no" means that there are no significant issues under the classification criteria.

Table 10-11: Institutional Variables for Terrestrial Sites

Site	Description	Social	Legal	Institutional	Sectorial
T1	Rio Mandinga	No	Yes	No	Yes
T2	Rio Camacho	No	Yes	No	Yes
T3	Gaillard Cut North	No	Yes	No	No
T4	Gaillard Cut East	Yes	No	Yes	Yes
T5	Gaillard Cut South	No	Yes	No	No
T6	UXO Area	Yes	Yes	No	No
T7	Miraflores West Bank	No	No	No	No
T8	1939 Locks Excavations	No	No	No	No
T9	Rodman - Horoko	Yes	Yes	Yes	Yes
T10	El Arado	Yes	Yes	No	Yes

10.5.3 Elements or variables pertinent to Marine Sites

Social Issues

For the purpose of this evaluation social variables are:

- The positive or negative impact on the population that may be affected by the use a particular site.
- The attitude of sectors of the population or social groups such as No Government Organization (NGO) may have because of the use of a particular site.

Legal Aspects or Jurisdictions

A legal aspect that should be taken in consideration is the Law 21 of July 2, 1997 by which the Regional Plan for the development of the Interoceanic Region and General Plan for the Use, Conservation and Development of the Canal Area are approved.

Institutional Considerations

Before a marine disposal site is selected it is necessary to know which Government Institution has jurisdiction over a particular site, or the institution that has jurisdiction or is related over a specific sector that may be affected by the selection of a site. Institutions that should be taken in consideration are:

- The Interoceanic Region Authority (Autoridad de la Región Interoceánica (ARI).
- The National Environmental Authority (Autoridad Nacional del Ambiente, ANAM)
- The Ministry of Public Works (Ministerio de Obras Públicas, MOP)
- The Ministry of Housing (Ministerio de Vivienda, MIVI)
- Maritime Authority of Panama (Autoridad Marítima de Panamá, AMP)
- Panamanian Institute of Tourism (Instituto Panameño de Turismo, IPAT)

Developmental Sectors

The developmental sectors include different productive national sectors which may be affected with the section of a site that is being use by another sector. Among the sectors that should be considered are:

- Tourism
- Transportation
- Fisheries
- Housing and urban development

Site M-1 - Panama Bay Filling

Public reaction to the filling of the Panama Bay may be significant and the objections of various special interest or environmental groups should be expected. There do not appear to be any significant legal concerns. There is an institutional interaction with the Ministry of Housing which is responsibly for the housing and urban policy. The transportation sector may be affected by the movement of the excavated material to the disposal site, although it is expected that barges would be the primary movers of material.

Site M-2 - El Chorrillo

There may be a positive interaction with the tourism sector if area to be filled will form a part of a road development that will connect to the Amador Causeway. There is an interaction with the transportation sector which may be affected by the transport of the excavated material to the site, although barges are expected to be the prime movers for material taken from the Pacific Channel dredging project.

Site M-3 - Amador Causeway

Users of the area will benefit from the fill project, particularly if the traffic congestion problem is resolved. This site falls under Law 21 of July 2, 1997, by which the Regional Plan for the development of the Interoceanic Region and General Plan for the Use, Conservation and Development of the Canal Area are approved. There is an institutional interaction with the Interoceanic Region Authority (ARI) and the Ministry of Housing and Public Works. There will be a positive interaction with the tourism sector if additional recreation and tourism related facilities can be built along the Causeway.

Site M-4 - Farfan/Palo Seco

There may be significant public reaction to this project if the site is used to build a sea port affecting the landscape of the natural environment and views from the Amador Causeway. There is an institutional interaction with Marine Authority of Panama which has the function of propose and execute the National Maritime Strategy.

Site M-5 - Artificial Island

The development of the island may generate a negative social reaction from the public in general and from environmental groups. There is an institutional interaction with Marine Authority of Panama which has the function of propose and execute the National Maritime Strategy. Construction of the island may have a negative effect in the fisheries, tourism and transportation sectors.

