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**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 3 of 3*

*Technical Appendices*

**March 2004**

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**LOUIS BERGER GROUP**



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**APPENDIX A - UXO ASSESSMENT**

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**TECHNICAL MEMO ON UXO INVESTIGATION  
AT THE PROPOSED DREDGE DISPOSAL SITE**

**INTRODUCTION**

The ACP is evaluating several alternatives for disposing of approximately 70 million cubic meters of excavation material from the proposed new lock construction at the Pacific site. Potential alternatives for disposal of this material include terrestrial or marine sites that could also be developed as land reclamation projects. One of the terrestrial disposal sites being considered is a former military firing range located (don't know if this is the Empire Range, Fort Clayton, Fort Sherman etc). This range was used by the United States Military for live firing training and munitions testing from 1910 to the late 1990s.

The problem is how to best prepare this area as an upland disposal site for the dredged materials at a minimum risk during construction activities and to people who may use the recovered area over the ensuing years. The standard approach for clearing a former firing range is by using geophysics followed by removal of potential dangerous materials identified by the investigation.

**BACKGROUND INFORMATION ON ORDNANCE**

Ordnance and explosives (O&E) consist of ammunitions, 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 (i.e. UXO) 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 (OE) in support of Defense Environmental Restoration Program fro 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 2000 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.

### **EXAMPLE CASE HISTORIES**

The use of geophysics to map OE at military bases has been ongoing for over 20 years. These programs have proven to be very successful and the land has been returned to the public and/or military for other activities. Several examples of these investigations are provided.

Fort Ord, California Used since 1917 by cavalry, field artillery and infantry units for target ranges. A wide variety of conventional UXO items have been located at sites throughout Fort Ord. This 950 acre site contained live, and sensitively fuzed surface OE items in close proximity to residential neighborhoods and schools with the potential for trespasser on the property. Hand grenades, rifle grenades, mortars were located at the surface to 4 feet below ground surface.

Waikoloa Maneuver Area, Hawaii Visual reconnaissance surveys were developed as a tool by CEHNC and their contractors to focus the geophysical investigation on the highest priority areas at a 123,000-acre FUDS on the Island of Hawaii. The purpose was to identify areas that warranted geophysical mapping and subsequent OE sampling. The visual survey attempted to identify any visible surface evidence of past military use of explosive ordnance. As a result of this survey the geophysical program was only required on 32,000 of the 63,000 acres.

Camp Bonneville, Washington is a 4,000 acres site in southwestern Washington State that was used by the Department of the Army for small arms, assault weapons, field artillery between 1910 and 1995. The reuse plan was developed for all of the Camp to be turned over to Clark County for the public benefit including education, law enforcement and parks.

## **GEOPHYSICAL INVESTIGATIONS FOR UNEXPLODED ORDNANCE (UXO)**

### **Objective of Investigation**

The general objective of the geophysical investigation is to efficiently and safely locate UXO for proper evaluation, recovery, and disposition. The geophysical investigations are generally conducted at former military ranges for two main purposes:

1. **Reconnaissance Surveys:** Geophysical investigations are performed at representative areas of a site as a means to characterize a larger area. The objective of this reconnaissance level of effort is to cost-effectively characterize the distribution, type and conditions of UXO on the site. These type of surveys also include visual investigations to focus the geophysical investigation on potentially high priority areas.
2. **Mapping Surveys:** Geophysical mapping is performed across an entire area suspected of containing ordnance and explosives (OE). The objective to locate all UXO type objects meeting certain criteria (size, type, composition, depth of burial etc.).

In each case the objective of the geophysical investigation is to efficiently locate buried UXO while minimizing the number of non-UXO anomalies generated by metallic debris or other cultural artifacts that are unrelated to OE.

Some advantages of using geophysical methods for locating UXOs include:

1. **Minimum Intrusion:** Provides relative safe working conditions for survey personnel during the initial phase of site characterization.
2. **Synoptic Description of Site:** Provides rapid coverage of a large area and can pinpoint areas of concern or identify areas for intrusive investigation.
3. **Large Search Radius:** Most geophysical instruments have an area of search or footprint and therefore have less chance of missing a target by a short distance which is common to boring or trenching.
4. **Cost Effective:** Geophysical surveys are cost effective providing high data returns for field time and do not require costly decontamination processes.

### **Types of Instruments**

Geophysical instruments are divided into two main categories based on how they detect a target. These are:

1. **Active Instruments:** These devices emit a signal (acoustic, electromagnetic, electrical) and then measure the response of the target to the signal. This class of

instruments include seismic or sonar, electromagnetic metal locators or conductivity meters and resistivity meters.

2. **Passive Instruments:** These devices measure existing fields (magnetic, gravitational) and the variation of these fields in time or space. This class of instruments includes magnetometers, gravity meters, infrared (IR), and chemical analyzer.

It is fundamentally difficult to detect small buried objects and even more difficult to classify or categorize these objects. The general consensus based on the published literature is that the two methods that appear to be the most promising for UXO detection are electromagnetic (active) and magnetic (passive); preferable used in combination. These two methods are non-intrusive (electrical and seismic are intrusive); can detect small objects (gravity has extremely poor resolution); have a reasonable size footprint for detecting objects outside of the survey transect (ground penetrating radar has a narrow vision of coverage); and provide high quality data even when used by technician level personnel.

#### **Electromagnetic Conductivity Meters (metal locators)**

These instruments work by pulsing small electrical current into the ground from a hand held antenna and measuring the induced electrical eddy currents that develop around metallic objects. They can detect any conductive metal, ferrous and nonferrous, and are little affected by geologic noise. The two most commonly used for UXO search are time domain electromagnetic meters (TDEM) and frequency domain electromagnetic meters (FDEM). The former has excellent detection depth and the latter excellent resolution.

#### **Magnetometer and Gradiometer**

These instruments measures disturbances in the Earth's magnetic field which is caused by the presence of ferrous objects. Some magnetometers, called gradiometers, use two sensors, one above the other, and determine the gradient of the field (magnetometer measures the absolute value) which is a more sensitive method for detecting small objects.

In 1993, Congress mandated that the U.S. Army conducts a program at Jefferson Proving Ground (JPG), near Madison, Indiana, to demonstrate and evaluate systems and technologies that can be used to detect, identify, and remediate buried UXO. This program consisted of JPG Phases I, II, and III that were conducted in 1994, 1995, and 1996, respectively. The instruments evaluated included electromagnetic induction (EMI), gradiometer (Grad), magnetometer (Mag), and ground penetrating radar (GPR). The overall probability of detection (Pd) on these tests was  $0.68 \pm 0.28$  with false alarm ratio of  $6.00 \pm 4.77$  (Table 1).

The inability to distinguish ordnance from prevalent metal clutter, producing false alarms, is the major cost factor in the remediation UXO properties. Therefore, in 1998 a JPG Phase IV was conducted to evaluate the ability of detection systems to differentiate UXO items from man-made ferrous objects. The various discrimination techniques that were used are listed in Table 2 and the results are shown in Figure 1<sup>(2)</sup>.

TABLE 1

DEMONSTRATOR ORDNANCE DETECTION BY SENSOR TECHNOLOGY  
FOR COMBINED SCENARIOS (1,2 AND/OR 3<sup>3</sup>)

| Sensor Type  | Demonstrator (Scenario #)    | P <sub>D</sub> | False Alarm (FA)<br>Rate (#/Hectare) | FA Ratio<br>(#/Ordnance<br>Detected) |
|--|------------------------------|----------------|--------------------------------------|--------------------------------------|
| Electromagnetic<br>Induction (EM)                    | CHEMRAD (1,2)                | .50            | 12.90                                | 1.91                                 |
|  | GRI (EM) (1,2,3)             | .87            | 123.89                               | 8.46                                 |
|  | GeoPotential (1,2,3)         | .06            | 9.04                                 | 8.54                                 |
| Gradiometer (Grad)                                   | Foerster (1)                 | .60            | 36.46                                | 4.85                                 |
| Magnetometer (Mag)                                   | Battelle (2)                 | .12            | 1.71                                 | 1.00                                 |
|  | GRI (Mag) (1,2,3)            | .70            | 223.68                               | 18.82                                |
|  | Rockwell (1,2)               | .34            | 25.93                                | 5.70                                 |
| EM & Grad<br>EM & Mag                                | Geophex (1,2)                | .77            | 32.44                                | 3.11                                 |
|  | ADI (3; Mag only in 1,2)     | .78            | 109.48                               | 8.3                                  |
|  | GRI (Combined) (1,2,3)       | .93            | 240.53                               | 15.23                                |
|  | Geo-Centers (1,2,3)          | .93            | 81.80                                | 5.18                                 |
|  | Geometrics (2)               | .90            | 38.44                                | 3.00                                 |
|  | NAEVA (1,2)                  | .94            | 24.84                                | 1.96                                 |
|  | SCA_ADI (3; Mag only in 1,2) | .63            | 46.80                                | 4.36                                 |
|  | SCA_Geo-Centers (1,2,3)      | .76            | 43.55                                | 3.36                                 |
|  | SCA_Geometrics (2)           | .96            | 41.86                                | 3.06                                 |
| Ground Penetrating<br>Radar (GPR)<br>GPR & EM & Grad | ENSCO (1,2)                  | .70            | 48.66                                | 5.14                                 |
|  | Average                      | .68 ±<br>.28   | 67.18                                | 6.00 ± 4.77                          |

<sup>3</sup> Note: Data is presented for JPG Phase III, Scenario 1,2, and 3 only. These scenarios had representative UXO for demonstrators to search for, localize, and classify. Scenario 4 was not a detection exercise. In scenario 4, targets were marked by the government test coordinators to assess the capability of demonstrated systems to *classify marked targets*.

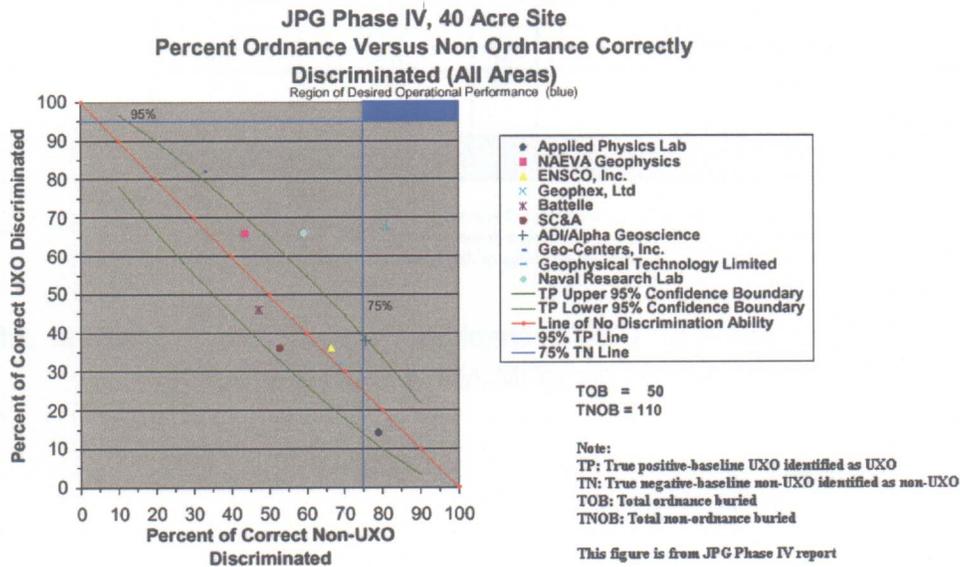
(This table is from the report of UXO Technology Demonstration Program at Jefferson Proving Ground (Phase IV) Report No. SFIM-AEC-ET-CR-99051, 1999)

**Table 2 Demonstrators' Technologies and Discrimination Techniques**

| Vendor   | Technology                           | Discrimination Technique*         |
|--|--------------------------------------|-----------------------------------|
| APL  | Pulsed Electromagnetic Induction     | Statistical Processing            |
| NAEVA  | TF Mag., EM-61, EM-61 3D, Protem 47D | Parameter Matching                |
| ENSCO  | Gradiometer, GPR, EM-61HH            | Sensor Fusion (matching)          |
| Geophex  | GEM-3 Multifrequency EM, TF Mag.     | Target Match to Signature Library |
| Battelle   | GPR                                  | Linear Shape using CNR            |
| SC&A   | TF Mag., EM-61HH, GPR                | Target Signature Comparison       |
| ADI  | TF Mag., EM-61HH, GPR                | Visual Interpretation of GPR      |
| Geo-Centers  | TF Mag., EM-61                       | Fuzzy Inference                   |
| GTL  | TF Mag., EM.                         | Statistical Fit to a Data Set     |
| NRL  | TF Mag., EM-61                       | Physics Based Algorithm           |
| TF Mag. – total field magnetometer, GPR – ground penetrating radar, EM-61HH – EM-61 handheld |                                      |                                   |
| * from demonstrators' proposals  |                                      |                                   |

(This table is from the report of UXO Technology Demonstration Program at Jefferson Proving Ground (Phase IV) Report No. SFIM-AEC-ET-CR-99051, 1999)

**Figure 1: TP versus TN for all areas**



**PLANNING FOR THE GEOPHYSICAL INVESTIGATION**

Four components, that should be integrated, have been identified as necessary for conducting a successful geophysical investigation. These are:

1. Experienced Personnel: Personnel experience with an understanding of the physics and practical aspects of the instrumentation necessary for detecting small UXO objects and discriminating these "hits" from non-UXO items.
2. Geophysical Instruments: The selection of the proper instrumentation is crucial to the investigation. The instruments must be ideally suited to detecting buried UXO taking into account the type of material they are made of, depth of burial, terrain and vegetation, geologic and cultural features.
3. Analysis Methods: The reduction of large amounts of data requires proper software and use of the software for analysis, interpretation and presentation of the data generated by the various instruments.
4. Navigation or Positioning: It is imperative that survey control or positioning be extremely accurate and precise (repeatable). Navigation is required for control during data acquisition to assure complete and thorough coverage of the site, for mapping the geophysical results, and for relocating geophysical anomalies during the verification and remediation stage.
5. Quality Control: A quality management program will define specific processes for ensuring that program and project objectives are properly defined and attained.

The failure to include or limit anyone of these components will result in an ineffective if not a complete failure of the geophysical investigation.

#### **GENERAL PROGRAM FOR GEOPHYSICAL INVESTIGATION**

1. 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.
2. 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.
3. 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.
4. 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.

5. 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.
6. 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.
7. Analysis and Interpretation: Ongoing with the field program the data must be analyzed and interpreted. This information will be 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.
8. 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 should only be 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.

## **ALTERNATIVE APPROACH TO EXTENSIVE GEOPHYSICAL INVESTIGATION**

### **Geostatistical Approach**

Pacific Northwest National Laboratory (PNNL) and Sandia Laboratory are being funded to develop statistically based site characterization and decision making processes for UXO

sites (optimal sampling designs for target detection, target delineation, anomaly/UXO density estimation, and post-remediation verification. Geostatistics has been used by them and others to map the risk of occurrence of UXOs over contaminated sites and to guide the selection of locations to be cleaned. This approach is meant to provide minimum error and unbiased estimates at unsampled locations. This approach may be applicable to the estimation of total anomaly count, count of anomalies above a prescribed geophysical threshold and/or the probability of having a least one UXO object at each unsampled location within the site. These organizations could be contacted to see if their methodologies are appropriate for this site.

### **Risk Characterization**

Risk characterization 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.

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

Various removal alternatives (including no action or site cover, as well as removal) can be evaluated in terms of their implementation costs and likely consequences. Regarding consequences, each removal 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. 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).

More cost-effective removal alternatives might be developed to address the high-risk areas, instead of the low risk areas. For example, selective removal instead of uniform removal could be done if the high-risk areas were known.

The uncertainties in the above risk factors can be reduced by additional investigation and analysis. The value of various investigation and analysis programs is in making better 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.

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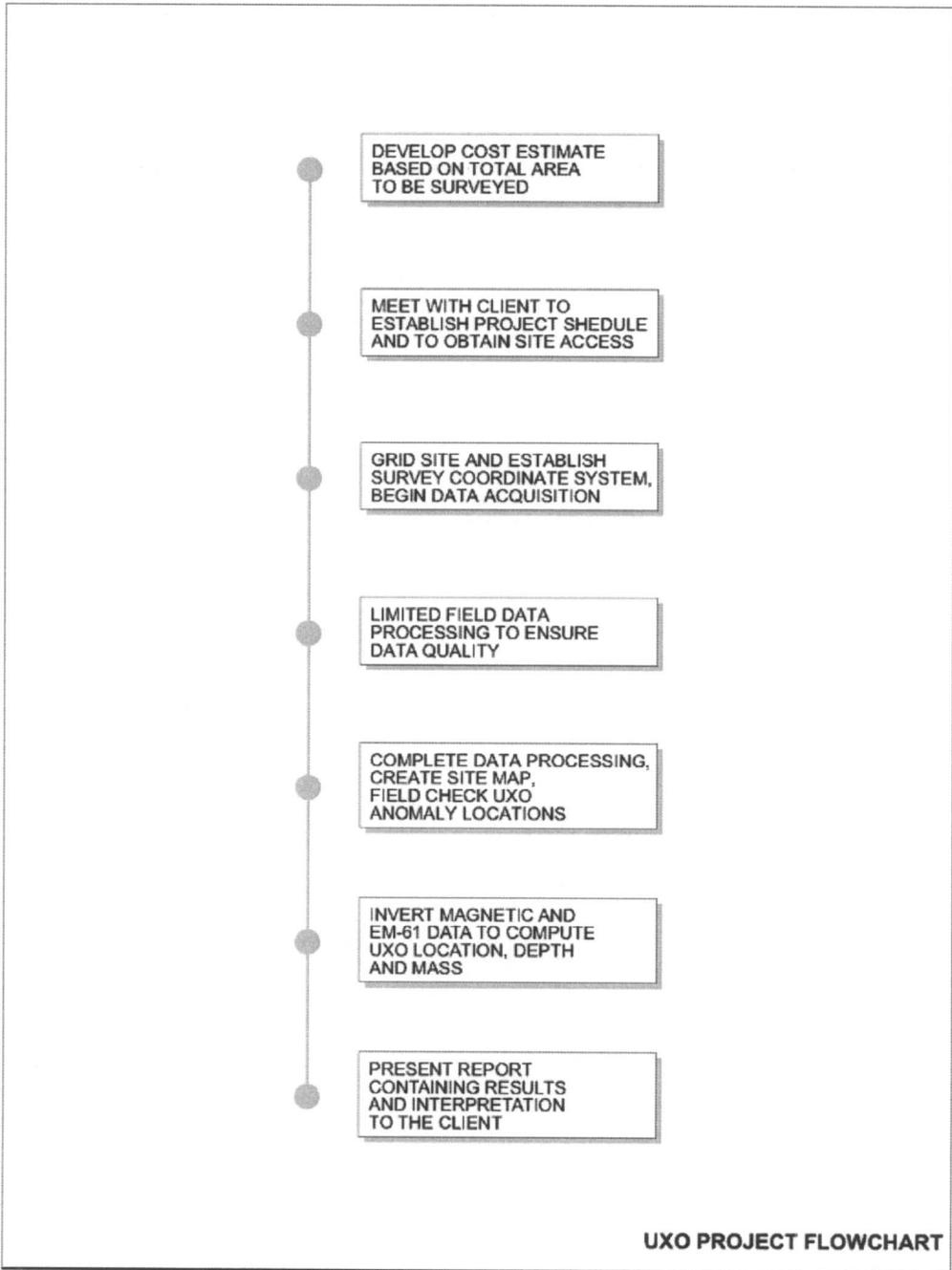
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[WWW.uxoinfo.com/download](http://WWW.uxoinfo.com/download) This site promotes information and data exchange with the entire UXO industry including U.S. Army and other agencies documents and manuals.



**UXO PROJECT FLOWCHART**

DRAWING NO. PR3190UX01g01 r09 DATE 05/09/05 DRAWN BY EL

**Golder Associates**

**Attachment to Chapter 20, EP 1110-1-18 Ordnance and Explosives Response**

**UXO Personnel Training and Experience Hierarchy**

| Position Description           | Training Required (Notes 1, 2, & 3)  | Minimum Years of EOD/UXO Experience (Note 4) | Special Requirements  |
|--------------------------------|--------------------------------------|--|---|
| UXO Safety Officer             | 1, 2                                 | 10 years                                     | Experience in all phases of UXO remediation and applicable safety standards   |
| UXO Quality Control Specialist | 1, 2                                 | 10 years                                     | Experience in all phases of UXO remediation and the transportation, handling and storage of ordnance and explosives materials |
| Senior UXO Supervisor          | 1, 2                                 | 15 years                                     | Significant experience in all aspects of UXO remediation. Five years experience in supervisory positions.                     |
| UXO Technician III             | 1, 2 or 3                            | 10 years                                     | Prior military EOD and/or commercial UXO experience   |
| UXO Technician II              | 1, 2                                 | N/A  | Prior military EOD experience   |
|                                | -----<br>or 3                        | -----<br>5 years                             | -----<br>Experience in UXO remediation/range clearance operations. Plus specific project/ordnance training                    |
| UXO Technician I               | 1, 2 or 3                            | 0  | Successfully completed approved course of instruction appropriate to this skill level   |
| UXO Sweep Personnel            | Equipment and site specific training | N/A  | Equipment and site specific training. (Experience at this position is not required for UXO Technician I certification.)       |

- Note: 1. Graduate of the Army Bomb Disposal School at Aberdeen, MD.  
 2. Graduate of the Naval EOD School  
 3. Graduate of a Department of Defense certified UXO Training Program  
 4. For computational purposes, 1 year is equal to 1,740 hours.  
 5. This is the minimum experience requirement for designation. This is not an automatic designation, but reserved for those that have demonstrated the requisite knowledge, maturity, judgement and are recommended by the contractor for recognition at the specified skill level.

**APPENDIX B - RAINFALL DATA FOR DRAINAGE ANALYSES**

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**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1972-2002**

**STATION: GAMBOA**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1972 | 1.1  | 1.5    | 2      | 2.3  | 2.7  | 2.7  | 2.8  | 2.8   | 3     |
| 1973 | 1.1  | 2      | 2.5    | 2.7  | 4.3  | 5.2  | 5.7  | 5.7   | 5.8   |
| 1974 | 1.8  | 2.9    | 4      | 4.8  | 5.8  | 5.8  | 5.8  | 5.8   | 6.5   |
| 1975 | 1.1  | 1.7    | 2.3    | 2.7  | 3.1  | 3.2  | 3.2  | 3.7   | 4.8   |
| 1976 | 1  | 1.4    | 1.5    | 1.6  | 1.8  | 2.1  | 2.3  | 2.3   | 2.3   |
| 1977 | 1.5  | 2.5    | 2.8    | 2.9  | 2.9  | 2.9  | 2.9  | 2.9   | 3.4   |
| 1978 | 1.5  | 2.2    | 2.9    | 3.5  | 3.9  | 3.9  | 3.9  | 4.1   | 4.1   |
| 1979 | 1.3  | 2      | 2.1    | 2.4  | 3.3  | 3.3  | 3.3  | 3.3   | 3.3   |
| 1980 | 1.5  | 1.9    | 2.2    | 2.8  | 3.6  | 3.6  | 3.6  | 3.6   | 3.7   |
| 1981 | 1  | 1.9    | 2.4    | 2.9  | 3.9  | 4.4  | 4.7  | 4.7   | 5     |
| 1982 | 1.1  | 1.6    | 1.8    | 2.1  | 3.3  | 3.4  | 3.4  | 3.8   | 5.7   |
| 1983 | 1.2  | 1.7    | 2.2    | 2.8  | 2.9  | 2.9  | 2.9  | 3.2   | 3.2   |
| 1984 | 1.2  | 2      | 2.6    | 3.2  | 3.7  | 3.9  | 4.2  | 4.2   | 4.4   |
| 1985 | 0.8  | 1.4    | 1.6    | 1.8  | 2    | 2.1  | 2.1  | 2.1   | 2.6   |
| 1986 | 1  | 1.6    | 2.2    | 2.7  | 3.1  | 3.7  | 4.1  | 4.2   | 4.4   |
| 1987 | 0.9  | 1.4    | 1.8    | 2.2  | 2.8  | 2.9  | 2.9  | 2.9   | 3.4   |
| 1988 | 0.9  | 1.3    | 1.7    | 1.9  | 2.1  | 2.2  | 2.3  | 2.4   | 3.5   |
| 1989 | 1.3  | 2.2    | 2.5    | 2.8  | 3.5  | 3.6  | 3.7  | 3.7   | 4     |
| 1990 | 1.2  | 2      | 2.6    | 2.8  | 3.3  | 3.6  | 4.1  | 4.7   | 5     |
| 1991 | 1.1  | 1.8    | 2.4    | 2.8  | 3.2  | 3.2  | 3.2  | 3.2   | 3.4   |
| 1992 | 1.2  | 2.4    | 2.7    | 2.8  | 2.9  | 3    | 3.3  | 3.8   | 3.8   |
| 1993 | 1.5  | 2.4    | 3.3    | 3.5  | 3.8  | 3.9  | 4    | 4     | 4     |
| 1994 | 1.2  | 2.3    | 3.2    | 3.5  | 3.5  | 3.6  | 3.6  | 3.7   | 3.9   |
| 1995 | 0.6  | 1.1    | 1.4    | 1.5  | 2    | 2.9  | 3.2  | 3.9   | 3.9   |
| 1996 | 1.2  | 2.3    | 2.8    | 2.9  | 3    | 3.2  | 3.2  | 3.2   | 3.2   |
| 1997 | 1.3  | 2.1    | 2.9    | 3.5  | 3.6  | 3.6  | 3.6  | 3.6   | 4     |
| 1998 | 1.1  | 1.9    | 2.6    | 2.9  | 3.8  | 3.8  | 3.8  | 3.8   | 4.9   |
| 1999 | 1.1  | 1.8    | 2.4    | 2.8  | 3.3  | 3.3  | 3.4  | 3.4   | 3.4   |
| 2000 | 1.3  | 1.8    | 2.4    | 2.6  | 2.7  | 2.7  | 3.8  | 4.1   | 4.8   |
| 2001 | 1.3  | 1.8    | 2.4    | 2.9  | 3.1  | 3.2  | 3.2  | 3.3   | 3.5   |
| 2002 | 1.1  | 1.7    | 2.1    | 2.4  | 3.2  | 3.4  | 3.9  | 3.9   | 3.9   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.4  | 2.7  | 3.2  | 3.4  | 3.6  | 3.7  | 4.0  |
| <b>STD DEV</b> | 0.23 | 0.40 | 0.55 | 0.65 | 0.76 | 0.78 | 0.83 | 0.83 | 0.94 |
| <b>b</b>       | 0.18 | 0.31 | 0.43 | 0.50 | 0.60 | 0.61 | 0.64 | 0.65 | 0.73 |
| <b>a</b>       | 1.08 | 1.72 | 2.16 | 2.46 | 2.90 | 3.05 | 3.19 | 3.31 | 3.62 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.14   | 1.83   | 2.31   | 2.65 | 3.12 | 3.28 | 3.43 | 3.55  | 3.89  |
| 5                     | 1.35   | 2.18   | 2.80   | 3.22 | 3.79 | 3.97 | 4.16 | 4.29  | 4.72  |
| 10                    | 1.49   | 2.41   | 3.13   | 3.59 | 4.24 | 4.43 | 4.64 | 4.78  | 5.27  |
| 25                    | 1.66   | 2.70   | 3.54   | 4.07 | 4.80 | 5.00 | 5.25 | 5.40  | 5.96  |
| 50                    | 1.79   | 2.92   | 3.84   | 4.43 | 5.22 | 5.43 | 5.71 | 5.85  | 6.48  |
| 100                   | 1.92   | 3.14   | 4.14   | 4.78 | 5.64 | 5.86 | 6.16 | 6.31  | 6.99  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1976-2002**

**STATION: BALBOA HEIGHTS**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1976 | 1.4  | 1.9    | 2.5    | 2.8  | 3    | 3.2  | 3.5  | 3.6   | 3.6   |
| 1977 | 1.7  | 2.2    | 2.7    | 3    | 3.1  | 3.2  | 3.6  | 3.6   | 3.6   |
| 1978 | 1  | 1.7    | 2.1    | 2.3  | 2.5  | 2.9  | 3    | 3     | 5.5   |
| 1979 | 1.1  | 1.8    | 2.3    | 2.5  | 2.8  | 2.8  | 2.8  | 2.8   | 2.9   |
| 1980 | 0.9  | 1.5    | 1.7    | 2.2  | 3.2  | 3.2  | 3.2  | 3.2   | 3.2   |
| 1981 | 1.4  | 1.8    | 2.4    | 3    | 4.3  | 5    | 5.3  | 5.3   | 6.3   |
| 1982 | 1.1  | 1.6    | 1.9    | 2.1  | 2.6  | 2.7  | 2.9  | 2.9   | 3.6   |
| 1983 | 1.6  | 2.5    | 2.9    | 3.5  | 4.1  | 4.1  | 4.1  | 4.1   | 4.7   |
| 1984 | 1.7  | 2.1    | 2.1    | 2.3  | 3    | 3.2  | 3.2  | 3.2   | 3.3   |
| 1985 | 1.3  | 1.8    | 2.1    | 2.3  | 3.3  | 4.5  | 4.9  | 4.9   | 4.9   |
| 1986 | 1.4  | 1.9    | 2.3    | 2.4  | 2.4  | 2.4  | 2.6  | 2.7   | 3     |
| 1987 | 1.1  | 1.9    | 2.4    | 2.6  | 2.9  | 2.9  | 2.9  | 3     | 3.2   |
| 1988 | 1  | 1.7    | 2.3    | 2.8  | 3.6  | 3.7  | 3.8  | 3.9   | 4.4   |
| 1989 | 1  | 1.7    | 2.1    | 2.2  | 2.2  | 2.3  | 2.3  | 2.4   | 4.4   |
| 1990 | 1  | 1.6    | 2.2    | 2.3  | 2.5  | 2.5  | 2.5  | 2.6   | 2.9   |
| 1991 | 0.7  | 1.4    | 1.9    | 2.5  | 2.8  | 3    | 3.2  | 4.1   | 4.2   |
| 1992 | 1.4  | 2.1    | 2.4    | 2.5  | 3.3  | 3.3  | 3.3  | 3.3   | 3.4   |
| 1993 | 1.3  | 1.6    | 2.2    | 2.6  | 3.2  | 3.6  | 4.6  | 4.7   | 6.5   |
| 1994 | 1.2  | 2      | 2.5    | 2.5  | 3.1  | 3.4  | 3.6  | 5     | 6.4   |
| 1995 | 1.2  | 2      | 2.4    | 2.8  | 3.2  | 4.1  | 5.5  | 5.7   | 8.3   |
| 1996 | 1.1  | 1.5    | 1.9    | 2.4  | 2.9  | 3.9  | 4    | 4.1   | 4.4   |
| 1997 | 1.2  | 2.2    | 3.1    | 3.9  | 4.4  | 4.4  | 4.4  | 4.4   | 4.8   |
| 1998 | 0.9  | 1.7    | 2.1    | 2.6  | 3.4  | 3.6  | 3.9  | 3.9   | 3.9   |
| 1999 | 1.7  | 2.8    | 3.4    | 4.2  | 4.6  | 4.6  | 4.6  | 4.6   | 4.6   |
| 2000 | 1.2  | 2      | 2.4    | 2.6  | 2.8  | 2.8  | 2.8  | 2.8   | 4     |
| 2001 | 0.9  | 1.5    | 1.7    | 1.9  | 2.4  | 2.5  | 2.6  | 2.6   | 2.7   |
| 2002 | 1.5  | 2.4    | 3      | 3.2  | 3.4  | 3.4  | 3.5  | 3.5   | 3.6   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.3  | 2.7  | 3.1  | 3.4  | 3.6  | 3.7  | 4.3  |
| <b>STD DEV</b> | 0.27 | 0.33 | 0.41 | 0.53 | 0.62 | 0.72 | 0.87 | 0.91 | 1.33 |
| <b>b</b>       | 0.21 | 0.26 | 0.32 | 0.41 | 0.48 | 0.56 | 0.67 | 0.71 | 1.04 |
| <b>a</b>       | 1.11 | 1.74 | 2.16 | 2.44 | 2.88 | 3.07 | 3.20 | 3.30 | 3.73 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.18   | 1.84   | 2.27   | 2.59 | 3.06 | 3.27 | 3.45 | 3.56  | 4.11  |
| 5                     | 1.42   | 2.13   | 2.64   | 3.06 | 3.60 | 3.91 | 4.21 | 4.37  | 5.29  |
| 10                    | 1.58   | 2.33   | 2.88   | 3.37 | 3.97 | 4.33 | 4.72 | 4.90  | 6.07  |
| 25                    | 1.78   | 2.57   | 3.18   | 3.76 | 4.42 | 4.86 | 5.36 | 5.58  | 7.05  |
| 50                    | 1.92   | 2.76   | 3.40   | 4.05 | 4.76 | 5.25 | 5.83 | 6.08  | 7.78  |
| 100                   | 2.07   | 2.94   | 3.63   | 4.33 | 5.10 | 5.65 | 6.31 | 6.57  | 8.51  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1978-2002**

**STATION: CANONES**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1978 | 1  | 1.8    | 2.4    | 2.9  | 4.1  | 4.2  | 4.2  | 5.1   | 6.3   |
| 1979 | 1.1  | 1.9    | 2.2    | 2.4  | 2.7  | 3.3  | 3.3  | 3.5   | 3.5   |
| 1980 | 1.2  | 2.1    | 2.9    | 3.1  | 4.4  | 4.8  | 5    | 5     | 5     |
| 1981 | 1.1  | 1.9    | 2.3    | 2.4  | 2.8  | 2.9  | 2.9  | 3.5   | 3.5   |
| 1982 | 1  | 1.6    | 1.7    | 1.9  | 2    | 2.3  | 2.6  | 2.8   | 3.1   |
| 1983 | 1.2  | 1.7    | 2      | 2.1  | 2.2  | 2.2  | 2.2  | 2.2   | 2.7   |
| 1984 | 1.3  | 1.8    | 2.3    | 2.8  | 3.6  | 3.7  | 3.7  | 3.7   | 4     |
| 1985 | 0.7  | 1.3    | 1.9    | 2.2  | 2.5  | 2.5  | 2.6  | 3.1   | 3.2   |
| 1986 | 0.4  | 0.7    | 0.9    | 1.2  | 1.7  | 1.8  | 3    | 3.9   | 4     |
| 1987 | 2.8  | 2.8    | 3.3    | 4.2  | 6.2  | 7.6  | 8.2  | 8.2   | 8.8   |
| 1988 | 1.3  | 2.1    | 2.2    | 2.5  | 3.2  | 3.2  | 3.4  | 3.4   | 4.8   |
| 1989 | 1.5  | 2.6    | 3.2    | 3.6  | 3.7  | 3.9  | 4.1  | 4.1   | 4.1   |
| 1990 | 1.3  | 2.1    | 2.7    | 3.3  | 3.5  | 3.5  | 3.6  | 3.6   | 3.7   |
| 1991 | 1  | 1.6    | 1.8    | 1.8  | 2.8  | 2.9  | 3.2  | 3.4   | 3.6   |
| 1992 | 1.2  | 1.7    | 2.2    | 2.4  | 2.6  | 2.8  | 2.8  | 3.7   | 4.3   |
| 1993 | 1.2  | 2      | 2.7    | 3    | 3.3  | 3.4  | 3.6  | 4.1   | 4.1   |
| 1994 | 1.1  | 2      | 2.6    | 2.8  | 2.8  | 2.8  | 3.4  | 3.4   | 3.4   |
| 1995 | 1.4  | 1.8    | 2      | 2    | 2.7  | 3.1  | 3.6  | 3.6   | 3.8   |
| 1996 | 1.3  | 2.1    | 2.5    | 2.9  | 3.3  | 3.5  | 4.8  | 6.5   | 9     |
| 1997 | 1.2  | 1.6    | 2.1    | 2.3  | 2.7  | 2.9  | 2.9  | 3.1   | 3.2   |
| 1998 | 1.1  | 1.9    | 2.6    | 3.1  | 3.4  | 3.4  | 4.1  | 4.3   | 4.3   |
| 1999 | 2  | 2.9    | 3.6    | 4    | 4.3  | 4.5  | 4.5  | 4.5   | 4.9   |
| 2000 | 1.1  | 1.8    | 2.4    | 2.7  | 3.1  | 3.2  | 3.2  | 4.9   | 6.1   |
| 2001 | 1.3  | 2.4    | 3      | 3.5  | 4.4  | 4.4  | 4.4  | 4.4   | 4.4   |
| 2002 | 1  | 1.8    | 2.5    | 3    | 4.6  | 5.7  | 7.9  | 10.2  | 10.8  |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.4  | 2.7  | 3.3  | 3.5  | 3.9  | 4.3  | 4.7  |
| <b>STD DEV</b> | 0.43 | 0.45 | 0.57 | 0.70 | 0.98 | 1.21 | 1.44 | 1.73 | 2.02 |
| <b>b</b>       | 0.34 | 0.35 | 0.44 | 0.54 | 0.76 | 0.95 | 1.12 | 1.35 | 1.57 |
| <b>a</b>       | 1.04 | 1.72 | 2.15 | 2.42 | 2.88 | 3.01 | 3.26 | 3.58 | 3.87 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.17   | 1.85   | 2.32   | 2.62 | 3.16 | 3.36 | 3.67 | 4.07  | 4.44  |
| 5                     | 1.55   | 2.25   | 2.82   | 3.24 | 4.02 | 4.43 | 4.95 | 5.60  | 6.23  |
| 10                    | 1.80   | 2.52   | 3.15   | 3.64 | 4.59 | 5.14 | 5.79 | 6.61  | 7.41  |
| 25                    | 2.12   | 2.85   | 3.56   | 4.16 | 5.32 | 6.04 | 6.85 | 7.88  | 8.90  |
| 50                    | 2.36   | 3.10   | 3.88   | 4.54 | 5.85 | 6.70 | 7.64 | 8.83  | 10.01 |
| 100                   | 2.59   | 3.35   | 4.18   | 4.92 | 6.39 | 7.36 | 8.43 | 9.77  | 11.11 |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1972-2002**

**STATION: CASCADAS**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1972 | 0.9  | 1.4    | 1.7    | 1.9  | 2.2  | 2.5  | 3    | 3.1   | 3.1   |
| 1973 | 0.9  | 1.5    | 2      | 2.4  | 3.1  | 3.2  | 3.6  | 3.6   | 3.6   |
| 1974 | 1.1  | 1.8    | 2.3    | 2.5  | 3.5  | 3.5  | 3.7  | 3.7   | 3.7   |
| 1975 | 1.1  | 2.1    | 2.2    | 2.3  | 2.4  | 2.4  | 2.5  | 2.7   | 2.7   |
| 1976 | 1.1  | 2      | 2.6    | 2.8  | 3.2  | 3.2  | 3.3  | 3.3   | 3.3   |
| 1977 | 1.2  | 1.6    | 1.9    | 2.3  | 3.2  | 3.3  | 3.4  | 3.4   | 3.4   |
| 1978 | 1.1  | 1.7    | 2.1    | 2.3  | 2.3  | 2.5  | 2.5  | 2.5   | 3.8   |
| 1979 | 1.2  | 2.1    | 2.8    | 3.4  | 4.2  | 4.3  | 4.4  | 4.4   | 4.7   |
| 1980 | 1.3  | 1.9    | 2.3    | 2.3  | 2.3  | 2.3  | 2.5  | 2.5   | 2.5   |
| 1981 | 1.1  | 2.1    | 3      | 3.5  | 5.4  | 6    | 6.5  | 6.5   | 6.6   |
| 1982 | 1.4  | 2.1    | 2.1    | 2.2  | 2.4  | 2.4  | 2.4  | 2.6   | 3.4   |
| 1983 | 0.9  | 1.4    | 2      | 2.1  | 2.6  | 3.1  | 3.5  | 3.9   | 4.1   |
| 1984 | 1  | 1      | 1      | 1.3  | 2.2  | 2.6  | 2.7  | 3     | 3     |
| 1985 | 1.1  | 1.8    | 2.4    | 2.5  | 2.9  | 2.9  | 2.9  | 3     | 3     |
| 1986 | 0.9  | 1.6    | 2      | 2.3  | 2.9  | 3.4  | 4.2  | 4.4   | 4.4   |
| 1987 | 0.9  | 1.4    | 1.7    | 1.8  | 1.9  | 2    | 2.7  | 2.7   | 2.8   |
| 1988 | 1.1  | 2      | 2.3    | 2.6  | 2.7  | 2.9  | 2.9  | 3     | 3.2   |
| 1989 | 0.9  | 1.6    | 2.1    | 2.5  | 2.7  | 2.7  | 2.7  | 3     | 3.2   |
| 1990 | 0.9  | 1.6    | 2      | 2.2  | 2.9  | 3.9  | 4.6  | 4.6   | 6     |
| 1991 | 1  | 1.7    | 2.4    | 2.9  | 3.6  | 3.8  | 4.1  | 4.2   | 5     |
| 1992 | 1.2  | 1.9    | 2.3    | 2.4  | 3.3  | 3.7  | 4.2  | 4.2   | 4.2   |
| 1993 | 1.2  | 1.8    | 1.9    | 2    | 3    | 3.5  | 3.6  | 3.6   | 3.7   |
| 1994 | 1.3  | 1.8    | 1.9    | 2    | 3.5  | 3.6  | 4    | 4     | 4.3   |
| 1995 | 1.3  | 2      | 2.3    | 2.4  | 3.5  | 3.5  | 3.8  | 4.3   | 4.3   |
| 1996 | 1.3  | 2.2    | 3      | 3.6  | 4.9  | 5.1  | 5.1  | 5.1   | 5.1   |
| 1997 | 1.3  | 2.1    | 2.8    | 3.4  | 3.9  | 3.9  | 3.9  | 3.9   | 4.3   |
| 1998 | 1.2  | 1.5    | 1.9    | 2.3  | 2.6  | 2.6  | 2.8  | 2.8   | 4.3   |
| 1999 | 1.2  | 2.3    | 2.5    | 2.6  | 3.7  | 4    | 4    | 4.1   | 4.1   |
| 2000 | 1.3  | 2      | 2.3    | 2.6  | 3.7  | 3.9  | 4.1  | 4.1   | 4.7   |
| 2001 | 1.1  | 1.7    | 2.2    | 2.9  | 3.1  | 3.2  | 3.2  | 3.2   | 3.2   |
| 2002 | 1  | 1.5    | 2.1    | 2.5  | 3.4  | 4.2  | 4.7  | 4.7   | 4.7   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.1  | 1.8  | 2.2  | 2.5  | 3.1  | 3.4  | 3.6  | 3.7  | 3.9  |
| <b>STD DEV</b> | 0.15 | 0.29 | 0.40 | 0.51 | 0.78 | 0.85 | 0.91 | 0.89 | 0.94 |
| <b>b</b>       | 0.12 | 0.23 | 0.31 | 0.39 | 0.61 | 0.66 | 0.71 | 0.69 | 0.73 |
| <b>a</b>       | 1.05 | 1.65 | 2.02 | 2.26 | 2.80 | 2.99 | 3.20 | 3.29 | 3.54 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.09   | 1.74   | 2.14   | 2.40 | 3.02 | 3.23 | 3.46 | 3.55  | 3.81  |
| 5                     | 1.22   | 2.00   | 2.49   | 2.85 | 3.71 | 3.98 | 4.27 | 4.33  | 4.64  |
| 10                    | 1.31   | 2.17   | 2.73   | 3.14 | 4.16 | 4.48 | 4.80 | 4.85  | 5.19  |
| 25                    | 1.43   | 2.39   | 3.03   | 3.52 | 4.74 | 5.11 | 5.48 | 5.51  | 5.89  |
| 50                    | 1.51   | 2.55   | 3.25   | 3.79 | 5.17 | 5.58 | 5.98 | 6.00  | 6.41  |
| 100                   | 1.59   | 2.71   | 3.47   | 4.07 | 5.59 | 6.04 | 6.47 | 6.48  | 6.92  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1972-2002**

**STATION: CANDELARIA**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1972 | 1.4  | 2.1    | 2.8    | 3.1  | 3.1  | 3.9  | 4.5  | 4.9   | 6.9   |
| 1973 | 1.8  | 1.9    | 2      | 2.1  | 3    | 3.6  | 4.1  | 7.2   | 7.3   |
| 1974 | 1.3  | 2.2    | 2.6    | 2.9  | 3.5  | 3.6  | 3.6  | 3.6   | 4.5   |
| 1975 | 1.7  | 2.1    | 2.3    | 2.9  | 4.3  | 5.6  | 5.8  | 6.1   | 6.2   |
| 1976 | 1.1  | 1.8    | 2.3    | 2.9  | 4    | 4.4  | 4.7  | 4.7   | 4.8   |
| 1977 | 1.9  | 2.5    | 2.7    | 3.3  | 4.8  | 5.1  | 5.6  | 5.7   | 5.7   |
| 1978 | 1.3  | 1.7    | 2.2    | 2.2  | 3.1  | 4.3  | 6.1  | 6.9   | 7     |
| 1979 | 1.3  | 2      | 2.6    | 3    | 3.5  | 3.8  | 4    | 4     | 4.2   |
| 1980 | 1.4  | 2      | 2.6    | 2.6  | 3.1  | 3.2  | 3.2  | 3.8   | 5     |
| 1981 | 1.5  | 2      | 2.4    | 2.8  | 3.2  | 3.5  | 6.5  | 9.1   | 9.1   |
| 1982 | 1.2  | 2.1    | 2.8    | 3.1  | 3.9  | 5    | 5.4  | 6.7   | 6.7   |
| 1983 | 1.4  | 2.4    | 2.9    | 3.1  | 3.6  | 4    | 4.4  | 4.5   | 5.9   |
| 1984 | 0.9  | 1.8    | 2.5    | 3    | 3.2  | 4.2  | 5.1  | 5.5   | 6.9   |
| 1985 | 0.4  | 0.8    | 1.2    | 1.6  | 2.9  | 3.2  | 3.9  | 4.3   | 5.4   |
| 1986 | 0.7  | 1.1    | 1.6    | 2.1  | 3.5  | 3.8  | 4.3  | 6.1   | 6.2   |
| 1987 | 1.6  | 3      | 3.2    | 3.4  | 3.8  | 4.3  | 6.5  | 7.9   | 11.7  |
| 1988 | 0.9  | 1.6    | 2      | 2.3  | 3.1  | 3.4  | 3.5  | 3.6   | 3.6   |
| 1989 | 0.6  | 1.1    | 1.4    | 1.7  | 2.5  | 2.9  | 3.3  | 3.7   | 4     |
| 1990 | 0.8  | 1.5    | 1.6    | 1.8  | 3    | 3.4  | 3.7  | 4.4   | 4.5   |
| 1991 | 1  | 1.7    | 2.3    | 2.6  | 3.3  | 3.5  | 3.7  | 3.9   | 5.1   |
| 1992 | 1  | 1.8    | 2.5    | 3.2  | 4.2  | 4.2  | 4.6  | 5.7   | 5.9   |
| 1993 | 1.2  | 2.4    | 2.8    | 3    | 4    | 5    | 5.2  | 7.2   | 7.3   |
| 1994 | 1  | 1.6    | 2      | 2.4  | 3.4  | 4    | 4.4  | 4.8   | 5.1   |
| 1995 | 1.1  | 1.9    | 2.4    | 2.7  | 2.7  | 2.9  | 4    | 4.2   | 5.5   |
| 1996 | 1.4  | 2.1    | 2.7    | 3.3  | 4.3  | 4.3  | 4.4  | 5.4   | 8.4   |
| 1997 | 1  | 1.4    | 1.8    | 2.3  | 3.8  | 3.8  | 4.2  | 4.8   | 5.1   |
| 1998 | 1.4  | 1.9    | 2.4    | 3.3  | 4    | 4    | 4    | 4.4   | 5.2   |
| 1999 | 1.1  | 1.9    | 2.5    | 3.3  | 4.7  | 4.8  | 5.2  | 6.1   | 6.5   |
| 2000 | 1  | 1.7    | 2.4    | 2.6  | 3    | 3.1  | 3.8  | 5.8   | 9.3   |
| 2001 | 1.4  | 1.8    | 2      | 2.5  | 4.4  | 4.7  | 5.7  | 6.3   | 6.3   |
| 2002 | 1.5  | 2.5    | 2.9    | 3.2  | 3.4  | 3.4  | 4.5  | 5.2   | 5.2   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.3  | 2.7  | 3.6  | 4.0  | 4.6  | 5.4  | 6.1  |
| <b>STD DEV</b> | 0.34 | 0.45 | 0.47 | 0.51 | 0.59 | 0.68 | 0.91 | 1.37 | 1.73 |
| <b>b</b>       | 0.27 | 0.35 | 0.37 | 0.40 | 0.46 | 0.53 | 0.71 | 1.07 | 1.35 |
| <b>a</b>       | 1.05 | 1.69 | 2.13 | 2.50 | 3.30 | 3.67 | 4.18 | 4.78 | 5.40 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.15   | 1.82   | 2.27   | 2.64 | 3.47 | 3.86 | 4.44 | 5.17  | 5.89  |
| 5                     | 1.46   | 2.21   | 2.68   | 3.09 | 3.99 | 4.47 | 5.25 | 6.38  | 7.41  |
| 10                    | 1.66   | 2.47   | 2.96   | 3.39 | 4.33 | 4.86 | 5.78 | 7.18  | 8.42  |
| 25                    | 1.91   | 2.80   | 3.30   | 3.77 | 4.77 | 5.37 | 6.46 | 8.19  | 9.70  |
| 50                    | 2.10   | 3.04   | 3.56   | 4.05 | 5.09 | 5.74 | 6.96 | 8.94  | 10.65 |
| 100                   | 2.28   | 3.29   | 3.82   | 4.32 | 5.41 | 6.11 | 7.46 | 9.68  | 11.59 |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1972-2002**