Site M-6 - Open Water Disposal Site

It is not expected that the deep water disposal option will be controversial or have any negative social effects. There is an institutional interaction with Marine Authority of Panama which has the function of propose and execute the National Maritime Strategy, and it is possible, but unlikely that local fisheries sector may be affected.

10.5.4 Summary of Institutional Classifications

The following table presents an assessment of the social, legal, institutional and development considerations presented above for each of the marine disposal sites. The word "yes" means that there is an interaction between a variable and a specific site.

Table 10-12: Institutional Variables for Marine Sites

Sites	Description	Variables			
		Social	Legal	Institutional	Sectorial
M-1	Panama Bay	Yes	No	Yes	Yes
M-2	Chorrillo Bay	Yes	No	Yes	Yes
M-3	Amador East	Yes	Yes	Yes	Yes
M-4	Farfan/Palo Seco	Yes	No	Yes	Yes
M-5	Artificial Island	Yes	No	Yes	Yes
M-6	Open water Disposal	No	No	Yes	Yes

Source: LBG, 2003

The results of the institutional and approval evaluations are presented in Table 10-13 according to the following categories and scores.

0 – No significant Institutional or Approval issues
3 - Moderate significant Institutional or Approval issues
7- Significant Institutional or Approval issues
10 - Strong Institutional or Approval issues

For each group of sites, each location is given a score of 0 to 10 for each variable, which is then averaged for the overall classification according to the four evaluated parameters.

Table 10-13: Classification of Sites According to Institutional or Approval Issues

Site Ref.	Designation	Classification on 10 point basis	Ranking
Gaillard Cut Materials Sites			
T1	Rio Mandinga	1.0	2
T2	Rio Camacho	1.0	2
T3	Gaillard Cut North	3.5	4
T4	Gaillard Cut East	0.5	1
T5	Gaillard Cut South	3.5	4
T6	UXO Area	3.5	4
A1	Trinidad Dam Project	n/a	n/a
Third Locks Excavation Sites			
T6	UXO Area	3.5	5
T7	Miraflores West Bank	0	1
T8	1939 Third Locks Excavation	0	1
T9	Rodman/Horoko	3.25	4
T10	El Arado	5.0	9
M1	Panama Bay Fill	5.5	11
M2	Chorrillo Bay Fill	5.25	10
M3	Amador East	3.5	5
M4	Farfan/Palo Seco	4.25	8
M5	Artificial Island	3.5	5
M6	Open Water Disposal	1.0	3
Pacific Entrance Channel Dredging Sites			
M1	Panama Bay Fill	5.5	6
M2	Chorrillo Bay Fill	5.25	5
M3	Amador East	3.5	2
M4	Farfan/Palo Seco	4.25	4
M5	Artificial Island	3.5	2
M6	Open Water Disposal	1	1

10.6 Summary of All Classifications

As can be seen from the foregoing paragraphs, the classification of each site varies considerably according to the category of evaluation. Table 10-14 presents the classifications for each site and category based on the ten-point system indicated earlier. As previously mentioned, due to the inherent defects in any weighting system, no attempt is made in this study to place any emphasis on any of the evaluation categories. Consequently, combined-score was simply the sum of the socioeconomic, environmental, value added, and institutional, scores.