**STATION: CHORRO**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1972 | 1  | 1.9    | 2.6    | 2.8  | 2.9  | 2.9  | 3    | 3     | 3.4   |
| 1973 | 1.2  | 2.2    | 2.9    | 4.1  | 5.1  | 5.2  | 5.3  | 5.3   | 5.9   |
| 1974 | 1.1  | 1.9    | 2.3    | 3.1  | 3.2  | 3.2  | 3.2  | 3.2   | 3.4   |
| 1975 | 1.6  | 2.1    | 2.8    | 3.1  | 4.2  | 4.2  | 4.2  | 4.6   | 4.6   |
| 1976 | 1  | 1.6    | 1.9    | 2.1  | 2.3  | 2.3  | 2.4  | 2.5   | 2.8   |
| 1977 | 1.4  | 2      | 2.2    | 2.4  | 2.8  | 3.2  | 3.2  | 3.2   | 3.4   |
| 1978 | 1.1  | 2      | 2.4    | 3.5  | 4.9  | 5.5  | 6.8  | 7.5   | 8.3   |
| 1979 | 1.7  | 2.4    | 3      | 3.2  | 3.2  | 3.2  | 3.2  | 3.3   | 3.3   |
| 1980 | 1.1  | 2.2    | 2.5    | 2.8  | 3.9  | 4.2  | 4.8  | 4.9   | 5.5   |
| 1981 | 1.2  | 1.7    | 2.2    | 2.4  | 2.8  | 2.8  | 3.2  | 3.6   | 3.7   |
| 1982 | 1.3  | 1.8    | 2.3    | 3.1  | 4.7  | 4.7  | 4.7  | 4.7   | 5.2   |
| 1983 | 1.3  | 1.8    | 1.9    | 1.9  | 2.3  | 2.4  | 2.6  | 2.8   | 2.9   |
| 1984 | 1.5  | 2.3    | 3.4    | 4.2  | 4.8  | 4.8  | 5.1  | 5.1   | 5.1   |
| 1985 | 1.1  | 1.5    | 2      | 2.3  | 3.1  | 3.9  | 4.8  | 5.8   | 6.2   |
| 1986 | 1.7  | 3.1    | 3.8    | 3.9  | 4.4  | 4.5  | 4.5  | 4.5   | 4.7   |
| 1987 | 1.2  | 1.7    | 1.8    | 2    | 2.6  | 2.8  | 3.4  | 3.5   | 3.8   |
| 1988 | 1.5  | 2      | 2.4    | 2.6  | 3    | 3.1  | 3.2  | 3.2   | 3.6   |
| 1989 | 1.6  | 2.5    | 3.1    | 3.4  | 3.6  | 3.6  | 3.6  | 3.9   | 3.9   |
| 1990 | 1.4  | 2.5    | 2.9    | 3.2  | 3.6  | 3.6  | 3.7  | 3.7   | 3.8   |
| 1991 | 1.3  | 2.4    | 3      | 3.2  | 3.2  | 3.2  | 3.2  | 3.2   | 5.6   |
| 1992 | 1.2  | 1.8    | 2.2    | 2.7  | 3.3  | 3.8  | 4.2  | 4.2   | 4.2   |
| 1993 | 3.6  | 4.2    | 4.2    | 4.2  | 4.2  | 4.2  | 4.2  | 4.2   | 4.2   |
| 1994 | 1.2  | 1.8    | 1.9    | 2.2  | 2.5  | 2.8  | 3    | 3.1   | 3.9   |
| 1995 | 2  | 2      | 2      | 2.1  | 2.2  | 2.2  | 2.9  | 3     | 3.1   |
| 1996 | 1.2  | 2      | 2.6    | 3.1  | 4.1  | 4.2  | 4.3  | 5.7   | 9.6   |
| 1997 | 1.2  | 1.9    | 2.2    | 2.9  | 3.9  | 4.2  | 4.4  | 4.4   | 5.7   |
| 1998 | 1.4  | 1.9    | 2.4    | 2.7  | 3.6  | 4    | 4.1  | 4.1   | 6     |
| 1999 | 1.1  | 1.5    | 1.9    | 2.5  | 3.1  | 3.2  | 3.4  | 3.4   | 5.7   |
| 2000 | 1.4  | 1.8    | 2.1    | 2.3  | 3    | 3    | 3    | 3.9   | 4.3   |
| 2001 | 1.3  | 2.4    | 2.8    | 3.1  | 3.5  | 3.5  | 3.5  | 3.5   | 3.5   |
| 2002 | 1.2  | 2.3    | 3.2    | 4    | 6.3  | 8.1  | 11.2 | 12.7  | 13.2  |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.4  | 2.1  | 2.5  | 2.9  | 3.6  | 3.8  | 4.1  | 4.3  | 4.9  |
| <b>STD DEV</b> | 0.47 | 0.52 | 0.58 | 0.66 | 0.94 | 1.16 | 1.62 | 1.89 | 2.17 |
| <b>b</b>       | 0.37 | 0.40 | 0.46 | 0.52 | 0.74 | 0.90 | 1.26 | 1.47 | 1.69 |
| <b>a</b>       | 1.19 | 1.88 | 2.29 | 2.65 | 3.15 | 3.26 | 3.37 | 3.49 | 3.98 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.32   | 2.03   | 2.46   | 2.84 | 3.42 | 3.59 | 3.83 | 4.03  | 4.60  |
| 5                     | 1.74   | 2.48   | 2.97   | 3.43 | 4.25 | 4.61 | 5.26 | 5.70  | 6.51  |
| 10                    | 2.01   | 2.79   | 3.32   | 3.81 | 4.80 | 5.28 | 6.21 | 6.80  | 7.78  |
| 25                    | 2.36   | 3.17   | 3.75   | 4.31 | 5.50 | 6.14 | 7.41 | 8.20  | 9.38  |
| 50                    | 2.61   | 3.45   | 4.07   | 4.67 | 6.02 | 6.77 | 8.30 | 9.23  | 10.57 |
| 100                   | 2.87   | 3.74   | 4.39   | 5.03 | 6.53 | 7.40 | 9.18 | 10.26 | 11.74 |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1983-2002**

**STATION: DIABLO HEIGHTS**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1983 | 1.2  | 2.2    | 2.7    | 3.1  | 3.6  | 3.6  | 3.6  | 3.6   | 4.1   |
| 1984 | 1.1  | 1.8    | 2      | 2.1  | 2.4  | 3    | 3.1  | 3.1   | 4.4   |
| 1985 | 1.3  | 2.4    | 3      | 3.5  | 3.6  | 4.7  | 5.1  | 5.1   | 5.1   |
| 1986 | 1.9  | 2.5    | 2.5    | 2.5  | 3.7  | 3.9  | 3.9  | 3.9   | 3.9   |
| 1987 | 1.3  | 2.2    | 2.9    | 3.6  | 4    | 4    | 4    | 4     | 4.1   |
| 1988 | 1.4  | 1.9    | 2.3    | 2.8  | 3.8  | 4    | 4    | 4.3   | 4.5   |
| 1989 | 1  | 2      | 2.8    | 2.9  | 2.9  | 3    | 3    | 3     | 3.4   |
| 1990 | 1  | 1.8    | 1.9    | 1.9  | 2.1  | 2.6  | 2.6  | 2.6   | 2.6   |
| 1991 | 0.8  | 1.5    | 1.8    | 1.9  | 2.7  | 2.8  | 2.9  | 3.3   | 3.4   |
| 1992 | 1.1  | 1.6    | 1.9    | 2    | 2.4  | 2.4  | 2.4  | 2.4   | 3.3   |
| 1993 | 0.9  | 1.4    | 1.8    | 2    | 2.5  | 3.3  | 4.4  | 4.5   | 6.4   |
| 1994 | 1.2  | 1.9    | 2      | 2.4  | 3.1  | 3.1  | 3.1  | 4     | 5.4   |
| 1995 | 1  | 1.5    | 1.9    | 2.3  | 2.8  | 3.5  | 3.9  | 4     | 4.7   |
| 1996 | 1  | 1.7    | 2.2    | 2.8  | 3.5  | 3.9  | 4    | 4.1   | 4.3   |
| 1997 | 1.2  | 2.2    | 2.7    | 2.9  | 3.5  | 3.5  | 3.5  | 3.5   | 3.9   |
| 1998 | 1.4  | 2.3    | 3.2    | 3.8  | 4.8  | 5.2  | 5.5  | 5.5   | 5.5   |
| 1999 | 1.3  | 1.9    | 2.2    | 2.2  | 3.4  | 3.5  | 3.5  | 3.5   | 3.6   |
| 2000 | 1  | 1.9    | 2      | 2    | 2.2  | 2.2  | 2.2  | 2.2   | 2.5   |
| 2001 | 1.2  | 2.1    | 2.7    | 2.9  | 3.5  | 3.5  | 3.5  | 3.5   | 4     |
| 2002 | 1.5  | 2.2    | 2.6    | 2.7  | 2.7  | 2.8  | 3    | 3     | 3.1   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 2.0  | 2.4  | 2.6  | 3.2  | 3.4  | 3.6  | 3.7  | 4.1  |
| <b>STD DEV</b> | 0.25 | 0.31 | 0.44 | 0.58 | 0.69 | 0.74 | 0.84 | 0.84 | 0.98 |
| <b>b</b>       | 0.19 | 0.24 | 0.35 | 0.45 | 0.54 | 0.58 | 0.65 | 0.66 | 0.77 |
| <b>a</b>       | 1.08 | 1.81 | 2.16 | 2.36 | 2.86 | 3.10 | 3.20 | 3.29 | 3.68 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.15   | 1.90   | 2.29   | 2.53 | 3.06 | 3.31 | 3.44 | 3.53  | 3.96  |
| 5                     | 1.37   | 2.18   | 2.68   | 3.04 | 3.67 | 3.97 | 4.17 | 4.27  | 4.83  |
| 10                    | 1.52   | 2.36   | 2.94   | 3.39 | 4.08 | 4.40 | 4.66 | 4.76  | 5.41  |
| 25                    | 1.70   | 2.59   | 3.27   | 3.82 | 4.59 | 4.95 | 5.28 | 5.39  | 6.13  |
| 50                    | 1.83   | 2.76   | 3.51   | 4.14 | 4.97 | 5.36 | 5.74 | 5.85  | 6.67  |
| 100                   | 1.97   | 2.93   | 3.75   | 4.45 | 5.35 | 5.76 | 6.19 | 6.30  | 7.21  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1978-2002**

**STATION: EMPIRE HILL**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1978 | 0.9  | 1.4    | 1.6    | 1.6  | 1.6  | 1.6  | 1.6  | 1.6   | 1.6   |
| 1979 | 1.4  | 2.6    | 3.3    | 3.6  | 4.1  | 4.3  | 4.4  | 4.8   | 4.8   |
| 1980 | 1  | 1.8    | 1.9    | 2    | 2.5  | 2.5  | 2.8  | 2.8   | 2.8   |
| 1981 | 1  | 1.8    | 2.5    | 3    | 4.9  | 5.2  | 5.9  | 5.9   | 6.3   |
| 1982 | 0.8  | 1.1    | 1.4    | 1.7  | 2.5  | 2.5  | 2.5  | 2.6   | 2.7   |
| 1983 | 1.2  | 1.6    | 1.9    | 2    | 2.3  | 2.4  | 2.9  | 2.9   | 2.9   |
| 1984 | 1  | 1.9    | 2.3    | 2.7  | 3    | 3.1  | 3.1  | 3.1   | 3.2   |
| 1985 | 1.3  | 1.6    | 1.9    | 2.1  | 2.3  | 2.3  | 2.5  | 2.8   | 2.9   |
| 1986 | 1.1  | 1.6    | 2      | 2.3  | 3.1  | 4.1  | 4.8  | 5.1   | 5.2   |
| 1987 | 1.8  | 3      | 3.9    | 4.8  | 6.7  | 6.8  | 7.1  | 7.2   | 7.2   |
| 1988 | 0.9  | 1.6    | 2      | 2.4  | 3.8  | 4    | 4.1  | 4.1   | 5.7   |
| 1989 | 1.2  | 1.8    | 2.2    | 3    | 4.1  | 4.2  | 4.2  | 4.2   | 4.2   |
| 1990 | 1.4  | 2.1    | 2.4    | 2.8  | 3.9  | 4.5  | 5.2  | 5.2   | 6.1   |
| 1991 | 1.2  | 2.2    | 3.2    | 3.6  | 3.9  | 4.3  | 4.9  | 5     | 5     |
| 1992 | 1.2  | 1.8    | 2.2    | 2.4  | 3.4  | 4    | 4.4  | 4.5   | 4.5   |
| 1993 | 1.3  | 2.2    | 2.8    | 3.1  | 3.4  | 3.4  | 3.4  | 3.5   | 5.1   |
| 1994 | 1.2  | 2      | 2.7    | 3.1  | 3.8  | 3.8  | 3.8  | 3.8   | 3.8   |
| 1995 | 1.2  | 1.9    | 2.3    | 3    | 3.3  | 3.3  | 3.3  | 3.3   | 3.3   |
| 1996 | 1.4  | 2.4    | 2.9    | 3.2  | 3.2  | 3.4  | 3.4  | 3.4   | 3.5   |
| 1997 | 1.2  | 1.3    | 1.4    | 1.6  | 2    | 2.1  | 2.1  | 2.1   | 2.1   |
| 1998 | 1.2  | 2.1    | 2.7    | 3.2  | 3.6  | 3.7  | 3.8  | 3.8   | 7.2   |
| 1999 | 1.1  | 1.7    | 2.2    | 2.5  | 3    | 3    | 3.1  | 3.1   | 5     |
| 2000 | 1  | 1.7    | 1.9    | 2.1  | 3.9  | 4.1  | 4.3  | 4.3   | 4.4   |
| 2001 | 0.8  | 1.6    | 2.2    | 2.7  | 3.2  | 3.7  | 4    | 4.1   | 4.3   |
| 2002 | 1  | 1.9    | 2.6    | 3    | 3.8  | 5.1  | 5.6  | 5.6   | 5.6   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.3  | 2.7  | 3.4  | 3.7  | 3.9  | 4.0  | 4.4  |
| <b>STD DEV</b> | 0.22 | 0.41 | 0.59 | 0.73 | 1.02 | 1.13 | 1.26 | 1.28 | 1.50 |
| <b>b</b>       | 0.17 | 0.32 | 0.46 | 0.57 | 0.80 | 0.88 | 0.98 | 1.00 | 1.17 |
| <b>a</b>       | 1.06 | 1.69 | 2.08 | 2.38 | 2.97 | 3.17 | 3.34 | 3.40 | 3.72 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.12   | 1.81   | 2.25   | 2.59 | 3.26 | 3.49 | 3.70 | 3.76  | 4.15  |
| 5                     | 1.31   | 2.17   | 2.77   | 3.24 | 4.16 | 4.49 | 4.82 | 4.89  | 5.48  |
| 10                    | 1.44   | 2.41   | 3.12   | 3.66 | 4.76 | 5.15 | 5.55 | 5.64  | 6.36  |
| 25                    | 1.61   | 2.71   | 3.55   | 4.20 | 5.52 | 5.98 | 6.49 | 6.59  | 7.47  |
| 50                    | 1.73   | 2.93   | 3.88   | 4.60 | 6.08 | 6.60 | 7.18 | 7.29  | 8.30  |
| 100                   | 1.85   | 3.16   | 4.20   | 4.99 | 6.64 | 7.21 | 7.87 | 7.98  | 9.12  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1972-2002**

**STATION: HODGES HILL**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1972 | 1.1  | 1.7    | 1.8    | 2    | 2.4  | 2.6  | 2.6  | 2.8   | 4.5   |
| 1973 | 2.1  | 3.8    | 4.6    | 4.6  | 4.6  | 4.7  | 4.7  | 4.8   | 4.8   |
| 1974 | 1.5  | 2.2    | 2.9    | 3.2  | 4.2  | 4.5  | 4.7  | 4.7   | 6     |
| 1975 | 1.5  | 2.1    | 2.8    | 3.3  | 3.9  | 3.9  | 4    | 4     | 4.2   |
| 1976 | 1  | 1.6    | 1.7    | 1.8  | 1.9  | 2.2  | 2.4  | 2.4   | 3.3   |
| 1977 | 0.8  | 1.5    | 2      | 2.7  | 3.6  | 3.7  | 3.7  | 3.8   | 4     |
| 1978 | 1.1  | 1.7    | 2.4    | 2.9  | 3.6  | 3.7  | 3.9  | 3.9   | 4.8   |
| 1979 | 1.4  | 2.5    | 3.2    | 3.7  | 4.9  | 5.5  | 5.6  | 5.6   | 6.1   |
| 1980 | 1.2  | 2.3    | 2.8    | 2.9  | 3.3  | 3.5  | 3.5  | 3.5   | 3.7   |
| 1981 | 1.1  | 1.9    | 2.3    | 2.7  | 3.6  | 4    | 4.7  | 4.7   | 4.9   |
| 1982 | 1.2  | 1.9    | 2.1    | 2.2  | 2.4  | 2.5  | 2.5  | 2.5   | 4.8   |
| 1983 | 1.3  | 2.1    | 2.5    | 2.6  | 2.8  | 2.9  | 2.9  | 2.9   | 2.9   |
| 1984 | 1.1  | 2      | 2.7    | 2.9  | 3    | 3    | 3.1  | 3.1   | 3.2   |
| 1985 | 0.9  | 1.6    | 2.3    | 2.9  | 3.2  | 3.2  | 3.3  | 3.7   | 3.7   |
| 1986 | 1  | 1.9    | 2.6    | 3    | 3.2  | 3.9  | 4.5  | 5     | 5     |
| 1987 | 1.8  | 3      | 3.9    | 4.8  | 6.7  | 6.8  | 7.1  | 7.2   | 7.4   |
| 1988 | 1.1  | 1.8    | 2.2    | 2.8  | 4.2  | 4.5  | 4.6  | 4.8   | 5.9   |
| 1989 | 0.9  | 1.8    | 2.5    | 3.2  | 4.8  | 4.8  | 4.8  | 4.8   | 4.9   |
| 1990 | 1.3  | 2.2    | 2.8    | 3.1  | 4    | 4.5  | 5.5  | 5.5   | 6.1   |
| 1991 | 1.4  | 2.1    | 2.9    | 3.1  | 3.1  | 3.4  | 3.5  | 3.5   | 4.6   |
| 1992 | 1.4  | 2.4    | 3      | 3.6  | 4    | 4.8  | 5.6  | 5.6   | 5.7   |
| 1993 | 1.2  | 2      | 2.4    | 2.6  | 3    | 3    | 3    | 3     | 3.2   |
| 1994 | 1  | 1.8    | 2.1    | 2.3  | 2.6  | 2.6  | 2.6  | 3.1   | 3.2   |
| 1995 | 0.9  | 1.6    | 1.9    | 2.6  | 3.7  | 4.2  | 4.3  | 4.3   | 4.3   |
| 1996 | 1.5  | 2.8    | 3      | 3.2  | 4.5  | 4.7  | 4.8  | 4.8   | 5     |
| 1997 | 1.1  | 2.1    | 2.3    | 2.3  | 2.4  | 2.4  | 2.4  | 2.4   | 2.4   |
| 1998 | 1.3  | 2.3    | 3      | 3.3  | 3.8  | 3.9  | 4    | 4     | 6.5   |
| 1999 | 1.2  | 1.9    | 2.2    | 2.5  | 3.3  | 3.4  | 3.7  | 3.7   | 5.3   |
| 2000 | 0.8  | 1.3    | 1.6    | 2    | 3    | 3.3  | 3.6  | 3.6   | 3.6   |
| 2001 | 1  | 1.3    | 1.7    | 2    | 2.7  | 2.7  | 2.7  | 2.8   | 3.2   |
| 2002 | 0.3  | 0.4    | 0.4    | 0.4  | 0.5  | 0.7  | 0.8  | 0.9   | 0.9   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 2.0  | 2.5  | 2.8  | 3.4  | 3.7  | 3.8  | 3.9  | 4.5  |
| <b>STD DEV</b> | 0.33 | 0.58 | 0.74 | 0.81 | 1.10 | 1.15 | 1.25 | 1.25 | 1.36 |
| <b>b</b>       | 0.25 | 0.45 | 0.58 | 0.63 | 0.86 | 0.90 | 0.98 | 0.97 | 1.06 |
| <b>a</b>       | 1.04 | 1.73 | 2.15 | 2.46 | 2.97 | 3.16 | 3.30 | 3.37 | 3.86 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.13   | 1.90   | 2.36   | 2.69 | 3.29 | 3.49 | 3.66 | 3.73  | 4.25  |
| 5                     | 1.42   | 2.42   | 3.02   | 3.41 | 4.25 | 4.51 | 4.76 | 4.83  | 5.45  |
| 10                    | 1.61   | 2.76   | 3.45   | 3.88 | 4.90 | 5.18 | 5.50 | 5.56  | 6.25  |
| 25                    | 1.85   | 3.19   | 4.00   | 4.48 | 5.71 | 6.03 | 6.43 | 6.48  | 7.25  |
| 50                    | 2.03   | 3.51   | 4.40   | 4.93 | 6.31 | 6.66 | 7.11 | 7.17  | 8.00  |
| 100                   | 2.21   | 3.82   | 4.81   | 5.37 | 6.91 | 7.29 | 7.80 | 7.84  | 8.74  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1972-2002**

**STATION: PELUCA**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1972 | 1.1  | 1.6    | 2.1    | 2.4  | 2.7  | 3.1  | 3.4  | 5.1   | 6.5   |
| 1973 | 0.9  | 1.5    | 1.9    | 2.2  | 3.9  | 4.1  | 4.2  | 6.8   | 7.3   |
| 1974 | 1.4  | 2.2    | 3      | 3.5  | 3.9  | 3.9  | 3.9  | 4     | 4.8   |
| 1975 | 1.1  | 2      | 2.7    | 2.9  | 3.3  | 4.1  | 5    | 5.1   | 6.4   |
| 1976 | 1.1  | 1.7    | 2.3    | 2.6  | 3.6  | 3.9  | 4.4  | 4.5   | 4.5   |
| 1977 | 1.2  | 1.9    | 1.9    | 1.9  | 2.4  | 2.5  | 2.9  | 3.2   | 3.7   |
| 1978 | 1  | 1.8    | 2.2    | 2.4  | 2.6  | 3.5  | 4.7  | 5.3   | 5.8   |
| 1979 | 1.3  | 2      | 2.4    | 2.6  | 2.9  | 3    | 3    | 3.2   | 3.7   |
| 1980 | 1.1  | 1.7    | 2.1    | 2.3  | 3.4  | 3.4  | 3.5  | 3.6   | 4.5   |
| 1981 | 1.6  | 2.2    | 2.8    | 3.2  | 3.4  | 3.6  | 6.9  | 8.4   | 9.2   |
| 1982 | 1  | 1.7    | 2.1    | 2.3  | 2.5  | 3.1  | 3.3  | 3.6   | 3.7   |
| 1983 | 1.5  | 2.2    | 2.6    | 2.9  | 3.7  | 4.3  | 4.5  | 4.7   | 6.3   |
| 1984 | 1  | 1.6    | 2.2    | 2.7  | 3.9  | 4    | 4    | 4.3   | 4.8   |
| 1985 | 1.1  | 1.7    | 2.3    | 2.6  | 2.8  | 2.9  | 3    | 3     | 4.1   |
| 1986 | 1  | 1.7    | 2.1    | 2.2  | 2.8  | 3    | 3.5  | 4.6   | 4.9   |
| 1987 | 2  | 3.8    | 4.6    | 5.2  | 5.2  | 5.2  | 5.4  | 6.5   | 7.4   |
| 1988 | 1  | 1.5    | 1.9    | 2.4  | 3.8  | 4.5  | 4.8  | 5.2   | 8.8   |
| 1989 | 1.1  | 1.9    | 2.6    | 2.7  | 2.7  | 2.7  | 3.2  | 3.4   | 6     |
| 1990 | 0.8  | 1.4    | 1.8    | 2    | 2.9  | 3.2  | 3.7  | 3.9   | 4.9   |
| 1991 | 1.1  | 1.5    | 1.9    | 2.4  | 2.6  | 2.7  | 2.7  | 4     | 4.6   |
| 1992 | 1.1  | 1.6    | 2      | 2.3  | 2.6  | 2.8  | 3.2  | 3.9   | 4.2   |
| 1993 | 1.3  | 1.9    | 2.2    | 2.5  | 3.5  | 3.7  | 4    | 5.1   | 5.1   |
| 1994 | 1  | 1.7    | 2.3    | 3.1  | 4.9  | 5.6  | 6.3  | 7.5   | 8.4   |
| 1995 | 1.1  | 1.7    | 2.1    | 2.6  | 3.3  | 3.3  | 4    | 4.2   | 5.1   |
| 1996 | 1.2  | 1.8    | 2.1    | 2.3  | 2.7  | 2.9  | 4.4  | 6.1   | 9.6   |
| 1997 | 1.2  | 1.8    | 2.1    | 2.3  | 3.4  | 3.8  | 3.9  | 3.9   | 4.1   |
| 1998 | 1.5  | 2.2    | 2.7    | 3    | 3.8  | 4.3  | 4.3  | 4.9   | 5.9   |
| 1999 | 1.2  | 1.9    | 2.5    | 3    | 4.8  | 6.5  | 7.1  | 9.2   | 9.8   |
| 2000 | 1.4  | 2.2    | 2.6    | 2.8  | 3    | 3    | 3.7  | 5.2   | 8.4   |
| 2001 | 1.1  | 1.7    | 2.3    | 2.6  | 3.9  | 4.1  | 4.8  | 5.9   | 5.9   |
| 2002 | 1.2  | 1.9    | 2.1    | 2.5  | 2.6  | 2.6  | 3    | 3.4   | 3.4   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.3  | 2.7  | 3.3  | 3.7  | 4.2  | 4.9  | 5.9  |
| <b>STD DEV</b> | 0.24 | 0.42 | 0.51 | 0.59 | 0.73 | 0.92 | 1.11 | 1.52 | 1.89 |
| <b>b</b>       | 0.18 | 0.33 | 0.40 | 0.46 | 0.57 | 0.71 | 0.86 | 1.19 | 1.47 |
| <b>a</b>       | 1.08 | 1.69 | 2.12 | 2.40 | 3.02 | 3.26 | 3.67 | 4.23 | 5.04 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.15   | 1.81   | 2.26   | 2.57 | 3.23 | 3.52 | 3.99 | 4.67  | 5.58  |
| 5                     | 1.36   | 2.18   | 2.72   | 3.09 | 3.88 | 4.33 | 4.97 | 6.01  | 7.25  |
| 10                    | 1.49   | 2.43   | 3.02   | 3.44 | 4.30 | 4.86 | 5.61 | 6.90  | 8.36  |
| 25                    | 1.67   | 2.75   | 3.40   | 3.87 | 4.84 | 5.54 | 6.43 | 8.03  | 9.76  |
| 50                    | 1.80   | 2.98   | 3.68   | 4.20 | 5.25 | 6.04 | 7.04 | 8.87  | 10.79 |
| 100                   | 1.93   | 3.21   | 3.96   | 4.52 | 5.64 | 6.54 | 7.64 | 9.69  | 11.82 |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1972-2002**

**STATION: PEDRO MIGUEL**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1972 | 1.2  | 1.9    | 2.2    | 2.4  | 2.6  | 2.8  | 3    | 3     | 4.9   |
| 1973 | 1.1  | 1.4    | 1.7    | 1.8  | 1.9  | 2    | 2.3  | 2.9   | 3.3   |
| 1974 | 1.2  | 1.8    | 2.3    | 2.6  | 3.2  | 3.3  | 3.6  | 3.6   | 3.7   |
| 1975 | 1  | 1.8    | 2.2    | 2.8  | 3    | 3    | 3    | 3     | 3.8   |
| 1976 | 1.1  | 2.1    | 2.8    | 3.2  | 3.4  | 3.5  | 3.6  | 3.6   | 4.9   |
| 1977 | 1.4  | 2.3    | 3.1    | 3.5  | 3.8  | 3.8  | 3.8  | 3.8   | 3.8   |
| 1978 | 1.4  | 2.7    | 3.2    | 3.8  | 4.9  | 5    | 5    | 5     | 5.6   |
| 1979 | 1.1  | 2      | 2.9    | 3.5  | 4.4  | 4.7  | 4.9  | 4.9   | 5.6   |
| 1980 | 1.2  | 2      | 2.6    | 3.1  | 3.6  | 3.8  | 3.9  | 3.9   | 4.3   |
| 1981 | 1  | 1.7    | 2.3    | 2.8  | 3.9  | 4.1  | 4.8  | 4.9   | 5.4   |
| 1982 | 1.4  | 2.3    | 2.4    | 2.6  | 2.7  | 2.7  | 2.7  | 2.7   | 2.9   |
| 1983 | 1.2  | 2      | 2.7    | 3    | 3    | 3    | 3    | 3     | 3     |
| 1984 | 1.5  | 2.3    | 2.9    | 3.2  | 3.6  | 3.6  | 3.6  | 3.6   | 3.7   |
| 1985 | 0.9  | 1.7    | 2.1    | 2.3  | 2.8  | 2.9  | 3.8  | 4.1   | 4.1   |
| 1986 | 1.2  | 1.6    | 2      | 2.2  | 3    | 3.2  | 3.5  | 3.8   | 4.5   |
| 1987 | 1.1  | 1.7    | 1.9    | 2.1  | 2.9  | 3.5  | 4.1  | 4.1   | 4.5   |
| 1988 | 0.9  | 1.6    | 2.1    | 2.3  | 3.9  | 4    | 4.1  | 5.1   | 5.3   |
| 1989 | 1.2  | 1.5    | 1.8    | 1.9  | 2.4  | 2.4  | 2.5  | 2.5   | 3.3   |
| 1990 | 1.1  | 1.7    | 2.6    | 2.8  | 3.1  | 3.4  | 4.1  | 4.1   | 4.2   |
| 1991 | 1.3  | 1.9    | 2.3    | 2.7  | 4.3  | 4.4  | 4.4  | 4.4   | 4.4   |
| 1992 | 1.2  | 1.9    | 2.5    | 3.4  | 4.8  | 5.6  | 5.9  | 6.8   | 6.9   |
| 1993 | 1.4  | 2.6    | 3.5    | 3.8  | 4.7  | 4.8  | 4.8  | 4.8   | 5     |
| 1994 | 1.2  | 2.4    | 3      | 3.5  | 4    | 4    | 4    | 4     | 4     |
| 1995 | 0.8  | 1.4    | 2      | 2.1  | 2.7  | 3.2  | 3.4  | 3.5   | 3.7   |
| 1996 | 1.2  | 2      | 2.5    | 2.6  | 3    | 3.2  | 3.4  | 3.5   | 3.7   |
| 1997 | 1.3  | 2.1    | 2.4    | 2.7  | 2.9  | 3    | 3.1  | 3.1   | 3.2   |
| 1998 | 1.2  | 2.2    | 2.7    | 3.1  | 3.2  | 3.2  | 3.3  | 3.3   | 3.9   |
| 1999 | 1.2  | 1.9    | 2.2    | 2.3  | 3.1  | 3.3  | 3.5  | 3.6   | 4.3   |
| 2000 | 1.2  | 1.7    | 1.8    | 1.9  | 2.3  | 2.5  | 2.8  | 2.8   | 3.1   |
| 2001 | 1.3  | 2.2    | 2.6    | 2.9  | 3.1  | 3.1  | 3.1  | 3.1   | 3.6   |
| 2002 | 1  | 1.4    | 1.6    | 1.7  | 1.9  | 2    | 2.2  | 2.2   | 2.9   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.4  | 2.7  | 3.3  | 3.5  | 3.7  | 3.8  | 4.2  |
| <b>STD DEV</b> | 0.16 | 0.34 | 0.46 | 0.59 | 0.79 | 0.84 | 0.85 | 0.95 | 0.93 |
| <b>b</b>       | 0.13 | 0.26 | 0.36 | 0.46 | 0.61 | 0.65 | 0.66 | 0.74 | 0.73 |
| <b>a</b>       | 1.11 | 1.78 | 2.22 | 2.47 | 2.95 | 3.09 | 3.28 | 3.35 | 3.77 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.15   | 1.88   | 2.35   | 2.64 | 3.18 | 3.33 | 3.53 | 3.62  | 4.04  |
| 5                     | 1.30   | 2.18   | 2.76   | 3.16 | 3.87 | 4.07 | 4.27 | 4.46  | 4.86  |
| 10                    | 1.39   | 2.38   | 3.03   | 3.51 | 4.33 | 4.56 | 4.77 | 5.02  | 5.41  |
| 25                    | 1.51   | 2.63   | 3.37   | 3.94 | 4.92 | 5.18 | 5.40 | 5.72  | 6.10  |
| 50                    | 1.60   | 2.81   | 3.62   | 4.27 | 5.35 | 5.64 | 5.86 | 6.24  | 6.61  |
| 100                   | 1.68   | 3.00   | 3.87   | 4.59 | 5.78 | 6.10 | 6.32 | 6.75  | 7.12  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 2000-2002**

**STATION: Gasparilla**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2000 | 0.5  | 0.7    | 0.7    | 0.8  | 1.2  | 1.3  | 1.9  | 2.6   | 3.8   |
| 2001 | 1  | 1.5    | 1.8    | 2.1  | 2.3  | 2.4  | 2.4  | 2.4   | 2.6   |
| 2002 | 1.1  | 2.0    | 2.6    | 2.9  | 3.6  | 3.8  | 4.1  | 5.3   | 5.7   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 0.9  | 1.4  | 1.7  | 1.9  | 2.4  | 2.5  | 2.8  | 3.4  | 4.0  |
| <b>STD DEV</b> | 0.32 | 0.66 | 0.95 | 1.06 | 1.20 | 1.25 | 1.15 | 1.62 | 1.56 |
| <b>b</b>       | 0.25 | 0.51 | 0.74 | 0.83 | 0.94 | 0.98 | 0.90 | 1.26 | 1.22 |
| <b>a</b>       | 0.73 | 1.12 | 1.29 | 1.47 | 1.84 | 1.96 | 2.30 | 2.73 | 3.35 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 0.82   | 1.30   | 1.56   | 1.78 | 2.19 | 2.31 | 2.63 | 3.19  | 3.80  |
| 5                     | 1.10   | 1.88   | 2.40   | 2.71 | 3.25 | 3.42 | 3.65 | 4.62  | 5.18  |
| 10                    | 1.29   | 2.27   | 2.96   | 3.33 | 3.95 | 4.15 | 4.32 | 5.57  | 6.10  |
| 25                    | 1.53   | 2.75   | 3.66   | 4.12 | 4.84 | 5.08 | 5.18 | 6.77  | 7.25  |
| 50                    | 1.70   | 3.11   | 4.19   | 4.70 | 5.50 | 5.77 | 5.81 | 7.66  | 8.11  |
| 100                   | 1.88   | 3.47   | 4.71   | 5.27 | 6.15 | 6.45 | 6.44 | 8.54  | 8.96  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1998-2002**

**STATION: JAGUA**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1998 | 1  | 1.7    | 2.1    | 2.1  | 2.2  | 3.4  | 3.4  | 3.4   | 4.4   |
| 1999 | 1.4  | 2.6    | 3.6    | 4.3  | 4.5  | 4.5  | 5.7  | 5.7   | 6.4   |
| 2000 | 1.3  | 2.3    | 3.5    | 3.8  | 4    | 4    | 4    | 4     | 4     |
| 2001 | 1.4  | 2.2    | 2.7    | 3    | 4.4  | 4.4  | 4.4  | 4.4   | 4.4   |
| 2002 | 1.7  | 2.8    | 3.7    | 4.2  | 5.6  | 5.6  | 5.6  | 5.6   | 5.6   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.4  | 2.3  | 3.1  | 3.5  | 4.1  | 4.4  | 4.6  | 4.6  | 5.0  |
| <b>STD DEV</b> | 0.25 | 0.42 | 0.69 | 0.93 | 1.24 | 0.81 | 1.01 | 1.01 | 1.00 |
| <b>b</b>       | 0.20 | 0.33 | 0.54 | 0.72 | 0.96 | 0.63 | 0.78 | 0.78 | 0.78 |
| <b>a</b>       | 1.25 | 2.14 | 2.82 | 3.08 | 3.60 | 4.03 | 4.18 | 4.18 | 4.52 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.32   | 2.26   | 3.02   | 3.34 | 3.96 | 4.26 | 4.47 | 4.47  | 4.81  |
| 5                     | 1.54   | 2.63   | 3.63   | 4.16 | 5.05 | 4.97 | 5.36 | 5.36  | 5.70  |
| 10                    | 1.69   | 2.88   | 4.04   | 4.70 | 5.77 | 5.45 | 5.95 | 5.95  | 6.29  |
| 25                    | 1.88   | 3.19   | 4.55   | 5.39 | 6.69 | 6.04 | 6.69 | 6.69  | 7.03  |
| 50                    | 2.01   | 3.42   | 4.93   | 5.89 | 7.36 | 6.49 | 7.24 | 7.24  | 7.58  |
| 100                   | 2.15   | 3.65   | 5.31   | 6.40 | 8.04 | 6.93 | 7.79 | 7.79  | 8.12  |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1971-2002**

**STATION: CRISTOBAL**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1971 | 1.5  | 1.7    | 1.8    | 1.8  | 1.9  | 2.2  | 2.3  | 3.3   | 3.9   |
| 1972 | 0.9  | 1.1    | 1.1    | 1.1  | 1.5  | 1.9  | 2.2  | 2.4   | 2.6   |
| 1973 | 1.1  | 1.4    | 1.4    | 1.4  | 1.5  | 1.5  | 1.7  | 2.1   | 2.6   |
| 1974 | 1.1  | 1.2    | 1.4    | 1.4  | 1.6  | 1.7  | 2    | 2.4   | 2.9   |
| 1975 | 1  | 1      | 1.3    | 1.3  | 1.4  | 1.4  | 1.9  | 2.5   | 2.9   |
| 1976 | 1.7  | 1.7    | 1.7    | 1.7  | 1.7  | 1.7  | 2.4  | 2.5   | 2.7   |
| 1977 | 0.9  | 1.3    | 1.3    | 1.3  | 1.3  | 1.4  | 2.2  | 3     | 3.4   |
| 1978 | 1.1  | 1.1    | 1.2    | 1.3  | 1.3  | 1.4  | 1.6  | 1.9   | 2.2   |
| 1979 | 0.9  | 1.6    | 2      | 2.2  | 2.6  | 2.6  | 3.2  | 3.6   | 3.6   |
| 1980 | 1  | 1.4    | 1.9    | 1.9  | 2.1  | 2.1  | 2.2  | 2.8   | 3.4   |
| 1981 | 1.5  | 2.4    | 3      | 3.2  | 4.3  | 4.7  | 5.4  | 5.4   | 7.6   |
| 1982 | 1  | 1.7    | 2.2    | 2.5  | 2.5  | 2.5  | 4.1  | 4.3   | 4.9   |
| 1983 | 1.3  | 1.9    | 2.1    | 2.3  | 4.1  | 4.6  | 5.2  | 5.7   | 6.5   |
| 1984 | 1.2  | 2      | 2.1    | 2.6  | 3.1  | 3.8  | 4    | 4.6   | 4.8   |
| 1985 | 1.1  | 1.9    | 2.6    | 2.9  | 3.4  | 3.4  | 4.2  | 4.6   | 5.6   |
| 1986 | 1.1  | 1.7    | 2      | 2.2  | 2.3  | 2.3  | 3.3  | 3.8   | 3.8   |
| 1987 | 2.8  | 2.9    | 3.2    | 3.6  | 4.7  | 6    | 7.6  | 7.9   | 10.9  |
| 1988 | 1.2  | 2      | 2.8    | 3.2  | 3.5  | 3.7  | 4.3  | 4.4   | 4.5   |
| 1989 | 0.9  | 1.6    | 2.2    | 2.9  | 4.1  | 4.1  | 4.4  | 5.4   | 6.8   |
| 1990 | 1.4  | 2      | 2.3    | 2.9  | 3.7  | 3.7  | 3.8  | 4.3   | 4.9   |
| 1991 | 1.6  | 3.1    | 4      | 4.3  | 4.7  | 4.7  | 4.7  | 5.5   | 5.9   |
| 1992 | 1.1  | 1.8    | 2.5    | 2.9  | 3.9  | 4.5  | 4.5  | 4.7   | 6.3   |
| 1993 | 1  | 1.5    | 1.8    | 1.9  | 2.9  | 3.8  | 5.4  | 5.9   | 7.6   |
| 1994 | 1.1  | 2      | 2.4    | 2.7  | 2.7  | 2.7  | 2.7  | 4     | 4.2   |
| 1995 | 1.1  | 1.7    | 2.2    | 2.5  | 3.9  | 4.3  | 4.5  | 4.5   | 5.7   |
| 1996 | 0.8  | 1.2    | 1.5    | 1.5  | 1.9  | 2.7  | 3.1  | 3.9   | 5.6   |
| 1997 | 1.4  | 2.7    | 3.1    | 3.3  | 3.4  | 3.4  | 3.8  | 4     | 4.5   |
| 1998 | 1  | 2      | 2.4    | 3.3  | 4.9  | 5.4  | 5.4  | 5.4   | 5.4   |
| 1999 | 1.1  | 2.1    | 2.5    | 2.7  | 3.2  | 3.6  | 5.5  | 7     | 7.6   |
| 2000 | 1.2  | 1.9    | 2      | 2.1  | 2.2  | 3.1  | 4.1  | 6     | 6.6   |
| 2001 | 1  | 1.7    | 2.2    | 2.8  | 3.7  | 4.4  | 5.1  | 5.2   | 5.2   |
| 2002 | 1.7  | 2.8    | 3.4    | 3.7  | 4.5  | 4.5  | 4.5  | 4.5   | 4.6   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.8  | 2.2  | 2.4  | 3.0  | 3.2  | 3.8  | 4.3  | 5.0  |
| <b>STD DEV</b> | 0.37 | 0.52 | 0.68 | 0.82 | 1.14 | 1.28 | 1.42 | 1.44 | 1.90 |
| <b>b</b>       | 0.29 | 0.41 | 0.53 | 0.64 | 0.89 | 1.00 | 1.10 | 1.12 | 1.48 |
| <b>a</b>       | 1.05 | 1.59 | 1.88 | 2.06 | 2.46 | 2.69 | 3.18 | 3.67 | 4.17 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.16   | 1.74   | 2.07   | 2.30 | 2.78 | 3.05 | 3.58 | 4.08  | 4.71  |
| 5                     | 1.49   | 2.20   | 2.67   | 3.02 | 3.79 | 4.18 | 4.83 | 5.36  | 6.39  |
| 10                    | 1.71   | 2.51   | 3.07   | 3.50 | 4.46 | 4.93 | 5.66 | 6.20  | 7.50  |
| 25                    | 1.98   | 2.90   | 3.57   | 4.10 | 5.30 | 5.87 | 6.71 | 7.26  | 8.90  |
| 50                    | 2.19   | 3.18   | 3.95   | 4.55 | 5.93 | 6.57 | 7.49 | 8.05  | 9.94  |
| 100                   | 2.39   | 3.47   | 4.32   | 4.99 | 6.55 | 7.27 | 8.26 | 8.84  | 10.97 |

**COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION  
FOR YEARS 1973-2002**

**STATION: GATUN**

| YEAR | ANNUAL MAXIMUM CALCULATED RAINFALL DEPTH (IN) FOR GIVEN DURATION |        |        |      |      |      |      |       |       |
|------|--|--------|--------|------|------|------|------|-------|-------|
|      | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 1973 | 0.9  | 1.2    | 1.5    | 1.7  | 2.4  | 3    | 3.5  | 3.5   | 4.6   |
| 1974 | 1.3  | 2.5    | 3.8    | 4.6  | 5.8  | 5.8  | 5.8  | 5.8   | 5.8   |
| 1975 | 1.2  | 2.2    | 2.4    | 2.6  | 2.7  | 2.7  | 3.5  | 4.1   | 4.4   |
| 1976 | 1.1  | 1.8    | 2.1    | 2.7  | 2.7  | 2.8  | 4.3  | 4.7   | 4.9   |
| 1977 | 1.1  | 2      | 2.3    | 2.4  | 2.5  | 2.5  | 2.7  | 3.3   | 3.4   |
| 1978 | 0.7  | 1.1    | 1.5    | 1.5  | 2.1  | 2.2  | 2.8  | 3.7   | 4.4   |
| 1979 | 1.5  | 1.9    | 2.3    | 2.4  | 2.5  | 2.7  | 3.1  | 3.1   | 3.6   |
| 1980 | 1.3  | 1.9    | 2.4    | 2.7  | 3.4  | 3.5  | 3.8  | 3.9   | 7.4   |
| 1981 | 1  | 1.7    | 2.4    | 2.5  | 3.8  | 4    | 4.6  | 4.8   | 6.6   |
| 1982 | 1.2  | 2.2    | 2.9    | 3.9  | 4.6  | 4.7  | 4.7  | 4.7   | 5     |
| 1983 | 1.6  | 2      | 2.7    | 3.1  | 3.2  | 3.4  | 3.9  | 4.8   | 6.3   |
| 1984 | 1  | 1.6    | 2      | 2.1  | 2.4  | 2.6  | 2.7  | 2.9   | 3.7   |
| 1985 | 1.1  | 1.7    | 1.9    | 2    | 2.9  | 3.2  | 3.5  | 3.7   | 4.6   |
| 1986 | 1.8  | 2.7    | 2.8    | 2.9  | 3    | 3.5  | 4.2  | 7     | 7     |
| 1987 | 1.2  | 2      | 2.9    | 3.2  | 3.9  | 5.5  | 5.5  | 5.5   | 7.1   |
| 1988 | 1  | 1.9    | 2.4    | 2.4  | 2.5  | 2.6  | 2.7  | 2.8   | 3.4   |
| 1989 | 1.1  | 2.1    | 2.3    | 3.2  | 3.4  | 3.4  | 3.4  | 3.4   | 4.1   |
| 1990 | 1.1  | 1.7    | 2.4    | 3.2  | 4.2  | 4.4  | 4.7  | 6.1   | 6.5   |
| 1991 | 1  | 1.3    | 1.6    | 1.9  | 2.8  | 3.1  | 3.4  | 4.8   | 5.7   |
| 1992 | 1.2  | 2.1    | 3.2    | 3.7  | 4.2  | 4.4  | 4.6  | 5.2   | 5.3   |
| 1993 | 1.5  | 2.7    | 3.5    | 3.7  | 4.2  | 5    | 5.9  | 6.4   | 7.4   |
| 1994 | 1.6  | 2.2    | 2.7    | 2.8  | 3.2  | 3.2  | 3.2  | 3.4   | 3.6   |
| 1995 | 1  | 1.5    | 1.9    | 2.2  | 2.7  | 3.2  | 5.4  | 5.9   | 6.8   |
| 1996 | 1.1  | 1.7    | 2.1    | 2.5  | 3.9  | 4.7  | 5.2  | 5.2   | 6.6   |
| 1997 | 1.3  | 2      | 2.6    | 2.8  | 3.4  | 3.6  | 4.5  | 5.2   | 5.5   |
| 1998 | 1  | 1.8    | 2.4    | 3.3  | 4    | 4    | 6.1  | 8.2   | 10.9  |
| 1999 | 1.3  | 2      | 2.5    | 2.9  | 3.2  | 3.4  | 3.8  | 4.9   | 5.5   |
| 2000 | 1.5  | 2.4    | 2.8    | 3.3  | 4.8  | 5    | 5.2  | 6.2   | 9.4   |
| 2001 | 1.1  | 1.8    | 2      | 2.3  | 3.6  | 4    | 4.2  | 4.2   | 4.4   |
| 2002 | 1.4  | 2.1    | 2.9    | 3.5  | 5    | 5.5  | 5.5  | 5.6   | 5.7   |

|                |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|
| <b>AVG</b>     | 1.2  | 1.9  | 2.4  | 2.8  | 3.4  | 3.7  | 4.2  | 4.8  | 5.7  |
| <b>STD DEV</b> | 0.24 | 0.38 | 0.54 | 0.69 | 0.89 | 0.99 | 1.03 | 1.30 | 1.75 |
| <b>b</b>       | 0.19 | 0.30 | 0.42 | 0.54 | 0.70 | 0.77 | 0.80 | 1.01 | 1.36 |
| <b>a</b>       | 1.10 | 1.76 | 2.21 | 2.50 | 3.05 | 3.29 | 3.77 | 4.20 | 4.89 |

| RETURN PERIOD (YEARS) | CALCULATED RAINFALL DEPTHS (IN) FOR A GIVEN DURATION AND RETURN PERIOD |        |        |      |      |      |      |       |       |
|-----------------------|--|--------|--------|------|------|------|------|-------|-------|
|                       | 15 min   | 30 min | 45 min | 1 hr | 2 hr | 3 hr | 6 hr | 12 hr | 24 hr |
| 2                     | 1.17   | 1.87   | 2.36   | 2.70 | 3.30 | 3.57 | 4.06 | 4.57  | 5.39  |
| 5                     | 1.38   | 2.21   | 2.83   | 3.31 | 4.09 | 4.45 | 4.97 | 5.72  | 6.94  |
| 10                    | 1.52   | 2.43   | 3.15   | 3.71 | 4.61 | 5.03 | 5.58 | 6.48  | 7.96  |
| 25                    | 1.70   | 2.71   | 3.55   | 4.22 | 5.27 | 5.76 | 6.34 | 7.44  | 9.26  |
| 50                    | 1.83   | 2.92   | 3.84   | 4.60 | 5.76 | 6.30 | 6.90 | 8.15  | 10.22 |
| 100                   | 1.97   | 3.13   | 4.13   | 4.98 | 6.25 | 6.84 | 7.47 | 8.86  | 11.17 |