Table 10-14: Summarized Classifications of Disposal Sites

Site Ref.	Designation	Ranking by Category				Combined Score	Costs $/m3	
		Socio Economic	Environmental	Value Added	Institutional		Dry material	Wet Material
Gaillard Cut Materials Sites								
T1	Rio Mandinga	0	1	10	0.10	11	2.13	3.92
T2	Rio Camacho	0	3	10	0.10	13	2.73	4.48
T3	Gaillard Cut North	0	1	10	3.50	15	3.65	4.16
T4	Gaillard Cut East	0	1	8	0.50	10	3.40	
T5	Gaillard Cut South	0	1	10	3.50	15	3.44	5.21
T6	UXO Area	0	3	8	3.50	15	4.85	4.06
A1	Trinidad Dam Project	n/a	n/a	n/a	n/a	n/a		4.84
Third Locks Excavation Sites								
A1	Trinidad Dam Project	n/a				n/a		12.72
T6	UXO Area	0	3	8	3.50	15	3.43	
T7	Miraflores West Bank	0	1	10	0.00	11	3.40	
T8	1939 Third Locks Excavation	0	3	10	0.00	13	3.00	
T9	Rodman/Horoko	0	8	10	3.25	21	4.46	
T10	El Arado	6	3	10	5.00	24	5.96	
M1	Panama Bay Fill	n/a	3	0	5.50	n/a	6.46	
M2	Chorrillo Bay Fill	6	3	4	5.25	18	7.98	2.42
M3	Amador East	2	3	4	3.50	13	7.98	2.42
M4	Farfan/Palo Seco	6	5	0	4.25	15	6.99	
M5-1	Artificial Island - Port	10	8	0	3.50	22	4.25	
M5-2	Artificial Island - Mixed Use	6	5	0	3.50	15	4.25	
M5-3	Artificial Island - Nature Reserve	2	3	8	3.50	17	4.25	
M6	Open Water Disposal	2	3	10	1.00	16	5.08	
Pacific Entrance Channel Dredging Sites								
M1	Panama Bay Fill	n/a	3	0	5.50	n/a		2.67
M2	Chorrillo Bay Fill	6	3	4	5.25	18		2.01
M3	Amador East	2	3	4	3.50	13		2.12
M4	Farfan/Palo Seco	6	5	0	4.25	15		2.33
M5	Artificial Island	6	8	0	3.50	18		2.15
M6	Open Water Disposal	2	3	10	3.00	18		2.15

11 SUMMARY & CONCLUSIONS

11.1 General Findings

As noted early in this report, it is important to classify and evaluate each of the disposal sites based on the source of material. The following discussion highlights the key points related to each group of sites, and presents some general recommendations for prioritization.

11.1.1 Gaillard Cut Sites

None of the Gaillard Cut candidate sites present any serious obstacles from environmental or cost standpoints, with the exception of sites T3 (Gaillard Cut North) T5 (Gaillard Cut south) and T6 (UXO area), all of which are within the UXO designated areas.

However, there is ample capacity in sites T1, T2 and T4 to meet the requirements of the project and the following terrestrial sites are appropriate for immediate use as disposal locations for Gaillard Cut material.

- T1 (Rio Mandinga) (Modified Delineation)
- T2 (Rio Camacho) (Modified Delineation)
- T4 (Gaillard Cut East)
- In the event that fill material is required for the Trinidad Dam project, the Gaillard Cut material represents the most cost effective source, although the transportation cost will be approximately $1.00 per m3 higher than deposition at the sites listed above.

11.1.2 Third Locks Sites

Sites T7 (Miraflores West Bank) and **T8 (1939 Locks Excavations)** are closest to the excavation site and present no obstacles to immediate use to receive fill material. However the combined capacity is limited to some 9.50 million m3 and dependent on the final alignment of the Locks and plans for the use of the area surrounding the new construction. Based on these limitations, it is recommended that these two sites fall under the jurisdiction of the group charged with the final planning and design of the Locks and supporting areas.

Site T6 (UXO area) represents an important potential site to receive material from the Locks project since it offers the capacity to receive the entire fill, with few environmental

problems. Transportation costs are very economic, but the key issue is the resolution of the UXO problem.

As a minimum, ground surveys and risk assessments are required, but it would appear logical that the placement of up to 30 m of fill over the UXO area should resolve the issue for once and for all.

In the event that the risk assessment indicates that it is not necessary to undertake extensive recovery and clearance of the unexploded materials, the development and restoration costs of this site will be significantly reduced.

A major disadvantage of the UXO site is that the resolution of the UXO issues and placement of fill at this location adds no value to the site, unless ACP were to reverse its policy on development within the Panama Canal area of control. This is an unlikely expectation.