COMPUTATION OF RAINFALL DEPTH - DURATION STATISTICS USING GUMBEL DISTRIBUTION FOR YEARS 1905-2002

| Year | STATION - ANNUAL MAXIMUM 24-HR RAINFALL DEPTH (IN) |       |        |           |                | Average of All Stations |
|------|--|-------|--------|-----------|----------------|-------------------------|
|      | Cristobal  | Gatun | Gamboa | Alhajuela | Balboa Heights |                         |
| 1905 | 2.84   | 5.88  | 2.27   | 3.96      | 3.47           | 2.55                    |
| 1906 | 8.47   | 10.48 | 6.29   | 8.19      | 4.48           | 7.00                    |
| 1907 | 4.03   | 2.98  | 4.92   | 3.01      | 3.18           | 2.79                    |
| 1908 | 3.65   | 3.64  | 3.83   | 3.62      | 3.10           | 2.10                    |
| 1909 | 6.13   | 6.51  | 3.88   | 5.56      | 2.20           | 3.61                    |
| 1910 | 3.99   | 5.70  | 3.40   | 4.70      | 4.12           | 2.31                    |
| 1911 | 4.27   | 3.79  | 4.02   | 3.92      | 4.47           | 2.14                    |
| 1912 | 3.64   | 3.35  | 3.45   | 2.89      | 7.06           | 2.16                    |
| 1913 | 4.74   | 3.19  | 3.31   | 2.92      | 2.78           | 2.09                    |
| 1914 | 4.91   | 6.72  | 5.18   | 3.45      | 2.37           | 2.33                    |
| 1915 | 7.12   | 7.54  | 3.72   | 5.32      | 3.13           | 3.15                    |
| 1916 | 3.17   | 4.13  | 3.03   | 4.06      | 4.70           | 2.19                    |
| 1917 | 4.15   | 6.63  | 6.34   | 3.43      | 2.44           | 2.67                    |
| 1918 | 5.47   | 3.54  | 2.62   | 2.25      | 2.46           | 1.99                    |
| 1919 | 3.62   | 4.00  | 2.29   | 3.48      | 2.58           | 2.19                    |
| 1920 | 4.97   | 2.83  | 4.04   | 4.81      | 5.33           | 2.12                    |
| 1921 | 4.30   | 3.76  | 2.61   | 3.66      | 3.34           | 2.70                    |
| 1922 | 3.53   | 4.38  | 3.37   | 3.34      | 3.17           | 2.64                    |
| 1923 | 10.03  | 10.99 | 6.75   | 8.22      | 5.03           | 7.37                    |
| 1924 | 4.32   | 4.60  | 5.14   | 3.50      | 3.37           | 3.12                    |
| 1925 | 6.89   | 4.07  | 3.42   | 2.65      | 4.00           | 2.68                    |
| 1926 | 4.93   | 5.70  | 3.32   | 3.69      | 4.52           | 2.81                    |
| 1927 | 7.98   | 6.39  | 3.09   | 4.93      | 2.57           | 3.43                    |
| 1928 | 4.06   | 5.47  | 3.19   | 4.07      | 3.02           | 2.09                    |
| 1929 | 6.16   | 5.51  | 2.78   | 3.77      | 3.01           | 2.86                    |
| 1930 | 4.41   | 4.78  | 4.26   | 3.82      | 3.67           | 2.32                    |
| 1931 | 6.72   | 8.02  | 5.50   | 6.11      | 4.07           | 6.01                    |
| 1932 | 6.23   | 7.08  | 3.75   | 5.33      | 3.66           | 4.33                    |
| 1933 | 6.97   | 8.47  | 3.14   | 3.79      | 3.15           | 4.16                    |
| 1934 | 7.54   | 6.08  | 3.44   | 4.11      | 4.48           | 4.28                    |
| 1935 | 5.41   | 8.09  | 5.21   | 4.80      | 4.64           | 4.93                    |
| 1936 | 5.95   | 4.36  | 3.20   | 3.83      | 3.42           | 2.67                    |
| 1937 | 9.95   | 6.02  | 5.48   | 3.26      | 3.70           | 4.40                    |
| 1938 | 4.11   | 5.54  | 4.24   | 4.19      | 3.99           | 2.42                    |
| 1939 | 7.70   | 8.29  | 2.57   | 3.76      | 3.92           | 3.31                    |
| 1940 | 6.28   | 4.59  | 3.59   | 2.59      | 2.25           | 2.41                    |
| 1941 | 5.62   | 4.03  | 2.98   | 4.87      | 3.74           | 3.48                    |
| 1942 | 7.67   | 8.95  | 3.79   | 3.80      | 2.95           | 5.19                    |
| 1943 | 4.66   | 6.98  | 5.00   | 4.46      | 2.92           | 4.78                    |
| 1944 | 10.80  | 6.74  | 3.86   | 3.95      | 5.32           | 4.76                    |
| 1945 | 4.47   | 6.13  | 3.19   | 2.45      | 3.15           | 2.82                    |
| 1946 | 5.55   | 4.74  | 3.99   | 3.97      | 3.92           | 2.38                    |
| 1947 | 5.37   | 2.14  | 3.62   | 3.08      | 2.76           | 2.76                    |
| 1948 | 3.24   | 5.25  | 3.13   | 3.91      | 3.16           | 2.20                    |
| 1949 | 4.67   | 3.63  | 3.26   | 2.71      | 2.07           | 1.85                    |
| 1950 | 9.00   | 6.67  | 2.19   | 3.58      | 2.85           | 3.84                    |
| 1951 | 3.14   | 3.93  | 3.35   | 3.18      | 3.54           | 2.28                    |
| 1952 | 5.60   | 6.35  | 3.55   | 5.41      | 4.51           | 3.11                    |
| 1953 | 4.63   | 5.14  | 2.59   | 4.03      | 2.97           | 2.42                    |
| 1954 | 4.39   | 6.70  | 3.35   | 3.83      | 3.40           | 3.56                    |
| 1955 | 5.46   | 5.31  | 3.10   | 3.07      | 3.03           | 2.37                    |
| 1956 | 6.08   | 5.26  | 3.16   | 2.69      | 5.37           | 2.47                    |
| 1957 | 5.47   | 7.21  | 3.38   | 3.31      | 4.44           | 3.18                    |
| 1958 | 5.56   | 5.43  | 3.24   | 3.40      | 4.97           | 1.86                    |
| 1959 | 4.51   | 6.69  | 2.79   | 2.87      | 4.29           | 2.85                    |
| 1960 | 5.75   | 6.98  | 3.41   | 2.50      | 6.29           | 3.30                    |
| 1961 | 2.98   | 3.51  | 3.30   | 3.14      | 3.21           | 1.93                    |
| 1962 | 5.17   | 5.68  | 3.22   | 3.62      | 5.75           | 2.40                    |
| 1963 | 4.48   | 3.58  | 4.76   | 4.11      | 4.44           | 2.10                    |
| 1964 | 3.29   | 4.58  | 2.52   | 4.06      | 3.06           | 2.39                    |
| 1965 | 4.40   | 5.92  | 3.28   | 5.07      | 4.60           | 2.58                    |
| 1966 | 9.15   | 7.86  | 3.35   | 7.64      | 4.92           | 5.85                    |
| 1967 | 5.49   | 6.25  | 4.09   | 5.21      | 4.12           | 1.98                    |
| 1968 | 3.60   | 4.45  | 2.94   | 3.73      | 2.86           | 2.09                    |
| 1969 | 5.34   | 5.23  | 4.30   | 3.93      | 4.36           | 2.90                    |
| 1970 | 6.92   | 5.07  | 5.41   | 3.76      | 2.52           | 3.42                    |
| 1971 | 5.00   | 3.82  | 4.40   | 5.30      | 2.39           | 3.09                    |
| 1972 | 5.30   | 4.48  | 5.40   | 2.60      | 3.23           | 1.99                    |
| 1973 | 4.10   | 3.50  | 5.80   | 5.50      | 3.72           | 2.19                    |
| 1974 | 4.90   | 5.30  | 5.80   | 3.20      | 0.00           | 2.65                    |
| 1975 | 4.70   | 4.20  | 3.90   | 3.40      | 0.00           | 3.09                    |
| 1976 | 5.20   | 4.70  | 2.30   | 3.30      | 3.30           | 2.36                    |
| 1977 | 5.60   | 3.30  | 2.90   | 2.80      | 3.60           | 1.88                    |
| 1978 | 3.70   | 3.30  | 3.90   | 3.60      | 3.00           | 2.32                    |
| 1979 | 3.80   | 3.10  | 3.90   | 2.80      | 2.80           | 2.06                    |
| 1980 | 3.00   | 4.00  | 3.60   | 4.40      | 3.20           | 2.10                    |
| 1981 | 5.40   | 5.00  | 4.10   | 3.10      | 5.30           | 1.98                    |
| 1982 | 4.50   | 4.90  | 5.70   | 3.60      | 2.90           | 1.94                    |
| 1983 | 5.50   | 4.60  | 3.20   | 3.10      | 4.10           | 2.30                    |
| 1984 | 4.80   | 3.00  | 4.20   | 4.00      | 3.20           | 2.64                    |
| 1985 | 5.40   | 3.70  | 2.60   | 4.80      | 4.90           | 2.12                    |
| 1986 | 3.80   | 7.00  | 4.40   | 3.20      | 2.60           | 2.62                    |
| 1987 | 9.90   | 6.60  | 2.90   | 5.00      | 3.00           | 3.76                    |
| 1988 | 4.40   | 3.20  | 2.40   | 4.50      | 4.00           | 1.74                    |
| 1989 | 5.00   | 3.40  | 3.70   | 3.40      | 2.30           | 3.35                    |
| 1990 | 4.50   | 6.20  | 4.70   | 5.40      | 2.50           | 3.88                    |
| 1991 | 5.50   | 4.90  | 3.20   | 3.30      | 4.20           | 3.88                    |
| 1992 | 5.60   | 5.30  | 3.80   | 4.80      | 3.30           | 2.10                    |
| 1993 | 5.90   | 7.10  | 4.00   | 4.60      | 4.70           | 2.70                    |
| 1994 | 4.20   | 3.50  | 3.70   | 2.30      | 5.00           | 2.36                    |
| 1995 | 4.50   | 6.30  | 3.90   | 2.90      | 5.70           | 3.24                    |
| 1996 | 3.60   | 5.20  | 3.20   | 3.50      | 4.10           | 2.92                    |
| 1997 | 4.00   | 5.30  | 3.60   | 3.70      | 4.70           | 2.28                    |
| 1998 | 4.00   | 9.50  | 3.90   | 5.30      | 3.90           | 3.28                    |
| 1999 | 7.40   | 5.10  | 3.40   | 4.60      | 4.60           | 2.88                    |
| 2000 | 6.10   | 6.70  | 4.20   | 5.00      | 2.80           | 4.10                    |
| 2001 | 5.10   | 4.20  | 3.30   | 2.40      | 2.60           | 2.26                    |
| 2002 | 4.50   | 5.60  | 3.90   | 2.40      | 3.50           | 2.32                    |

|         |      |      |      |      |      |      |
|---------|------|------|------|------|------|------|
| AVG     | 5.31 | 5.39 | 3.74 | 4.03 | 3.62 | 2.93 |
| STD DEV | 1.66 | 1.68 | 0.98 | 1.31 | 1.11 | 1.08 |
| b       | 1.30 | 1.31 | 0.76 | 1.02 | 0.87 | 0.84 |
| a       | 4.59 | 4.86 | 3.32 | 3.46 | 3.14 | 2.46 |

| RETURN PERIOD (YEARS) | CALC. 24-HR RAINFALL DEPTHS (IN) FOR A GIVEN RETURN PERIOD |       |        |           |                | Avg. of all Stations |
|-----------------------|--|-------|--------|-----------|----------------|----------------------|
|                       | Cristobal  | Gatun | Gamboa | Alhajuela | Balboa Heights |                      |
| 2                     | 5.07   | 5.14  | 3.60   | 3.83      | 3.46           | 2.77                 |
| 5                     | 6.96   | 6.69  | 4.76   | 4.92      | 4.44           | 3.72                 |
| 10                    | 7.51   | 7.61  | 5.03   | 5.75      | 5.10           | 4.35                 |
| 25                    | 8.73   | 8.86  | 5.76   | 6.72      | 5.92           | 5.14                 |
| 50                    | 9.65   | 9.78  | 6.29   | 7.43      | 6.53           | 5.73                 |
| 100                   | 10.55  | 10.69 | 6.82   | 8.14      | 7.14           | 6.32                 |

## **APPENDIX C - TRANSPORTATION COST MODELING**

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# 1 MATERIAL TRANSPORTATION

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This section discusses methodologies and potential costs for the transportation of excavated and dredged material from the three main study areas to the various disposal sites. It should be noted that the methodologies proposed reflect the consultant's expectations for an independent contract, and may not necessarily reflect the procedures currently adopted by ACP for its ongoing dredging and disposal operations.

The fundamental driver in the selection of the transportation methods evaluated is to present the system that will offer the most economic cost to an outside contractor, based on the haul distance, volume and characteristics of the material to be handled.

Due to the large quantities of material and relatively short timeframes associated with the material disposal operations, it is anticipated that the largest available equipment will be necessary in order to achieve the required production rates at economical cost.

Several possible transportation systems are presented from which to establish a basis for cost for each of the disposal sites. Each of these options will require creation of either dedicated haul roads, conveyor systems or railroads - depending on the transportation system investigated and these costs are included in the final unit cost for each alternative.

## 1.1 Transportation Systems

In order to effectively move material between source and destination, several methods of transportation and material transfer may be required, based on the nature of excavated material and the disposal site location. This combination of equipment and methodology is collectively referred to as the transportation system.

Primary modes of transport investigated include train, tug and scow and off-road dump truck. In addition to the major transportation components, various methods of material transfer are also investigated to complete the respective systems. Wheeled loaders, railcar dumpers, conveyors and bucket cranes provide for material transfer requirements.

Certain of the options will also require the establishment of buffer storage areas and transfer stations, in order to maintain the high rates of productivity required to meet the overall project schedules and to optimize equipment use.

Based on material sources, methods of excavation and disposal site locations, seven distinct transportation systems have been identified. Each system is described below and presented graphically in Figure 1-1 through Figure 1-4.

Note: Equipment included in the respective cost estimates is identified below in bold italic text.

- **System A**
  1. Haul from dredge to transfer station using **scow and tug**
  2. Transfer from scow to off-road truck using **bucket crane**
  3. Short haul to disposal site stockpile using **off-road truck**
  
- **System B**
  1. Haul from dredge to transfer station using **scow and tug**
  2. Transfer from scow to off-road truck using **bucket crane**
  3. Short haul to temporary stockpile using **medium capacity dump truck**
  4. Transfer from stockpile to train using **wheeled loader and loading conveyor**
  5. Transport to disposal site transfer station using **50-car train**
  6. Unload train to disposal site stockpile using **railcar dumper and conveyor**
  
- **System C**
  1. Haul from dredge to transfer station using **scow and tug**
  2. Transfer from scow to off-road truck using **bucket crane**
  3. (Sub-system: Short haul to temporary stockpile using **medium capacity dump truck** to maintain removal of material from excavation site)
  4. Haul to disposal site stockpile using **large capacity dump truck**
  
- **System D**
  1. Direct-load dump trucks at excavation site using mass excavator/shovel
  2. Short haul to temporary stockpile using **medium capacity off-road truck**
  3. Transfer from stockpile to train using **wheeled loader and loading conveyor**
  4. Transport to disposal site transfer station using **50-car train**
  5. Unload train to disposal site stockpile using **railcar dumper and conveyor**

- **System E**

1. Direct-load dump trucks at excavation site using mass excavator/shovel
2. (Sub-system: Short haul to temporary stockpile using **medium capacity dump trucks** and load large capacity trucks as available using **wheeled loader** - maintains removal of material from excavation site and allows for delays to long-haul trucks)
3. Haul to disposal site stockpile using **large capacity dump truck** and unload

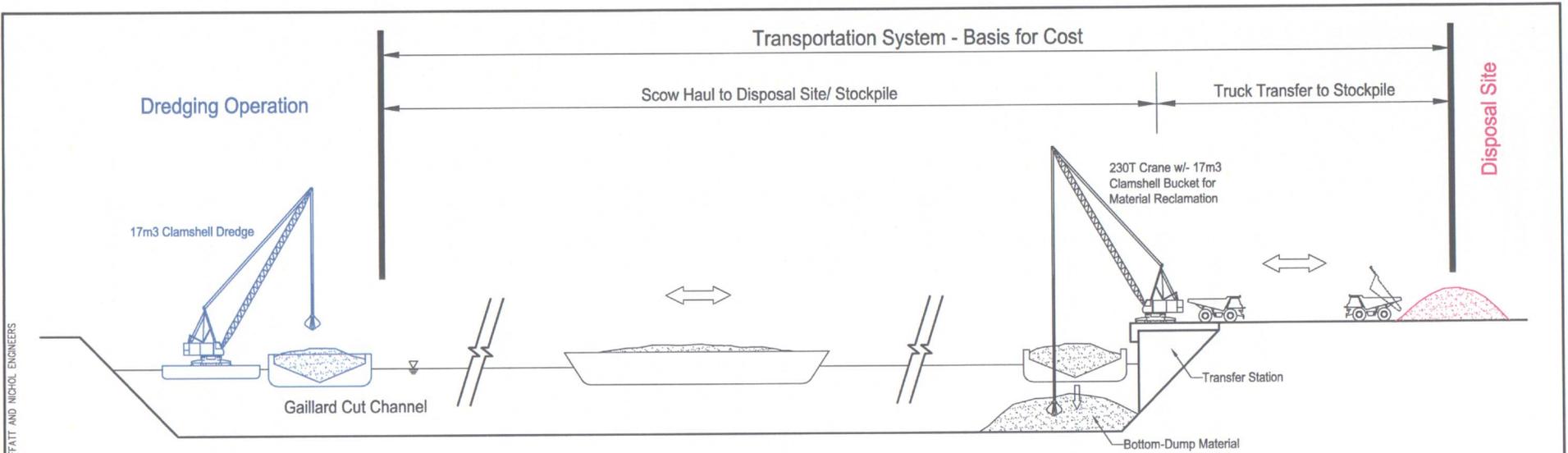
- **System F**

1. Direct-load dump trucks at excavation site using mass excavator/shovel
2. (Sub-system: Short haul to temporary stockpile using **medium capacity dump trucks** and load large capacity trucks as available using **wheeled loader** - maintains removal of material from excavation site and allows for delays to long-haul trucks)
3. Haul to disposal site transfer station stockpile using **large capacity dump trucks** and unload
4. Transfer to scow using **wheeled loader and conveyor**
5. Haul to disposal site using **scow and tug**

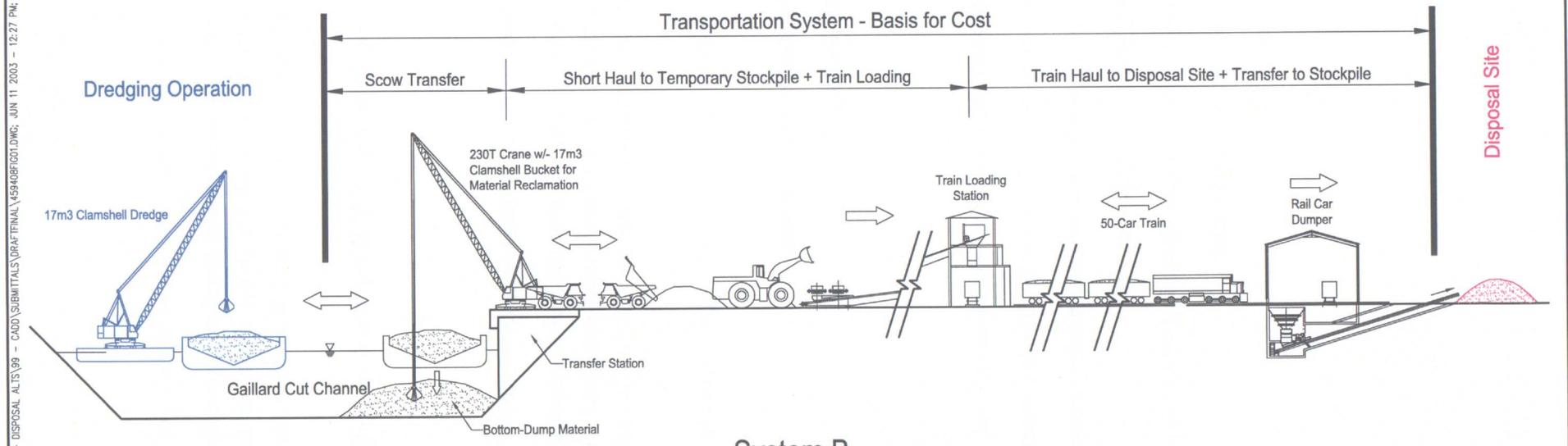
- **System G**

1. Direct-load dump trucks at excavation site using mass excavator/shovel
2. Short haul to temporary stockpile using **medium capacity off-road truck**
3. Transfer from stockpile to train using **wheeled loader and loading conveyor**
4. Transport to disposal site transfer station using **50-car train**
5. Unload train to disposal site stockpile using **railcar dumper and conveyor**
6. Transfer to scow using **wheeled loader and conveyor**
7. Haul to disposal site using **scow and tug**

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**System A**  
 Typical Scow Haul Operation (Wet Excavation Source)



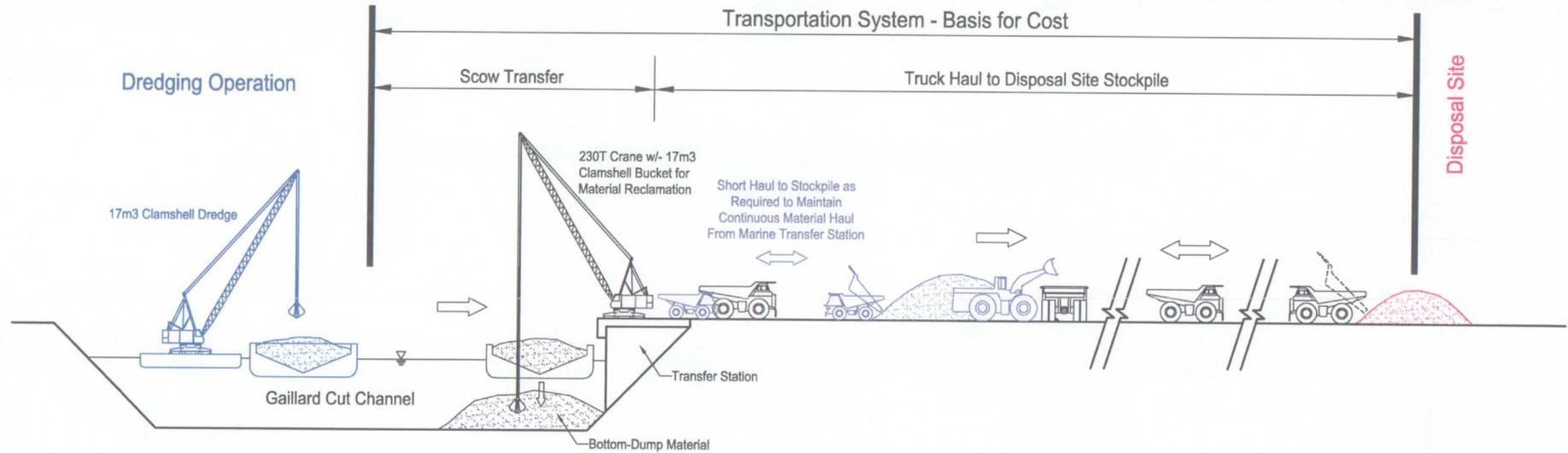
**System B**  
 Typical Scow/Train Haul Operation (Wet Excavation Source)

**Legend**

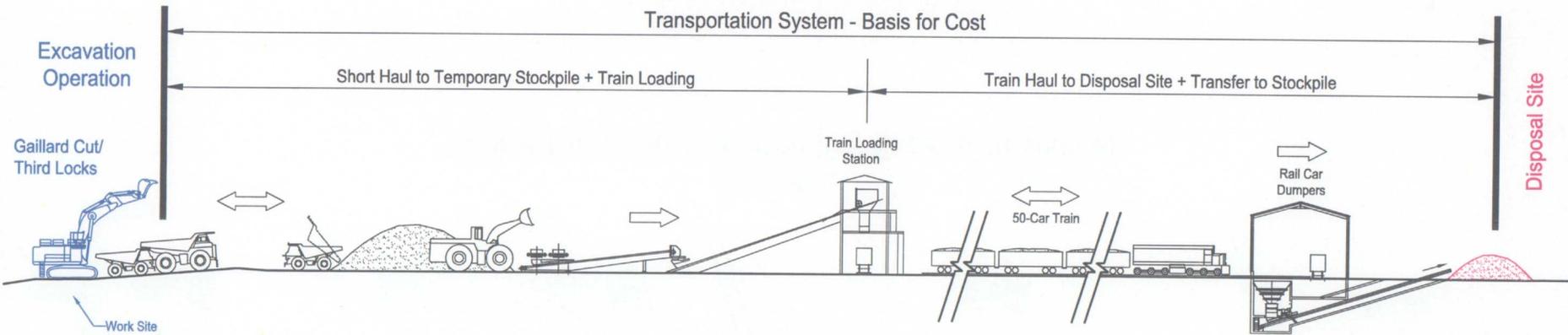


**Figure 1-1: Transportation Systems A and B**

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



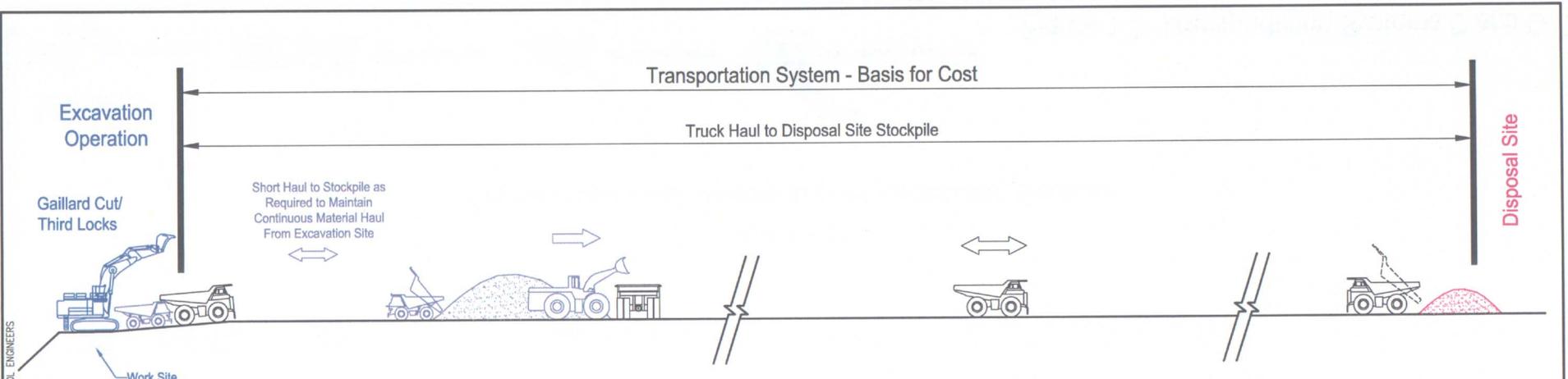
System D  
Typical Train Haul Operation (Dry Excavation Source)

Legend

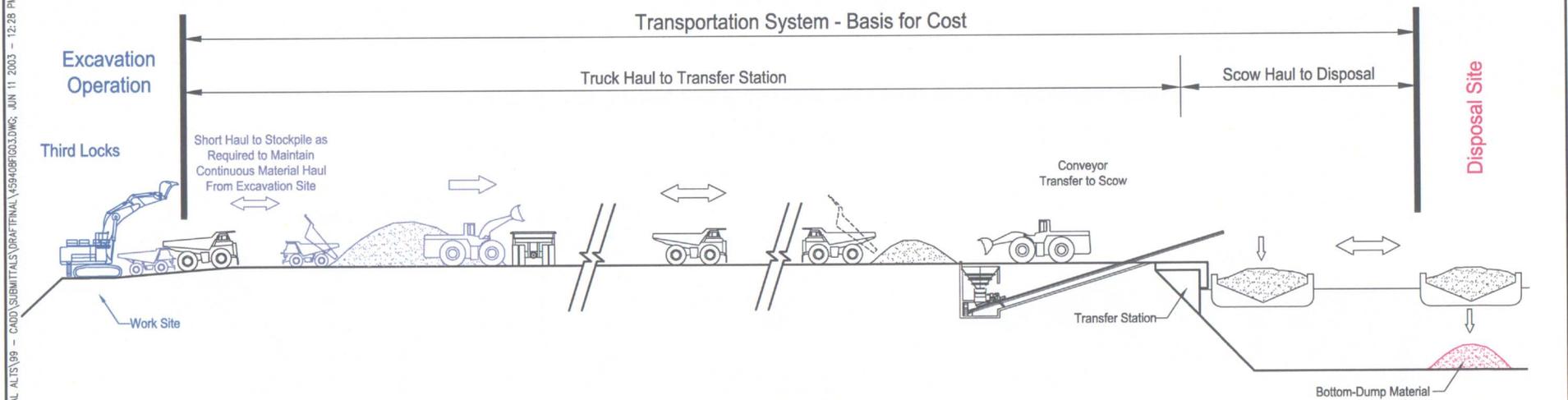


Figure 1-2: Transportation Systems C and D

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System E  
Typical Truck Haul Operation (Dry Excavation Source)



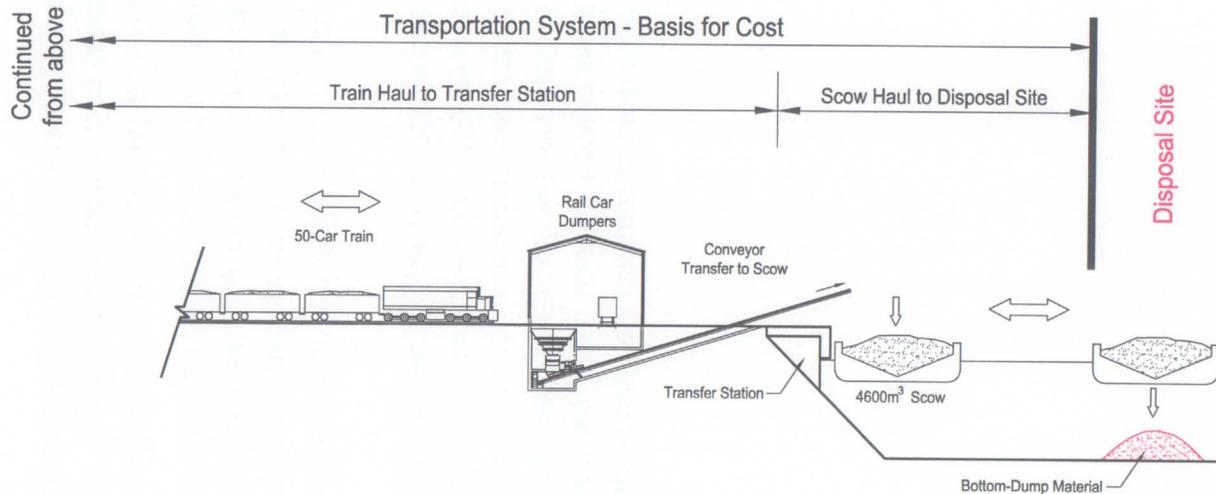
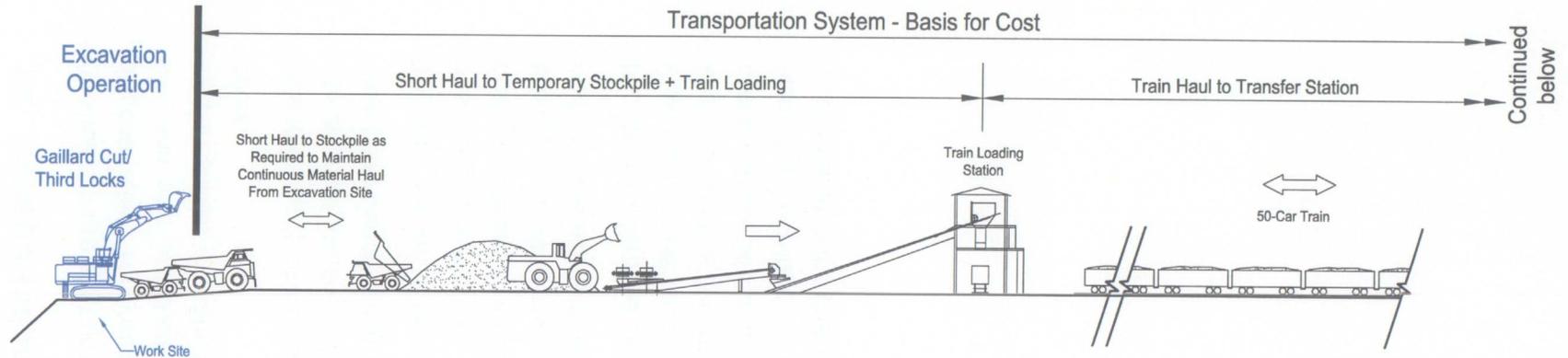
System F  
Typical Truck/Scow Haul Operation (Dry Excavation Source)

**Legend**



Figure 1-3: Transportation Systems E and F

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

Legend



Figure 1-4: Transportation System G

## 1.2 Transportation Costs

As shown, there are numerous options available for transporting material to the respective disposal sites. The contracting firm(s) selected to do the work will undertake the final selection of a particular system. However, the computation of costs presented in this section should indicate the most economical system or systems for each disposal site option.

Due to capacity of the various disposal sites, some sites will function as part of a multiple-site disposal solution. For the purpose of comparison and simplicity, unit cost calculations have been performed independently for each disposal site/transportation system option.

The total system costs and resulting unit prices are based on the respective systems as described in Section 1.1 above. No contingencies or ACP administration and engineering costs have been included, as they are expected to be allocated to the basic excavation or dredge projects. However contractor's labour, profits and overhead are factored into the respective equipment rates.

In order to determine cycle times and equipment matching, production rates of excavation equipment (mass excavators, bucket dredges, etc.) were used. The cost of excavation is assumed part of the respective excavation operations however and is not included in system costs. Site preparation, final disposal site grading and general site improvements also are excluded from the transportation system cost calculations, but will be incorporated in the final cost estimates used to compare the various site alternatives. .

| PRELIMINARY COST ESTIMATE                                     |                  |                |  | DATE PREPARED<br>19-Mar-04 |  |
|---|------------------|----------------|--|----------------------------|--|
| CLIENT<br>AUTORIDAD DEL CANAL DE PANAMA                       |                  |                | PROJECT NO.<br>4594-08                     |                            |  |
|   |                  |                | ESTIMATED BY<br>MOFFATT & NICHOL ENGINEERS |                            |  |
| PROJECT TITLE<br>Material Disposal Alternatives Study         |                  |                | STATUS OF DESIGN<br>Conceptual             |                            |  |
| <b>Typical Transportation Costs to Various Disposal Sites</b> |                  |                |  |                            |  |
| <b>Material Source: Gaillard Cut Excavation</b>               |                  |                |  |                            |  |
| Item  | Maximum Quantity | Units          | Unit Cost                                  | Total                      |  |
| <b>Material Transportation to A1</b>                          |                  |                |  |                            |  |
| Scow Haul to Disposal Site - Wet Source                       | 34,524,112       | m <sup>3</sup> | \$4.84                                     | \$167,068,241              |  |
| Train Haul to Disposal Site - Wet Source                      | 34,524,112       | m <sup>3</sup> | \$13.76                                    | \$475,019,048              |  |
| Truck Haul to Disposal Site - Wet Source                      | 34,524,112       | m <sup>3</sup> | \$32.46                                    | \$1,120,590,403            |  |
| <b>Material Transportation to T1</b>                          |                  |                |  |                            |  |
| Truck Haul to Disposal Site - Wet Source                      | 34,524,112       | m <sup>3</sup> | \$3.85                                     | \$132,856,701              |  |
| Truck Haul to Disposal Site - Dry Source                      | 32,900,678       | m <sup>3</sup> | \$2.06                                     | \$67,838,969               |  |
| <b>Material Transportation to T2</b>                          |                  |                |  |                            |  |
| Truck Haul to Disposal Site - Wet Source                      | 32,350,000       | m <sup>3</sup> | \$4.39                                     | \$141,968,054              |  |
| Truck Haul to Disposal Site - Dry Source                      | 32,350,000       | m <sup>3</sup> | \$2.64                                     | \$85,404,000               |  |
| <b>Material Transportation to T3</b>                          |                  |                |  |                            |  |
| Truck Haul to Disposal Site - Wet Source                      | 28,132,315       | m <sup>3</sup> | \$3.86                                     | \$108,452,177              |  |
| Truck Haul to Disposal Site - Dry Source                      | 28,132,315       | m <sup>3</sup> | \$3.35                                     | \$94,349,091               |  |
| <b>Material Transportation to T4</b>                          |                  |                |  |                            |  |
| Truck Haul to Disposal Site - Dry Source                      | 12,555,399       | m <sup>3</sup> | \$3.32                                     | \$41,668,606               |  |
| <b>Material Transportation to T5</b>                          |                  |                |  |                            |  |
| Truck Haul to Disposal Site - Wet Source                      | 7,279,264        | m <sup>3</sup> | \$4.88                                     | \$35,530,481               |  |
| Truck Haul to Disposal Site - Dry Source                      | 7,279,264        | m <sup>3</sup> | \$3.11                                     | \$22,631,590               |  |
| <b>Material Transportation to T6</b>                          |                  |                |  |                            |  |
| Truck Haul to Disposal Site - Wet Source                      | 34,524,112       | m <sup>3</sup> | \$3.87                                     | \$133,637,201              |  |
| Truck Haul to Disposal Site - Dry Source                      | 32,900,678       | m <sup>3</sup> | \$4.66                                     | \$153,209,824              |  |

Note: Costs for respective dredging, excavation and disposal site work not included

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**  
**Project Specifications - Scow Haul to A1**

| Item   | Unit          | Qty            | Price/Rate | Comments   |
|--|---------------|----------------|------------|--|
| <b>General Parameters</b>  |               |                |            |  |
| Total Material to be Hauled  | m3            | 34,524,112     |            | disposal volume matched to total wet excavation                          |
| Time to transport material   | year          | 3.8            |            |  |
| Working days per year  | day/year      | 345            |            |  |
| Total working days   | day           | 1,311          |            |  |
| <b>Target Production (total volume/working days)</b>   | <b>m3/day</b> | <b>26,335</b>  |            |  |
| ACP Production Rate  | m3/day        | 4,522          |            | based on published production rate (weighted) of 94,800m3/week           |
| Working Hours per day  | hr            | 24             |            | Ref: worksheet Input Sheet   |
| <b>Equipment Parameters</b>  |               |                |            |  |
| <b>3000m3 Scow</b>   |               |                |            |  |
| Scow Fill Factor   |               | 60%            |            |  |
| Scow Capacity  | m3            | 1,800          |            | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.           | 19,181         |            |  |
| Scow/Tug trips required per day  | no.           | 14.63          |            |  |
| Max. load/unload time per scow *   | hr            | 1.64           |            | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |               |                |            |  |
| <b>41m3 Clamshell Bucket Dredge</b>  |               |                |            |  |
| Single Bucket Capacity   | m3            | 41.3           |            |  |
| Bucket Fill Factor   | no.           | 45%            |            | Used for logistics calculations only, cost not included                  |
| Actual Bucket Capacity   | m3            | 18.585         |            |  |
| Bucket Cycle Time  | sec           | 120            |            |  |
| Production Rate for 41m3 clamshell dredge  | m3/hr         | 557.55         |            | Compares with CEDEP (Corps of Engineers cost model - 600m3/hr)           |
| Daily Loading Rate (hourly rate x working hours)   | m3/day        | 13,380.0       |            |  |
| <b>No. Dredges Required to maintain Target Rate</b>  | <b>no.</b>    | <b>2.0</b>     |            |  |
| <b>Loading rate for 2 dredge(s)</b>  | <b>m3/hr</b>  | <b>1,115.1</b> |            |  |
| <b>CAT 775E Off-Road Truck (41.5m3 Capacity)</b>   |               |                |            |  |
| Design Truck Capacity  | m3            | 41.5           |            |  |
| Truck Fill Factor  | no.           | 80%            |            |  |
| Factored Truck Capacity  | m3            | 33             |            |  |
| Total Truck Trips Required to Meet Target  | no.           | 1,039,883      |            |  |
| Calculated truck trips per day   | no.           | 794.0          |            |  |
| Max. load/unload time per truck *  | hr            | 0.030          |            | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |               |                |            |  |
| <b>Dredging/Trip Cycle</b>   |               |                |            |  |
| Average distance (dredge to unloading station)   | km            | 38.0           |            | Assume scows loaded by 41m3 clamshell dredge                             |
| Average Scow/Tug Travel Speed  | km/hr         | 9.0            |            | Ref: site plan   |
| Time to Load Scow  | hr            | 1.61           |            |  |
| Average Travel Time (round Trip)   | hr            | 8.44           |            |  |
| Time to Berth and Dump Scow  | hr            | 0.50           |            |  |
| <b>Total trip cycle time</b>   | <b>hr</b>     | <b>10.56</b>   |            |  |
| Max scow trips per day (assuming 24 operating hours)   | no.           | 2.27           |            |  |
| <b>No. Scow(s) required</b>  | <b>no.</b>    | <b>8.0</b>     |            |  |
| <b>No. Tow Tug(s) required</b>   | <b>no.</b>    | <b>5.0</b>     |            | Tug estimate based on cycle time, assumes tandem tows                    |
| <b>Truck Transfer Cycle</b>  |               |                |            |  |
| Average distance (marine transfer station to stockpile)  | km            | 1              |            | Source: site plan  |
| Average Truck Travel Speed   |               | 25             |            |  |
| Estimated Load Time  | hr            | 0.030          |            | 1.8 minutes  |
| Estimated Travel Time (Round Trip)   | hr            | 0.080          |            | Calculated round-trip distance of 2 km                                   |
| Estimated Unload Time  | hr            | 0.017          |            | 1 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>     | <b>0.13</b>    |            |  |
| Calculated Trips Per Truck per Day   | no.           | 189.8          |            |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b>    | <b>6.0</b>     |            | plus one spare   |
| <b>Equipment Costs</b>   |               |                |            |  |
| <b>Scow/Tugs</b>   |               |                |            |  |
| 3000m3 scow (includes labor and operating costs)   | \$/day        |                | \$ 2,333   | Source: Corps of Engineers, divide monthly cost by 30.4375               |
| 3000HP towing tug (includes labor and operating costs)   | \$/day        |                | \$ 9,035   | Source: Corps of Engineers, divide monthly cost by 30.4375               |
| Total cost for 8 scows   | \$/day        | 8.00           | \$ 18,661  |  |
| Total cost for 5 tow tug(s)  | \$/day        | 5.00           | \$ 45,175  |  |
| <b>230t Manitowoc Crane + 41m3 Clamshell Bucket (Material Transfer)</b>  |               |                |            |  |
| Hourly Rate  | \$/hr         |                | \$ 500     | Source: Dredging Specialist, M&N Walnut Creek                            |
| Daily Rate   | \$/day        |                | \$ 12,000  | 24 pay hours per day   |
| Daily Cost for 2 crane(s) (loading 24 hours per day)   | \$day         | 2              | \$ 24,000  |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |               |                |            |  |
| Hourly Rate  | \$/hr         |                | \$ 275.00  |  |
| Daily Rate per truck   | \$/day        |                | \$ 6,600   | 24 pay hours   |
| Daily Rate for 6 trucks  | \$/day        | 6.0            | \$ 39,600  |  |

**Transportation Costs**

| Item   | Unit | Qty   | Price/Rate   | Comments                                 |
|--|------|-------|--------------|--|
| <b>Equipment</b>                             |      |       |              |  |
| Scow(s)                                      | day  | 1,311 | \$18,661 \$  | 24,464,821                               |
| Tow Tug(s)                                   | day  | 1,311 | \$45,175 \$  | 59,223,819                               |
| 230t Manitowoc Crane + 41m3 Clamshell Bucket | day  | 1,311 | \$24,000 \$  | 31,464,000 transfer material to landside |
| 41.5m3 Truck(s)                              | no.  | 1,311 | \$ 39,600 \$ | 51,915,600                               |

|  |  |
|--|--|
| <b>Total - Material Transportation</b> | <b>\$167,068,241</b>                           |
| <b>Unit Cost</b>                       | <b>\$4.84</b> Excludes dredge/excavation costs |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Scow/Train Haul to A1**

| Item   | Unit       | Qty      | Price/Rate | Total | Comments                              |
|--|------------|----------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |          |            |       |                                       |
| Formation (Section) Length                     | m          | 60000    |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2        |            |       |                                       |
| Formation cut volume                           | m3         | 14510000 |            |       |                                       |
| Formation fill volume                          | m3         | 15440000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30       |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0.6      |            |       |                                       |
| Ballast Width                                  | m          | 6        |            |       |                                       |
| Spacing of ties                                | m          | 0.6      |            |       |                                       |
| Wood tie dimensions                            |            |          |            |       |                                       |
| width  | m          | 0.2      |            |       |                                       |
| depth  | m          | 0.15     |            |       |                                       |
| length   | m          | 2.6      |            |       |                                       |
| volume   | m3         | 0.078    |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$       | 40,000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |          |            |       |                                       |
| Total Track Length                             | m          | 130,000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 216,667  |            |       |                                       |
| Ballast volume                                 | m3         | 495,500  |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 891,900  |            |       |                                       |

**Construction Costs**

| Item                                   | Unit           | Qty        | Price/Rate   | Total                 | Comments   |
|--|----------------|------------|--------------|-----------------------|--|
| <b>Track Laying on Formation</b>       |                |            |              |                       |  |
| Survey                                 | Ha             | 1200       | \$ 2,000.00  | \$ 2,400,000          | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea             | 120        | \$ 2,400.00  | \$ 288,000            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha             | 180        | \$ 14,820.00 | \$ 2,667,600          | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m <sup>3</sup> | 29,950,000 | \$ 1.10      | \$ 32,905,431         | Cut + Fill Volumes   |
| Ballast                                | t              | 891,900    | \$ 34.00     | \$ 30,324,600         | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea             | 216,667    | \$ 58.00     | \$ 12,566,667         |  |
| Tie plates                             | ea             | 433,334    | \$ 8.60      | \$ 3,726,672          |  |
| 132lb Rail                             | m              | 260,000    | \$ 62.34     | \$ 16,207,349         |  |
| Track spikes                           | ea             | 866,667    | \$ 6.26      | \$ 5,425,333          |  |
| Rail anchors                           | ea             | 433,333    | \$ 5.90      | \$ 2,556,667          | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea             | 15         | \$ 30,000.00 | \$ 450,000            |  |
| <b>Total Cost - Track on Formation</b> |                |            |              | <b>\$ 109,518,319</b> |  |
| <b>Unit Cost per km</b>                |                |            |              | <b>842,500</b>        |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2,000,000.00 | \$ 2,000,000 |  |
| Culvert - crossings | no.  | 90  |                 |              |  |
| Pipe (Class 5)      | ea   | 360 | \$ 23,580.58    | \$ 8,489,007 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 180 | \$ 4,703.60     | \$ 846,648   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1,819.00     | \$ 12,733    | Assume 8m-wide roadway                                     |

|  |  |  |  |                       |  |
|--|--|--|--|-----------------------|--|
| <b>Total Cost - Formation + Track Laying</b> |  |  |  | <b>\$ 109,518,319</b> |  |
| <b>Total Cost - Railway Structures</b>       |  |  |  | <b>\$ 11,348,388</b>  |  |
| <b>Total Cost - Railway Construction</b>     |  |  |  | <b>\$ 120,866,708</b> |  |

**MATERIAL TRANSPORTATION**

**General Specifications**

| Item   | Unit     | Qty        | Price/Rate | Total | Comments   |
|--|----------|------------|------------|-------|--|
| <b>General Parameters</b>                                  |          |            |            |       |  |
| Total Material to be Hauled                                | m3       | 34,524,112 |            |       |  |
| Time to transport material                                 | year     | 3.80       |            |       |  |
| Working Days   | day/year | 345        |            |       |  |
| Total Working Days   | day      | 1,311      |            |       |  |
| Calculated Target Production (total material/working days) | m3/day   | 26,335     |            |       |  |
| ACP Production Rate  | m3/day   | 4,522      |            |       | based on published production rate (weighted) of 94,800m3/week |
| Working Hours per day                                      | hr       | 24         |            |       | Ref: worksheet Input Sheet                                     |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Parameters**

|  |              |                |  |
|--|--------------|----------------|--|
| <b>3000m3 Scow</b>   |              |                |  |
| Scow Fill Factor   |              | 60%            |  |
| Scow Capacity  | m3           | 1,800          | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.          | 19,181         |  |
| Scow/Tug trips required per day  | no.          | 14.63          |  |
| <b>230t Manitowoc Crane + 41m3 Clamshell Bucket (Material Transfer)</b>  |              |                |  |
| Single Bucket Capacity   | m3           | 41.3           |  |
| Bucket Fill Factor   | no.          | 45%            |  |
| Actual Bucket Capacity   | m3           | 18.585         |  |
| Bucket Cycle Time  | sec          | 120            |  |
| Production Rate for 41m3 clamshell + crane   | m3/hr        | 557.55         | Compares with CEDEP (Corps of Engineers cost model)                      |
| Daily Loading Rate (hourly rate x working hours)   | m3/day       | 13,381.20      |  |
| <b>No. Cranes Required to maintain Target Rate</b>   | <b>no.</b>   | <b>2.0</b>     |  |
| <b>Hourly Loading Rate for 2 crane(s)</b>  | <b>m3/hr</b> | <b>1,115</b>   | Indicates train loading rate   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |  |
| Single Bucket Capacity   | m3           | 20.0           |  |
| Bucket Fill Factor   | no.          | 70%            |  |
| Factored Bucket Capacity   | m3           | 14             |  |
| Dig/Load Cycle Time  | sec          | 45.0           |  |
| Production Rate for Loader   | m3/hr        | 1120.0         | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Loader  | m3/day       | 26,880.00      |  |
| <b>No. Loaders Required to maintain Target Rate</b>  | <b>no.</b>   | <b>1.0</b>     |  |
| <b>Hourly Loading Rate for 1 Loaders</b>   | <b>m3/hr</b> | <b>1,120.0</b> |  |
| <b>CAT 775E Off-Road Truck (41.5m3 Capacity)</b>   |              |                |  |
| Design Truck Capacity  | m3           | 41.5           |  |
| Truck Fill Factor  | no.          | 80%            |  |
| Factored Truck Capacity  | m3           | 33             |  |
| Total Truck Trips Required to Meet Target  | no.          | 1,039,883      |  |
| Calculated truck trips per day   | no.          | 794.0          |  |
| Max. load/unload time per truck *  | hr           | 0.030          | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |  |
| <b>Trains</b>  |              |                |  |
| Rail Car Capacity  | m3           | 40             |  |
| Rail Cars Per Train  | no.          | 50             |  |
| Locos per Train  | no.          | 2              | Ruling Grade @ 1.5%  |
| Total Train Capacity   | m3           | 2,000          |  |
| Train Trips Required Per Day to Meet Target  | no.          | 13             | To meet target, requires 2 tracks at unloading site                      |
| Max. load/unload time per train *  | hr/train     | 1.818          | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |  |
| <b>Scow Transfer Cycle</b>   |              |                |  |
| Average Scow/Tug Travel Speed  | km/hr        | 9              | Assume scows loaded by 41m3 clamshell dredge                             |
| Average distance (dredge to unloading station)   | km           | 5              | Ref: site plan   |
| Time to Load Scow  | hr           | 1.61           |  |
| Average Travel Time (round Trip)   | hr           | 1.11           |  |
| Time to Berth and Dump Scow  | hr           | 0.50           |  |
| <b>Total trip cycle time</b>   | <b>hr</b>    | <b>3.23</b>    |  |
| Max scow trips per day (assuming 24 operating hours)   | no.          | 7.44           |  |
| <b>No. Scow(s) required</b>  | <b>no.</b>   | <b>2.0</b>     |  |
| <b>No. Tow Tug(s) required</b>   | <b>no.</b>   | <b>1.0</b>     | Tug estimate based on cycle time   |
| <b>Truck Transfer Cycle</b>  |              |                |  |
| Average one-way distance (marine transfer station to stockpile)  | km           | 1.0            | Source: site plan  |
| Average Truck Travel Speed   | km/hr        | 25             |  |
| Estimated Load Time  | hr           | 0.030          | 1.8 minutes  |
| Estimated Travel Time (Round Trip)   | hr           | 0.080          | Calculated round-trip distance of 2 km                                   |
| Estimated Unload Time  | hr           | 0.017          | 1 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>    | <b>0.13</b>    |  |
| Calculated Trips Per Truck per Day   | no.          | 189.8          |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b>   | <b>5.0</b>     |  |
| <b>Rail Transportation Cycle</b>   |              |                |  |
| Avg. one-way track distance (transfer to disposal site)  | km           | 60.0           |  |
| Average Train Speed  | km/hr        | 15             | factor included for train movements and delays                           |
| Time to Load Train   | hr           | 1.79           |  |
| Average Travel Time (Round Trip)   | hr           | 8.00           |  |
| Time to Unload Train   | hr           | 0.83           | Dual-car dumpers, 2min per car per dumper                                |
| <b>Total trip cycle time</b>   | <b>hr</b>    | <b>10.63</b>   |  |
| No. trains loading/dumping simultaneously  | no.          | 0.50           | Indicates no. of trains loading/unloading to meet production target      |
| Calculated Trips Per Train Per Day   | no.          | 2.3            |  |
| <b>No. of Train Consists Required</b>  | <b>no.</b>   | <b>6.0</b>     |  |
| <b>Total Rail Cars Required</b>  | <b>no.</b>   | <b>300.0</b>   |  |
| <b>Total Locos Required</b>  | <b>no.</b>   | <b>12.0</b>    |  |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Costs**

**Scow/Tugs**

|  |        |         |       |  |
|--|--------|---------|-------|--|
| 3000m3 scow (includes labor and operating costs)       | \$/day | \$      | 2,333 |  |
| 3000HP towing tug (includes labor and operating costs) | \$/day | \$      | 9,035 |  |
| Total cost for 2 scow(s)                               | \$/day | 2.00 \$ | 4,665 |  |
| Total cost for 1 tow tug(s)                            | \$/day | 1.00 \$ | 9,035 |  |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

**230t Manitowoc Crane + 41m3 Clamshell Bucket (Material Transfer)**

|  |        |    |             |                      |
|--|--------|----|-------------|----------------------|
| Hourly Rate  | \$/hr  | \$ | 500         |                      |
| Daily Rate   | \$/day | \$ | 12,000      | 24 pay hours per day |
| Daily Cost for 2 crane(s) (loading 24 pay hours per day) | \$/day | 2  | \$24,000.00 |                      |

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |        |        |              |
|-------------------------|--------|--------|--------|--------------|
| Hourly Rate             | \$/hr  | \$     | 275.00 |              |
| Daily Rate per truck    | \$/day | \$     | 6,600  | 24 pay hours |
| Daily Rate for 5 trucks | \$/day | 5.0 \$ | 33,000 |              |

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                          |        |        |        |              |
|--------------------------|--------|--------|--------|--------------|
| Hourly Rate              | \$/hr  | \$     | 600.00 |              |
| Daily Rate per loader    | \$/day | \$     | 14,400 | 24 pay hours |
| Daily Rate for 1 loaders | \$/day | 1.0 \$ | 14,400 |              |

**Rollingstock**

|  |             |    |           |                  |
|--|-------------|----|-----------|------------------|
| Locomotive - Purchase Cost                 | ea          | \$ | 2,200,000 | Research results |
| Locomotive - Salvage Value (@ 20%)         | ea          | \$ | 440,000   | Research results |
| Side-dump rail car - Purchase Cost         | ea          | \$ | 80,000    | Research results |
| Side-dump rail car - Salvage Value (@ 20%) | ea          | \$ | 16,000    | Research results |
| Locomotive operational cost                | \$/day/unit | \$ | 1,500     | Research results |
| Locomotive maintenance cost                | \$/day/unit | \$ | 1,000     | Research results |
| Rail car maintenance cost                  | \$/day/unit | \$ | 100       | Research results |