Sites that are not considered suitable as disposal options are **T9 (Rodman/Horoko)**, due to environmental concerns & capacity limitations and site **T10 (El Arado)** due to cost and institutional issues. In particular, the El Arado site is in private ownership and should only be considered for disposal in the event that all other possibilities have been exhausted.

Site M1 (Panama Bay Fill) is an exciting option but most unlikely to take place without years of discussion, planning and the expenditure of significant amounts on sewage line diversion and other water quality related projects. Given this uncertainty and the potential high cost of movement of material to the site, it is recommended that it not be given a high priority as a disposal site for this project.

Sites M2 (Chorrillo Bay) and M3 (Amador East) are excellent candidates to receive material but the cost of transport from the Locks excavation is higher than for the Pacific entrance dredging project and it is recommended that they be designated as potential sites for this latter source.

Site M4 (Farfan – Palo Seco) is likely to be controversial since there may be impacts of development on the land side areas adjacent to the fill. At the same time, any extension of the headland parallel to Amador will block the view from the Causeway and is likely to be unpopular with the public and also with the investors in the Causeway projects.

However, limited fill at this location could provide the basis for additional container terminals or a mixed use residential-commercial type of development, in conjunction with one of the other disposal sites.

Site M5 – (the artificial island) is the only one marine site that offers the potential to receive all of the excavated material from the Locks Project. However, the impact of development of a port complex on the island may not be favorably accepted by the neighboring communities and public at large.

The mixed use development option is likely to meet with less resistance and has the advantage that it can be designed to dispel many of the objections to the less flexible port option.

The costs of transportation of materials to the island are relatively close to the costs of development and transport to the UXO areas, although additional study of the UXO site is needed to confirm the site preparation costs.

11.1.3 Pacific Entrance Channel Dredging

The favored site for receipt of material from this project is **M3 (Amador East)**, closely followed by **M2 (Chorrillo Bay)**. Transport costs to both are similar and very low, and there are likely to be few objections to filling the area east of the Causeway to improve traffic flows and add recreational features to this attractive location. However, relocation of the Smithsonian Pier and access would be required, and it is not clear which entity would take responsibility for the cost of this work. Approvals for filling Chorrillo Bay will be more difficult and there are socio economic issues associated with this project.

11.2 Summary of Recommendations

In summary, there are few difficulties associated with the allocation of terrestrial sites T1, T2 and T4 for receipt of materials from the Gaillard Cut project. They have ample capacity to meet the projected volume of material and pose no significant environmental challenges. For the Gaillard cut work, sites T3, T5 and T6 are less cost effective and not required to meet the expected volume of materials to be excavated or dredged.

Amador Causeway East (M3) is the preferred candidate for material from the Pacific entrance dredging, although placement of the full volume of some 14 million m3 would require expansion of the Causeway by 500 m, hat may be seen as excessive. In the event that filling can be approved for the Chorrillo Bay site, (M2), this then resolves this issue.

The key issue related to this study is the selection of one or more sites to receive some 90 million m3 of material from the Third Locks Project. If the El Arado site is discounted for the reasons noted earlier, only the UXO area (site T6) and the artificial island (Site M5) remain as sites that could receive all of the fill material. The combined capacity of all of the other acceptable sites does not meet the project needs. Hence the basic choice comes down to the selection of one of these two options,

Unfortunately there are a number of serious issues to be resolved at both locations. The resolution of the UXO issue at Site T6 requires approvals from high level government

and the development of the site provides no added value for the investment in UXO clearance and site restoration.

On the other hand, recent waterfront fill projects in Panamá have been surprisingly controversial and it is difficult to gage the public reaction to the construction of a new island north of Taboga. The presentation of the four development alternatives introduced in this report may go a long way to gaining public support of this project, but it is still relatively unknown territory at this time.

Based on these conclusions and concerns, it is recommended that detailed studies should now be commenced to resolve as many of the identified issues related to the UXO site and the artificial island project as soon as possible. In this way, ACP can assess the reaction to both projects while getting a better understanding of the cost and time implications of each option.

With all of the required information and approvals in hand, a decision can then be made on the preferred site or sites, based on value added or cost considerations.