**Railway Operation and Maintenance Costs**

**Rollingstock**

|  |        |    |        |  |
|--|--------|----|--------|--|
| Daily Operations Cost for 12 Locos       | \$/day | \$ | 18,000 |  |
| Daily Maintenance Cost for 12 Locos      | \$/day | \$ | 12,000 |  |
| Daily Maintenance Cost for 300 Rail Cars | \$/day | \$ | 30,000 |  |

**Track**

|                        |        |        |           |        |
|------------------------|--------|--------|-----------|--------|
| No. Mainline Tracks    | no.    | 2      |           |        |
| Daily maintenance cost | \$/day | 120 \$ | 100.00 \$ | 12,000 |

**Haul Roads**

|  |           |              |            |
|--|-----------|--------------|------------|
| Construction Cost per km                     | \$/km     | \$250,000.00 |            |
| Maintenance Cost per km per day              | \$/km/day | \$1,000.00   |            |
| Daily maintenance cost for 1 km of haul road | \$/day    | 1.0          | \$1,000.00 |

**Conveyors**

|                                |        |            |             |
|--------------------------------|--------|------------|-------------|
| Maintenance and operation      | \$/km  | \$4,000.00 |             |
| Daily cost for 5km of conveyor | \$/day | 5          | \$20,000.00 |

**Train Loading and Transportation Costs**

| Item                               | Unit     | Qty           | Price/Rate   | Total          | Comments  |
|------------------------------------|----------|---------------|--------------|----------------|---|
| <b>Rail Transportation Costs</b>   |          |               |              |                |   |
| Scow(s)                            | day      | 1,311         | \$4,665      | \$ 6,116,205   |   |
| Tow Tug(s)                         | day      | 1,311         | \$9,035      | \$ 11,844,764  |   |
| 230T Crane                         | day      | 1,311         | \$24,000     | \$ 31,464,000  | transfer to landside                                      |
| 41.5m3 Truck(s)                    | no.      | 1,311         | \$33,000     | \$ 43,263,000  |   |
| 20m3 Front End Loader              | no.      | 1,311         | \$14,400     | \$ 18,878,400  |   |
| Conveyor/Railcar Loading System    | LS       | 1             | \$20,000,000 | \$ 20,000,000  | Source: EDC report April 2003                             |
| Railway Equipment/Operation        | tonne.km | 3,521,459,424 | \$ 0.050     | \$ 176,072,971 | ** Cost comparison provided by 'Rollingstock Costs' below |
| Railway Construction               | LS       |               |              | \$ 120,866,708 |   |
| Track Maintenance                  | day      | 1,311         | \$12,000.00  | \$ 15,732,000  |   |
| Railcar dumper + stacker conveyor  | no.      | 1             | \$ 3,000,000 | \$ 3,000,000   |   |
| <b>Haul Roads and Conveyor</b>     |          |               |              |                |   |
| Haul Road Construction             | km       | 1.0           | \$ 250,000   | \$ 250,000     |   |
| Haul Road Maintenance              | day      | 1,311         | \$ 1,000     | \$ 1,311,000   |   |
| Conveyor maintenance and operation | day      | 1,311         | \$ 20,000    | \$ 26,220,000  |   |

**Total Cost - Material Transportation** \$475,019,048  
**Unit cost of transport per m<sup>3</sup>** \$13.76

**\*\*Rollingstock Costs**

| Item                               | Unit | Qty  | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|------|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |      |              |                |                           |
| Locomotives                        | no.  | 14   | \$ 2,200,000 | \$ 30,800,000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 310  | \$ 80,000    | \$ 24,800,000  | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |      |              |                |                           |
| Operational cost of locomotives    | day  | 1311 | \$ 18,000    | \$ 23,598,000  |                           |
| Maintenance cost of locomotives    | day  | 1311 | \$ 12,000    | \$ 15,732,000  |                           |
| Maintenance cost of rail cars      | day  | 1311 | \$ 30,000    | \$ 39,330,000  |                           |
| <b>Salvage Value</b>               |      |      |              |                |                           |
| Locomotives                        | no.  | 14   | \$ 440,000   | \$ (6,160,000) |                           |
| Rail cars                          | no.  | 310  | \$ 16,000    | \$ (4,960,000) |                           |

**\*\* Total Cost - Rollingstock** \$123,140,000

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Scow/Truck Haul to A1**

| Item   | Unit      | Qty         | Price/Rate | Total | Comments   |
|--|-----------|-------------|------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |             |            |       |  |
| <b>General Parameters</b>  |           |             |            |       |  |
| Total Material to be Hauled by Truck   | m3        | 34,524,112  |            |       |  |
| Time to transport material   | year      | 8.0         |            |       |  |
| Working Days per Year  | day/year  | 345         |            |       |  |
| Total Working Days   | day       | 2,760       |            |       |  |
| ACP Production Rate - Wet  | m3/day    | 4,522       |            |       | based on published average production rate of 30,000m3/week        |
| Calculated Target Production (total material/working days)   | m3/day    | 12,509      |            |       |  |
| Working Hours per day  | hr        | 24          |            |       |  |
| <b>Equipment Parameters</b>  |           |             |            |       |  |
| <b>3000m3 Scow</b>   |           |             |            |       |  |
| Scow Capacity  | m3        | 2,760       |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.       | 12,509      |            |       |  |
| Scow/Tug trips required per day  | no.       | 4.53        |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>  |           |             |            |       |  |
| Single Bucket Capacity   | m3        | 41.3        |            |       | used to calculate transport cycles                                 |
| Bucket Fill Factor   | no.       | 45%         |            |       |  |
| Factored Bucket Capacity   | m3        | 18,585      |            |       |  |
| Bucket Cycle Time  | sec       | 120         |            |       |  |
| Production Rate for 41m3 clamshell + crane   | m3/hr     | 557.55      |            |       | Compares with CEDEP (Corps of Engineers cost model)                |
| Daily Loading Rate (hourly rate x working hours)   | m3/day    | 13,381.20   |            |       |  |
| No. Dredges Required to maintain Target Rate   | no.       | 1.0         |            |       |  |
| Hourly Loading Rate for 1 dredge(s)  | m3/hr     | 557.6       |            |       | Indicates train loading rate                                       |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |             |            |       |  |
| Truck Capacity (Max.)  | m3        | 105         |            |       |  |
| Truck Capacity (Struck)  | m3        | 73          |            |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 472,933     |            |       |  |
| Calculated truck trips per day   | no.       | 172.0       |            |       |  |
| Max. load/unload time per truck *  | hr        | 0.140       |            |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |             |            |       |  |
| <b>Scow Transfer Cycle</b>   |           |             |            |       |  |
| Average distance (dredge to unloading station)   | km        | 5.0         |            |       | Assume scows loaded by 41m3 clamshell dredge                       |
| Average Scow/Tug Travel Speed  | km/hr     | 9           |            |       | Ref: site plan   |
| Time to Load Scow  | hr        | 4.95        |            |       |  |
| Average Travel Time (round Trip)   | hr        | 1.11        |            |       |  |
| Time to Berth and Dump Scow  | hr        | 0.50        |            |       |  |
| <b>Total trip cycle time</b>   | <b>hr</b> | <b>6.56</b> |            |       |  |
| Max scow trips per day (assuming 24 operating hours)   | no.       | 3.66        |            |       |  |
| Calculated Scow(s) required  | no.       | 2.0         |            |       |  |
| Tow Tug(s) required  | no.       | 2.0         |            |       | Tug estimate based on cycle time                                   |
| <b>Truck Transportation Cycle</b>  |           |             |            |       |  |
| Average one-way distance (transfer station to disposal site)   | km        | 60.0        |            |       | Source: site plan  |
| Average Truck Travel Speed   | km/hr     | 30          |            |       |  |
| Estimated Load Time  | hr        | 0.131       |            |       | 7.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 4.000       |            |       | Calculated round-trip distance of 120 km                           |
| Estimated Unload Time  | hr        | 0.050       |            |       | 3 minutes  |
| <b>Total Cycle Time</b>  | <b>hr</b> | <b>4.18</b> |            |       |  |
| Calculated Trips Per Truck per Day   | no.       | 5.7         |            |       |  |
| No. 105m3 Trucks Required (long haul)  | no.       | 30.0        |            |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 8.0         |            |       | Arbitrary no. used to maintain continuous flow at transfer station |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Costs**

**Scow/Tugs**

|  |        |      |       |        |
|--|--------|------|-------|--------|
| 3000m3 scow (includes labor and operating costs)       | \$/day | \$   | 2,333 |        |
| 3000HP towing tug (includes labor and operating costs) | \$/day | \$   | 9,035 |        |
| Total cost for 2 scow(s)                               | \$/day | 2.00 | \$    | 4,665  |
| Total cost for 2 tow tug(s)                            | \$/day | 2.00 | \$    | 18,070 |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

**230t Manitowoc Crane + 41m3 Clamshell Bucket**

|  |        |      |        |        |
|--|--------|------|--------|--------|
| Hourly Rate (inclusive)                              | \$/hr  | \$   | 500    |        |
| Daily rate per crane                                 | \$/day | \$   | 12,000 |        |
| Daily cost for 1 crane(s) (loading 24 hours per day) | \$/day | 1.00 | \$     | 12,000 |

24 pay hours per day

**CAT 789C Off-Road Truck (105m3 Capacity)**

|                          |        |       |        |         |
|--------------------------|--------|-------|--------|---------|
| Hourly Rate              | \$/hr  | \$    | 331.45 |         |
| Daily Rate per truck     | \$/day | \$    | 7,955  |         |
| Daily Rate for 30 trucks | \$/day | 30.00 | \$     | 238,641 |

24 pay hours per day

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |     |        |        |
|-------------------------|--------|-----|--------|--------|
| Hourly Rate             | \$/hr  | \$  | 275.00 |        |
| Daily Rate per truck    | \$/day | \$  | 6,600  |        |
| Daily Rate for 8 trucks | \$/day | 8.0 | \$     | 52,800 |

24 pay hours

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                       |        |    |        |  |
|-----------------------|--------|----|--------|--|
| Hourly Rate           | \$/hr  | \$ | 600.00 |  |
| Daily Rate per loader | \$/day | \$ | 14,400 |  |

24 pay hours

**Haul Roads**

|                                 |           |      |            |           |
|---------------------------------|-----------|------|------------|-----------|
| Construction Cost per km        | \$/km     | \$   | 250,000.00 |           |
| Maintenance Cost per km per day | \$/km/day | \$   | 1,000.00   |           |
| Maintenance Cost per day        | \$/day    | 60.0 | \$         | 60,000.00 |

**Transportation Costs**

| Equipment              | Item | Unit | Qty     | Price/Rate | Total          | Comments |
|------------------------|------|------|---------|------------|----------------|----------|
| 3000m3 Scow            |      | day  | 2,760.0 | \$ 4,665   | \$ 12,876,222  |          |
| 3000HP Tug             |      | day  | 2,760.0 | \$ 18,070  | \$ 49,872,690  |          |
| 230t Crane             |      | day  | 2,760.0 | \$ 12,000  | \$ 33,120,000  |          |
| 105m3 Off-Road Trucks  |      | day  | 2,760.0 | \$ 238,641 | \$ 658,649,491 |          |
| 41.5m3 Off-Road Trucks |      | day  | 2,760.0 | \$ 52,800  | \$ 145,728,000 |          |
| 20m3 Front End Loader  |      | day  | 2,760.0 | \$ 14,400  | \$ 39,744,000  |          |
| <b>Haul Roads</b>      |      |      |         |            |                |          |
| Construction           |      | km   | 60.0    | \$ 250,000 | \$ 15,000,000  |          |
| Maintenance            |      | day  | 2,760.0 | \$ 60,000  | \$ 165,600,000 |          |

|  |                        |
|--|------------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$1,120,590,403</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$32.46</b>         |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Scow/Truck Haul to T1**

| Item   | Unit      | Qty         | Price/Rate | Total | Comments   |
|--|-----------|-------------|------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |             |            |       |  |
| <b>General Parameters</b>  |           |             |            |       |  |
| Total Material to be Hauled by Scow/Truck (Wet Excavation)   | m3        | 34,524,112  |            |       | Disposal volume matched to total wet excavation                    |
| Time to transport material   | year      | 3.8         |            |       |  |
| Working Days per Year  | day/year  | 345         |            |       |  |
| Total Working Days   | day       | 1,311       |            |       |  |
| Target Production (total material/working days)  | m3/day    | 26,335      |            |       |  |
| ACP Production Rate - Wet  | m3/day    | 4,522       |            |       | based on published average production rate of 30,000m3/week        |
| Working Hours per day  | hr        | 24          |            |       |  |
| <b>Equipment Parameters</b>  |           |             |            |       |  |
| <b>3000m3 Scow</b>   |           |             |            |       |  |
| Scow Capacity  | m3        | 1,800       |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.       | 19,181      |            |       |  |
| Scow/Tug trips required per day  | no.       | 14.63       |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>  |           |             |            |       |  |
| Single Bucket Capacity   | m3        | 41.3        |            |       | used to calculate transport cycles                                 |
| Bucket Fill Factor   | no.       | 45%         |            |       |  |
| Factored Bucket Capacity   | m3        | 18.585      |            |       |  |
| Bucket Cycle Time  | sec       | 120         |            |       |  |
| Production Rate for 41m3 clamshell + crane   | m3/hr     | 557.55      |            |       | Compares with CEDEP (Corps of Engineers cost model)                |
| Daily Loading Rate (hourly rate x working hours)   | m3/day    | 13,381.20   |            |       |  |
| No. Cranes Required to maintain Target Rate  | no.       | 2.0         |            |       |  |
| Hourly Loading Rate for 2 dredge(s)  | m3/hr     | 1,115.1     |            |       | Indicates train loading rate                                       |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |             |            |       |  |
| Truck Capacity (Max.)  | m3        | 105         |            |       |  |
| Truck Capacity (Struck)  | m3        | 73          |            |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 472,933     |            |       |  |
| Calculated truck trips per day   | no.       | 361.0       |            |       |  |
| Max. load/unload time per truck *  | hr        | 0.066       |            |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |             |            |       |  |
| <b>Scow Transfer Cycle</b>   |           |             |            |       |  |
| Average one-way distance (dredge to transfer station)  | km        | 5.0         |            |       | Assume scows loaded by 41m3 clamshell dredge                       |
| Average Scow/Tug Travel Speed  | km/hr     | 9           |            |       | Ref: site plan   |
| Time to Load Scow  | hr        | 1.61        |            |       |  |
| Average Travel Time (round Trip)   | hr        | 1.11        |            |       |  |
| Time to Berth and Dump Scow  | hr        | 0.50        |            |       |  |
| <b>Total trip cycle time</b>   | <b>hr</b> | <b>3.23</b> |            |       |  |
| Max scow trips per day (assuming 24 operating hours)   | no.       | 7.44        |            |       |  |
| Calculated Scow(s) required  | no.       | 2.0         |            |       |  |
| Tow Tug(s) required  | no.       | 2.0         |            |       | Tug estimate based on cycle time                                   |
| <b>Truck Transportation Cycle</b>  |           |             |            |       |  |
| Average distance (transfer station to disposal site)   | km        | 1.5         |            |       | Source: site plan  |
| Average Truck Travel Speed   |           | 25          |            |       |  |
| Estimated Load Time  | hr        | 0.065       |            |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.120       |            |       | Calculated round-trip distance of 3 km                             |
| Estimated Unload Time  | hr        | 0.050       |            |       | 3 minutes  |
| <b>Total Cycle Time</b>  | <b>hr</b> | <b>0.24</b> |            |       |  |
| Calculated Trips Per Truck per Day   | no.       | 101.9       |            |       |  |
| No. 105m3 Trucks Required (long haul)  | no.       | 4.0         |            |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 1.0         |            |       | Arbitrary no. used to maintain continuous flow at transfer station |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Costs**

**Scow/Tugs**

|  |        |         |        |  |
|--|--------|---------|--------|--|
| 3000m <sup>3</sup> scow (includes labor and operating costs) | \$/day | \$      | 2,333  |  |
| 3000HP towing tug (includes labor and operating costs)       | \$/day | \$      | 9,035  |  |
| Total cost for 2 scow(s)                                     | \$/day | 2.00 \$ | 4,665  |  |
| Total cost for 2 tow tug(s)                                  | \$/day | 2.00 \$ | 18,070 |  |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

**230t Manitowoc Crane + 41m<sup>3</sup> Clamshell Bucket**

|  |        |         |        |                      |
|--|--------|---------|--------|----------------------|
| Hourly Rate (inclusive)                              | \$/hr  | \$      | 500    |                      |
| Daily rate per crane                                 | \$/day | \$      | 12,000 | 24 pay hours per day |
| Daily cost for 2 crane(s) (loading 24 hours per day) | \$/day | 2.00 \$ | 24,000 |                      |

**CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)**

|                         |        |         |        |                      |
|-------------------------|--------|---------|--------|----------------------|
| Hourly Rate             | \$/hr  | \$      | 331.45 |                      |
| Daily Rate per truck    | \$/day | \$      | 7,955  | 24 pay hours per day |
| Daily Rate for 4 trucks | \$/day | 4.00 \$ | 31,819 |                      |

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |        |        |              |
|-------------------------|--------|--------|--------|--------------|
| Hourly Rate             | \$/hr  | \$     | 275.00 |              |
| Daily Rate per truck    | \$/day | \$     | 6,600  | 24 pay hours |
| Daily Rate for 1 trucks | \$/day | 1.0 \$ | 6,600  |              |

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                       |        |    |        |              |
|-----------------------|--------|----|--------|--------------|
| Hourly Rate           | \$/hr  | \$ | 600.00 |              |
| Daily Rate per loader | \$/day | \$ | 14,400 | 24 pay hours |

**Haul Roads**

|                                 |           |              |            |
|---------------------------------|-----------|--------------|------------|
| Construction Cost per km        | \$/km     | \$250,000.00 |            |
| Maintenance Cost per km per day | \$/km/day | \$1,000.00   |            |
| Maintenance Cost per day        | \$/day    | 1.5 \$       | \$1,500.00 |

**Transportation Costs**

| Equipment | Item                               | Unit | Qty     | Price/Rate | Total         | Comments |
|-----------|------------------------------------|------|---------|------------|---------------|----------|
|           | 3000m <sup>3</sup> Scow            | day  | 1,311.0 | \$ 4,665   | \$ 6,116,205  |          |
|           | 3000HP Tug                         | day  | 1,311.0 | \$ 18,070  | \$ 23,689,528 |          |
|           | 230t Crane                         | day  | 1,311.0 | \$ 24,000  | \$ 31,464,000 |          |
|           | 105m <sup>3</sup> Off-Road Trucks  | day  | 1,311.0 | \$ 31,819  | \$ 41,714,468 |          |
|           | 41.5m <sup>3</sup> Off-Road Trucks | day  | 1,311.0 | \$ 6,600   | \$ 8,652,600  |          |
|           | 20m <sup>3</sup> Front End Loader  | day  | 1,311.0 | \$ 14,400  | \$ 18,878,400 |          |
|           | <b>Haul Roads</b>                  |      |         |            |               |          |
|           | Construction                       | km   | 1.5     | \$ 250,000 | \$ 375,000    |          |
|           | Maintenance                        | day  | 1,311.0 | \$ 1,500   | \$ 1,966,500  |          |

|  |                      |
|--|----------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$132,856,701</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.85</b>        |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Truck Haul to T1**

| Item   | Unit      | Qty        | Price/Rate   | Total | Comments   |
|--|-----------|------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |            |              |       |  |
| <b>General Parameters</b>  |           |            |              |       |  |
| Total Material to be Hauled by Truck (Dry Excavation)  | m3        | 32,900,678 |              |       | Disposal volume matched to total dry excavation                    |
| Time to transport material   | year      | 3.6        |              |       |  |
| Working Days per Year  | day/year  | 345        |              |       |  |
| Total Working Days   | day       | 1,242      |              |       |  |
| ACP Production Rate - Dry  | m3/day    | 22,609     |              |       | based on published average production rate of 150,000m3/week       |
| Calculated Target Production (total material/working days)   | m3/day    | 26,491     |              |       |  |
| Working Hours per day  | hr        | 24         |              |       |  |
| <b>Equipment Parameters</b>  |           |            |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |            |              |       |  |
| Truck Capacity (Max.)  | m3        | 105        |              |       |  |
| Truck Capacity (Struck)  | m3        | 73         |              |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 450,694    |              |       |  |
| Calculated truck trips per day   | no.       | 363.0      |              |       |  |
| Max. load/unload time per truck *  | hr        | 0.066      |              |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |            |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |            |              |       |  |
| Single Bucket Capacity   | m3        | 17.0       |              |       |  |
| Bucket Fill Factor   |           | 55%        |              |       |  |
| Factored Bucket Capacity   |           | 9.35       |              |       |  |
| Bucket Cycle Time  |           | 30.0       |              |       |  |
| Production Rate for Excavator  |           | 1122.0     |              |       | Comparison: Harza Report, 1200m3/hr                                |
| Daily Loading Rate per Excavator   |           | 26,928.00  |              |       |  |
| No. Excavators Required to maintain Target Rate  |           | 1.0        |              |       |  |
| Hourly Loading Rate for 1 Excavators   |           | 1,122.0    |              |       |  |
| <b>Truck Transportation Cycle</b>  |           |            |              |       |  |
| Average one-way distance (work face to disposal site)  | km        | 1.5        |              |       | Source: site plan  |
| Average Truck Travel Speed   |           | 25         |              |       |  |
| Estimated Load Time  | hr        | 0.065      |              |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.120      |              |       | Calculated round-trip distance of 3 km                             |
| Estimated Unload Time  | hr        | 0.050      |              |       | 3 minutes  |
| <b>Total Cycle Time</b>  | hr        | 0.24       |              |       |  |
| Calculated Trips Per Truck per Day   | no.       | 102.1      |              |       |  |
| No. 105m3 Trucks Required (long haul)  | no.       | 4.0        |              |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 1.0        |              |       | Arbitrary no. used to maintain continuous flow at transfer station |
| <b>Equipment Costs</b>   |           |            |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |            |              |       |  |
| Hourly Rate  | \$/hr     |            | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day    |            | \$ 7,955     |       | 24 pay hours per day   |
| Daily Rate for 4 trucks  | \$/day    | 4.0        | \$ 31,819    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |           |            |              |       |  |
| Hourly Rate  | \$/hr     |            | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day    |            | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 1 trucks  | \$/day    | 1.0        | \$ 6,600     |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |           |            |              |       |  |
| Hourly Rate  | \$/hr     |            | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day    |            | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |           |            |              |       |  |
| Construction Cost per km   | \$/km     |            | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day |            | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day    | 1.5        | \$1,500.00   |       |  |

**Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total         | Comments |
|------------------------|------|---------|------------|---------------|----------|
| <b>Equipment</b>       |      |         |            |               |          |
| 105m3 Off-Road Trucks  | day  | 1,242.0 | \$ 31,819  | \$ 39,518,969 |          |
| 41.5m3 Off-Road Trucks | day  | 1,242.0 | \$ 6,600   | \$ 8,197,200  |          |
| 20m3 Front End Loader  | day  | 1,242.0 | \$ 14,400  | \$ 17,884,800 |          |
| <b>Haul Roads</b>      |      |         |            |               |          |
| Construction           | km   | 1.5     | \$ 250,000 | \$ 375,000    |          |
| Maintenance            | day  | 1,242.0 | \$ 1,500   | \$ 1,863,000  |          |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$67,838,969</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$2.06</b>       |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Scow/Truck Haul to T2**

| Item   | Unit     | Qty        | Price/Rate | Total | Comments   |
|--|----------|------------|------------|-------|--|
| Cells requiring user input are highlighted thus:   |          |            |            |       |  |
| <b>General Parameters</b>  |          |            |            |       |  |
| Total Material to be Hauled by Scow/Truck (Wet Excavation)   | m3       | 32,350,000 |            |       |  |
| Time to transport material   | year     | 3.0        |            |       |  |
| Working Days per Year  | day/year | 345        |            |       |  |
| Total Working Days   | day      | 1,035      |            |       |  |
| Target Production (total material/working days)  | m3/day   | 31,257     |            |       |  |
| ACP Production Rate - Wet  | m3/day   | 4,522      |            |       | based on published average production rate of 30,000m3/week        |
| Working Hours per day  | hr       | 24         |            |       |  |
| <b>Equipment Parameters</b>  |          |            |            |       |  |
| <b>3000m3 Scow</b>   |          |            |            |       |  |
| Scow Capacity  | m3       | 1,800      |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.      | 17,973     |            |       |  |
| Scow/Tug trips required per day  | no.      | 17.37      |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>  |          |            |            |       |  |
| Single Bucket Capacity   | m3       | 41.3       |            |       | used to calculate transport cycles                                 |
| Bucket Fill Factor   | no.      | 45%        |            |       |  |
| Factored Bucket Capacity   | m3       | 18,585     |            |       |  |
| Bucket Cycle Time  | sec      | 120        |            |       |  |
| Production Rate for 41m3 clamshell + crane   | m3/hr    | 557.55     |            |       | Compares with CEDEP (Corps of Engineers cost model)                |
| Daily Loading Rate (hourly rate x working hours)   | m3/day   | 13,381.20  |            |       |  |
| No. Cranes Required to maintain Target Rate  | no.      | 3.0        |            |       |  |
| Hourly Loading Rate for 3 dredge(s)  | m3/hr    | 1,672.7    |            |       | Indicates train loading rate                                       |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |          |            |            |       |  |
| Truck Capacity (Max.)  | m3       | 105        |            |       |  |
| Truck Capacity (Struck)  | m3       | 73         |            |       |  |
| Total Truck Trips Required to Meet Target  | no.      | 443,151    |            |       |  |
| Calculated truck trips per day   | no.      | 429.0      |            |       |  |
| Max. load/unload time per truck *  | hr       | 0.056      |            |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |          |            |            |       |  |
| <b>Scow Transfer Cycle</b>   |          |            |            |       |  |
| Average one-way distance (dredge to transfer station)  | km       | 5.0        |            |       | Assume scows loaded by 41m3 clamshell dredge                       |
| Average Scow/Tug Travel Speed  | km/hr    | 9          |            |       | Ref: site plan   |
| Time to Load Scow  | hr       | 1.08       |            |       |  |
| Average Travel Time (round Trip)   | hr       | 1.11       |            |       |  |
| Time to Berth and Dump Scow  | hr       | 0.50       |            |       |  |
| Total trip cycle time  | hr       | 2.69       |            |       |  |
| Max scow trips per day (assuming 24 operating hours)   | no.      | 8.93       |            |       |  |
| Calculated Scow(s) required  | no.      | 2.0        |            |       |  |
| Tow Tug(s) required  | no.      | 2.0        |            |       | Tug estimate based on cycle time                                   |
| <b>Truck Transportation Cycle</b>  |          |            |            |       |  |
| Average one-way distance (transfer station to disposal site)   | km       | 2.5        |            |       | Source: site plan  |
| Average Truck Travel Speed   |          | 25         |            |       |  |
| Estimated Load Time  | hr       | 0.044      |            |       | 2.6 minutes  |
| Estimated Travel Time (Round Trip)   | hr       | 0.200      |            |       | Calculated round-trip distance of 5 km                             |
| Estimated Unload Time  | hr       | 0.050      |            |       | 3 minutes  |
| Total Cycle Time   | hr       | 0.29       |            |       |  |
| Calculated Trips Per Truck per Day   | no.      | 81.7       |            |       |  |
| No. 105m3 Trucks Required (long haul)  | no.      | 6.0        |            |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.      | 2.0        |            |       | Arbitrary no. used to maintain continuous flow at transfer station |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Costs**

**Scow/Tugs**

|  |        |      |       |        |
|--|--------|------|-------|--------|
| 3000m <sup>3</sup> scow (includes labor and operating costs) | \$/day | \$   | 2,333 |        |
| 3000HP towing tug (includes labor and operating costs)       | \$/day | \$   | 9,035 |        |
| Total cost for 2 scow(s)                                     | \$/day | 2.00 | \$    | 4,665  |
| Total cost for 2 tow tug(s)                                  | \$/day | 2.00 | \$    | 18,070 |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

**230t Manitowoc Crane + 41m<sup>3</sup> Clamshell Bucket**

|  |        |      |        |                      |
|--|--------|------|--------|----------------------|
| Hourly Rate (inclusive)                              | \$/hr  | \$   | 500    |                      |
| Dail rate per crane                                  | \$/day | \$   | 12,000 | 24 pay hours per day |
| Daily cost for 3 crane(s) (loading 24 hours per day) | \$/day | 3.00 | \$     | 36,000               |

**CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)**

|                         |        |      |        |                      |
|-------------------------|--------|------|--------|----------------------|
| Hourly Rate             | \$/hr  | \$   | 331.45 |                      |
| Daily Rate per truck    | \$/day | \$   | 7,955  | 24 pay hours per day |
| Daily Rate for 6 trucks | \$/day | 6.00 | \$     | 47,728               |

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |     |        |              |
|-------------------------|--------|-----|--------|--------------|
| Hourly Rate             | \$/hr  | \$  | 275.00 |              |
| Daily Rate per truck    | \$/day | \$  | 6,600  | 24 pay hours |
| Daily Rate for 2 trucks | \$/day | 2.0 | \$     | 13,200       |

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                       |        |    |        |              |
|-----------------------|--------|----|--------|--------------|
| Hourly Rate           | \$/hr  | \$ | 600.00 |              |
| Daily Rate per loader | \$/day | \$ | 14,400 | 24 pay hours |

**Haul Roads**

|                                 |           |     |            |          |
|---------------------------------|-----------|-----|------------|----------|
| Construction Cost per km        | \$/km     | \$  | 250,000.00 |          |
| Maintenance Cost per km per day | \$/km/day | \$  | 1,000.00   |          |
| Maintenance Cost per day        | \$/day    | 2.5 | \$         | 2,500.00 |

**Transportation Costs**

| Item                               | Unit | Qty     | Price/Rate | Total         | Comments |
|------------------------------------|------|---------|------------|---------------|----------|
| <b>Equipment</b>                   |      |         |            |               |          |
| 3000m <sup>3</sup> Scow            | day  | 1,035.0 | \$ 4,665   | \$ 4,828,583  |          |
| 3000HP Tug                         | day  | 1,035.0 | \$ 18,070  | \$ 18,702,259 |          |
| 230t Crane                         | day  | 1,035.0 | \$ 36,000  | \$ 37,260,000 |          |
| 105m <sup>3</sup> Off-Road Trucks  | day  | 1,035.0 | \$ 47,728  | \$ 49,398,712 |          |
| 41.5m <sup>3</sup> Off-Road Trucks | day  | 1,035.0 | \$ 13,200  | \$ 13,662,000 |          |
| 20m <sup>3</sup> Front End Loader  | day  | 1,035.0 | \$ 14,400  | \$ 14,904,000 |          |
| <b>Haul Roads</b>                  |      |         |            |               |          |
| Construction                       | km   | 2.5     | 250,000    | \$ 625,000    |          |
| Maintenance                        | day  | 1,035.0 | \$ 2,500   | \$ 2,587,500  |          |

|  |                      |
|--|----------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$141,968,054</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$4.39</b>        |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Truck Haul to T2**

| Item   | Unit      | Qty        | Price/Rate   | Total | Comments   |
|--|-----------|------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |            |              |       |  |
| <b>General Parameters</b>  |           |            |              |       |  |
| Total Material to be Hauled by Truck (Dry Excavation)  | m3        | 32,350,000 |              |       |  |
| Time to transport material   | year      | 3.0        |              |       |  |
| Working Days per Year  | day/year  | 345        |              |       |  |
| Total Working Days   | day       | 1,035      |              |       |  |
| ACP Production Rate - Dry  | m3/day    | 22,609     |              |       | based on published average production rate of 150,000m3/week       |
| Calculated Target Production (total material/working days)   | m3/day    | 31,257     |              |       |  |
| Working Hours per day  | hr        | 24         |              |       |  |
| <b>Equipment Parameters</b>  |           |            |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |            |              |       |  |
| Truck Capacity (Max.)  | m3        | 105        |              |       |  |
| Truck Capacity (Struck)  | m3        | 73         |              |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 443,151    |              |       |  |
| Calculated truck trips per day   | no.       | 429.0      |              |       |  |
| Max. load/unload time per truck *  | hr        | 0.056      |              |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |            |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |            |              |       |  |
| Single Bucket Capacity   | m3        | 17.0       |              |       |  |
| Bucket Fill Factor   |           | 55%        |              |       |  |
| Factored Bucket Capacity   |           | 9.35       |              |       |  |
| Bucket Cycle Time  |           | 30.0       |              |       |  |
| Production Rate for Excavator  |           | 1122.0     |              |       | Comparison: Harza Report, 1200m3/hr                                |
| Daily Loading Rate per Excavator   |           | 26,928.00  |              |       |  |
| No. Excavators Required to maintain Target Rate  |           | 2.0        |              |       |  |
| Hourly Loading Rate for 2 Excavators   |           | 2,244.0    |              |       |  |
| <b>Truck Transportation Cycle</b>  |           |            |              |       |  |
| Average one-way distance (work face to disposal site)  | km        | 2.5        |              |       | Source: site plan  |
| Average Truck Travel Speed   |           | 25         |              |       |  |
| Estimated Load Time  | hr        | 0.033      |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.200      |              |       | Calculated round-trip distance of 5 km                             |
| Estimated Unload Time  | hr        | 0.050      |              |       | 3 minutes  |
| Total Cycle Time   | hr        | 0.28       |              |       |  |
| Calculated Trips Per Truck per Day   | no.       | 84.9       |              |       |  |
| No. 105m3 Trucks Required (long haul)  | no.       | 6.0        |              |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 2.0        |              |       | Arbitrary no. used to maintain continuous flow at transfer station |
| <b>Equipment Costs</b>   |           |            |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |            |              |       |  |
| Hourly Rate  | \$/hr     |            | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day    |            | \$ 7,955     |       | 24 pay hours per day   |
| Daily Rate for 6 trucks  | \$/day    | 6.0        | \$ 47,728    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |           |            |              |       |  |
| Hourly Rate  | \$/hr     |            | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day    |            | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 2 trucks  | \$/day    | 2.0        | \$ 13,200    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |           |            |              |       |  |
| Hourly Rate  | \$/hr     |            | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day    |            | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |           |            |              |       |  |
| Construction Cost per km   | \$/km     |            | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day |            | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day    | 2.5        | \$2,500.00   |       |  |

**Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total         | Comments |
|------------------------|------|---------|------------|---------------|----------|
| <b>Equipment</b>       |      |         |            |               |          |
| 105m3 Off-Road Trucks  | day  | 1,035.0 | \$ 47,728  | \$ 49,398,712 |          |
| 41.5m3 Off-Road Trucks | day  | 1,035.0 | \$ 13,200  | \$ 13,662,000 |          |
| 20m3 Front End Loader  | day  | 1,035.0 | \$ 14,400  | \$ 14,904,000 |          |
| <b>Haul Roads</b>      |      |         |            |               |          |
| Construction           | km   | 2.5     | 250,000    | \$ 625,000    |          |
| Maintenance            | day  | 1,035.0 | 2,500      | \$ 2,587,500  |          |

**Total Cost - Material Transportation**

**\$81,177,212**

**Unit cost of truck haul per m<sup>3</sup>**

**\$2.64**

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Scow/Truck Haul to T3**

| Item   | Unit      | Qty         | Price/Rate | Total | Comments   |
|--|-----------|-------------|------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |             |            |       |  |
| <b>General Parameters</b>  |           |             |            |       |  |
| Total Material to be Hauled by Truck (Wet Excavation)  | m3        | 28,132,315  |            |       |  |
| Time to transport material   | year      | 3.1         |            |       |  |
| Working Days per Year  | day/year  | 345         |            |       |  |
| Total Working Days   | day       | 1,070       |            |       |  |
| Calculated Target Production (total material/working days)   | m3/day    | 26,305      |            |       |  |
| ACP Production Rate - Wet  | m3/day    | 4,522       |            |       | based on published average production rate of 30,000m3/week        |
| Working Hours per day  | hr        | 24          |            |       |  |
| <b>Equipment Parameters</b>  |           |             |            |       |  |
| <b>3000m3 Scow</b>   |           |             |            |       |  |
| Scow Capacity  | m3        | 1,800       |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.       | 15,630      |            |       |  |
| Scow/Tug trips required per day  | no.       | 14.61       |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>  |           |             |            |       |  |
| Single Bucket Capacity   | m3        | 41.3        |            |       | used to calculate transport cycles                                 |
| Bucket Fill Factor   | no.       | 45%         |            |       |  |
| Factored Bucket Capacity   | m3        | 18,585      |            |       |  |
| Bucket Cycle Time  | sec       | 120         |            |       |  |
| Production Rate for 41m3 clamshell + crane   | m3/hr     | 557.55      |            |       | Compares with CEDEP (Corps of Engineers cost model)                |
| Daily Loading Rate (hourly rate x working hours)   | m3/day    | 13,381.20   |            |       |  |
| No. Cranes Required to maintain Target Rate  | no.       | 2.0         |            |       |  |
| Hourly Loading Rate for 2 dredge(s)  | m3/hr     | 1,115.1     |            |       | Indicates train loading rate                                       |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |             |            |       |  |
| Truck Capacity (Max.)  | m3        | 105         |            |       |  |
| Truck Capacity (Struck)  | m3        | 73          |            |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 385,374     |            |       |  |
| Calculated truck trips per day   | no.       | 361.0       |            |       |  |
| Max. load/unload time per truck *  | hr        | 0.066       |            |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |             |            |       |  |
| <b>Scow Transfer Cycle</b>   |           |             |            |       |  |
| Average one-way distance (dredge to unloading station)   | km        | 5.0         |            |       | Assume scows loaded by 41m3 clamshell dredge                       |
| Average Scow/Tug Travel Speed  | km/hr     | 9           |            |       | Ref: site plan   |
| Time to Load Scow  | hr        | 1.61        |            |       |  |
| Average Travel Time (round Trip)   | hr        | 1.11        |            |       |  |
| Time to Berth and Dump Scow  | hr        | 0.50        |            |       |  |
| <b>Total trip cycle time</b>   | <b>hr</b> | <b>3.23</b> |            |       |  |
| Max scow trips per day (assuming 24 operating hours)   | no.       | 7.44        |            |       |  |
| Calculated Scow(s) required  | no.       | 2.0         |            |       |  |
| Tow Tug(s) required  | no.       | 2.0         |            |       | equipment matching based on cycle time                             |
| <b>Truck Transportation Cycle</b>  |           |             |            |       |  |
| Average one-way distance (transfer station to disposal site)   | km        | 1.5         |            |       | Source: site plan  |
| Average Truck Travel Speed   |           | 25          |            |       |  |
| Estimated Load Time  | hr        | 0.065       |            |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.120       |            |       | Calculated round-trip distance of 3 km                             |
| Estimated Unload Time  | hr        | 0.050       |            |       | 3 minutes  |
| <b>Total Cycle Time</b>  | <b>hr</b> | <b>0.24</b> |            |       |  |
| Calculated Trips Per Truck per Day   | no.       | 101.9       |            |       |  |
| No. 105m3 Trucks Required (long haul)  | no.       | 4.0         |            |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 1.0         |            |       | Arbitrary no. used to maintain continuous flow at transfer station |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Costs**

**Scow/Tugs**

|  |        |      |       |        |
|--|--------|------|-------|--------|
| 3000m <sup>3</sup> scow (includes labor and operating costs) | \$/day | \$   | 2,333 |        |
| 3000HP towing tug (includes labor and operating costs)       | \$/day | \$   | 9,035 |        |
| Total cost for 2 scow(s)                                     | \$/day | 2.00 | \$    | 4,665  |
| Total cost for 2 tow tug(s)                                  | \$/day | 2.00 | \$    | 18,070 |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

**230t Manitowoc Crane + 41m<sup>3</sup> Clamshell Bucket**

|  |        |      |        |                      |
|--|--------|------|--------|----------------------|
| Hourly Rate (inclusive)                              | \$/hr  | \$   | 500    |                      |
| Daily rate per crane                                 | \$/day | \$   | 12,000 | 24 pay hours per day |
| Daily cost for 2 crane(s) (loading 24 hours per day) | \$/day | 2.00 | \$     | 24,000               |

**CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)**

|                         |        |      |        |                      |
|-------------------------|--------|------|--------|----------------------|
| Hourly Rate             | \$/hr  | \$   | 331.45 |                      |
| Daily Rate per truck    | \$/day | \$   | 7,955  | 24 pay hours per day |
| Daily Rate for 4 trucks | \$/day | 4.00 | \$     | 31,819               |

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |     |        |              |
|-------------------------|--------|-----|--------|--------------|
| Hourly Rate             | \$/hr  | \$  | 275.00 |              |
| Daily Rate per truck    | \$/day | \$  | 6,600  | 24 pay hours |
| Daily Rate for 1 trucks | \$/day | 1.0 | \$     | 6,600        |

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                       |        |    |        |              |
|-----------------------|--------|----|--------|--------------|
| Hourly Rate           | \$/hr  | \$ | 600.00 |              |
| Daily Rate per loader | \$/day | \$ | 14,400 | 24 pay hours |

**Haul Roads**

|                                 |           |              |  |
|---------------------------------|-----------|--------------|--|
| Construction Cost per km        | \$/km     | \$250,000.00 |  |
| Maintenance Cost per km per day | \$/km/day | \$1,000.00   |  |
| Maintenance Cost per day        | \$/day    | \$1,500.00   |  |

**Transportation Costs**

| Equipment  | Item                               | Unit | Qty     | Price/Rate | Total         | Comments |
|------------|------------------------------------|------|---------|------------|---------------|----------|
| Equipment  | 3000m <sup>3</sup> Scow            | day  | 1,069.5 | \$ 4,665   | \$ 4,989,536  |          |
|            | 3000HP Tug                         | day  | 1,069.5 | \$ 18,070  | \$ 19,325,667 |          |
|            | 230t Crane                         | day  | 1,069.5 | \$ 24,000  | \$ 25,668,000 |          |
|            | 105m <sup>3</sup> Off-Road Trucks  | day  | 1,069.5 | \$ 31,819  | \$ 34,030,224 |          |
|            | 41.5m <sup>3</sup> Off-Road Trucks | day  | 1,069.5 | \$ 6,600   | \$ 7,058,700  |          |
|            | 20m <sup>3</sup> Front End Loader  | day  | 1,069.5 | \$ 14,400  | \$ 15,400,800 |          |
| Haul Roads | Construction                       | km   | 1.5     | \$ 250,000 | \$ 375,000    |          |
|            | Maintenance                        | day  | 1,069.5 | \$ 1,500   | \$ 1,604,250  |          |

**Total Cost - Material Transportation**

**\$108,452,177**

**Unit cost of truck haul per m<sup>3</sup>**

**\$3.86**

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Truck Haul to T3**

| Item   | Unit       | Qty            | Price/Rate   | Comments  |
|--|------------|----------------|--------------|---|
| Cells requiring user input are highlighted thus:   |            |                |              |   |
| <b>General Parameters</b>  |            |                |              |   |
| Total Material to be Hauled by Truck   | m3         | 28,132,315     |              |   |
| Time to transport material   | year       | 3.10           |              |   |
| Working Days per Year  | day/year   | 345            |              |   |
| Total Working Days   | day        | 1,070          |              |   |
| ACP Production Rate - Dry  | m3/day     | 22,609         |              | based on published average production rate of 150,000m3/week      |
| Calculated Target Production (total material/working days)   | m3/day     | 26,305         |              |   |
| Working Hours per day  | hr         | 24             |              |   |
| <b>Equipment Parameters</b>  |            |                |              |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |   |
| Single Bucket Capacity   | m3         | 17.0           |              |   |
| Bucket Fill Factor   |            | 55%            |              |   |
| Factored Bucket Capacity   |            | 9.35           |              |   |
| Bucket Cycle Time  |            | 30.0           |              |   |
| Production Rate for Excavator  |            | 1122.0         |              | Comparison: Harza Report, 1200m3/hr                               |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |   |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>1.0</b>     |              |   |
| <b>Hourly Loading Rate for 1 Excavators</b>  |            | <b>1,122.0</b> |              |   |
| <b>CAT 789 Off-Road Truck</b>  |            |                |              |   |
| Truck Capacity (Max.)  | m3         | 105            |              |   |
| Truck Capacity (Struck)  | m3         | 73             |              |   |
| Total Truck Trips Required to Meet Target  | no.        | 385,374        |              |   |
| Calculated truck trips per day   | no.        | 361.0          |              |   |
| Max. load/unload time per truck *  | hr         | 0.066          |              | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |   |
| <b>Truck Transportation Cycle</b>  |            |                |              |   |
| Average one-way distance (work face to disposal site)  | km         | 4.0            |              | Source: site plan   |
| Average Truck Travel Speed   |            | 25             |              |   |
| Estimated Load Time  | hr         | 0.065          |              | 3.9 minutes   |
| Estimated Travel Time (Round Trip)   | hr         | 0.320          |              | Calculated round-trip distance of 8 km                            |
| Estimated Unload Time  | hr         | 0.050          |              | 3 minutes   |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.44</b>    |              |   |
| Calculated Trips Per Truck per Day   | no.        | 55.2           |              |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>7.0</b>     |              |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>2.0</b>     |              | Arbitrary no. used to maintain continuous flow at excavation site |
| <b>Equipment Costs</b>   |            |                |              |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |   |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |   |
| Daily Rate per excavator   | \$/day     |                | \$ 14,231    | 24 pay hours  |
| Daily Rate for 1 excavators  | \$/day     | 1.0            | \$ 14,231    |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |            |                |              |   |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |   |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     | 24 pay hours per day  |
| Daily Rate for 7 trucks  | \$/day     | 7.0            | \$ 55,683    |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |            |                |              |   |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |   |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     | 24 pay hours  |
| Daily Rate for 2 trucks  | \$/day     | 2.0            | \$ 13,200    |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |            |                |              |   |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |   |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    | 24 pay hours  |
| <b>Haul Roads</b>  |            |                |              |   |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |   |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |   |
| Maintenance Cost per day   | \$/day     |                | \$4,000.00   |   |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Comments      |
|------------------------|------|---------|------------|---------------|
| <b>Equipment</b>       |      |         |            |               |
| 105m3 Off-Road Trucks  | day  | 1,069.5 | \$ 55,683  | \$ 59,552,891 |
| 41.5m3 Off-Road Trucks | day  | 1,069.5 | \$ 13,200  | \$ 14,117,400 |
| 20m3 Front End Loader  | day  | 1,069.5 | \$ 14,400  | \$ 15,400,800 |
| <b>Haul Roads</b>      |      |         |            |               |
| Construction           | km   | 4.0     | \$ 250,000 | \$ 1,000,000  |
| Maintenance            | day  | 1,069.5 | \$ 4,000   | \$ 4,278,000  |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$94,349,091</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.35</b>       |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Truck Haul to T4**

| Item   | Unit      | Qty            | Price/Rate   | Comments  |
|--|-----------|----------------|--------------|---|
| Cells requiring user input are highlighted thus:   |           |                |              |   |
| <b>General Parameters</b>  |           |                |              |   |
| Total Material to be Hauled by Truck   | m3        | 12,555,399     |              |   |
| Time to transport material   | year      | 1.50           |              | Maximum from excavation source                                    |
| Working Days per Year  | day/year  | 345            |              |   |
| Total Working Days   | day       | 518            |              |   |
| ACP Production Rate - Dry  | m3/day    | 22,609         |              | based on published average production rate of 150,000m3/week      |
| Calculated Target Production (total material/working days)   | m3/day    | 24,262         |              |   |
| Working Hours per day  | hr        | 24             |              |   |
| <b>Equipment Parameters</b>  |           |                |              |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |                |              |   |
| Single Bucket Capacity   | m3        | 17.0           |              |   |
| Bucket Fill Factor   |           | 55%            |              |   |
| Factored Bucket Capacity   |           | 9.35           |              |   |
| Bucket Cycle Time  |           | 30.0           |              |   |
| Production Rate for Excavator  |           | 1122.0         |              | Comparison: Harza Report, 1200m3/hr                               |
| Daily Loading Rate per Excavator   |           | 26,928.00      |              |   |
| <b>No. Excavators Required to maintain Target Rate</b>   |           | <b>1.0</b>     |              |   |
| <b>Hourly Loading Rate for 1 Excavators</b>  |           | <b>1,122.0</b> |              |   |
| <b>CAT 789 Off-Road Truck</b>  |           |                |              |   |
| Truck Capacity (Max.)  | m3        | 105            |              |   |
| Truck Capacity (Struck)  | m3        | 73             |              |   |
| Total Truck Trips Required to Meet Target  | no.       | 171,992        |              |   |
| Calculated truck trips per day   | no.       | 333.0          |              |   |
| Max. load/unload time per truck *  | hr        | 0.072          |              | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |                |              |   |
| <b>Truck Transportation Cycle</b>  |           |                |              |   |
| Average one-way distance (transfer station to disposal site)   | km        | 3.5            |              | Source: site plan   |
| Average Truck Travel Speed   |           | 25             |              |   |
| Estimated Load Time  | hr        | 0.065          |              | 3.9 minutes   |
| Estimated Travel Time (Round Trip)   | hr        | 0.280          |              | Calculated round-trip distance of 7 km                            |
| Estimated Unload Time  | hr        | 0.050          |              | 3 minutes   |
| <b>Total Cycle Time</b>  | hr        | <b>0.40</b>    |              |   |
| Calculated Trips Per Truck per Day   | no.       | 60.7           |              |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | no.       | <b>6.0</b>     |              |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | no.       | <b>2.0</b>     |              | Arbitrary no. used to maintain continuous flow at excavation site |
| <b>Equipment Costs</b>   |           |                |              |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |                |              |   |
| Hourly Rate  | \$/hr     |                | \$ 592.95    |   |
| Daily Rate per excavator   | \$/day    |                | \$ 14,231    | 24 pay hours  |
| Daily Rate for 1 excavators  | \$/day    | 1.0            | \$ 14,231    |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |                |              |   |
| Hourly Rate  | \$/hr     |                | \$ 331.45    |   |
| Daily Rate per truck   | \$/day    |                | \$ 7,955     | 24 pay hours per day  |
| Daily Rate for 6 trucks  | \$/day    | 6.0            | \$ 47,728    |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |           |                |              |   |
| Hourly Rate  | \$/hr     |                | \$ 275.00    |   |
| Daily Rate per truck   | \$/day    |                | \$ 6,600     | 24 pay hours  |
| Daily Rate for 2 trucks  | \$/day    | 2.0            | \$ 13,200    |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |           |                |              |   |
| Hourly Rate  | \$/hr     |                | \$ 600.00    |   |
| Daily Rate per loader  | \$/day    |                | \$ 14,400    | 24 pay hours  |
| <b>Haul Roads</b>  |           |                |              |   |
| Construction Cost per km   | \$/km     |                | \$250,000.00 |   |
| Maintenance Cost per km per day  | \$/km/day |                | \$1,000.00   |   |
| Maintenance Cost per day   | \$/day    |                | \$3,500.00   |   |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Comments      |
|------------------------|------|-------|------------|---------------|
| <b>Equipment</b>       |      |       |            |               |
| 105m3 Off-Road Trucks  | day  | 517.5 | \$ 47,728  | \$ 24,699,356 |
| 41.5m3 Off-Road Trucks | day  | 517.5 | \$ 13,200  | \$ 6,831,000  |
| 20m3 Front End Loader  | day  | 517.5 | \$ 14,400  | \$ 7,452,000  |
| <b>Haul Roads</b>      |      |       |            |               |
| Construction           | km   | 3.5   | \$ 250,000 | \$ 875,000    |
| Maintenance            | day  | 517.5 | \$ 3,500   | \$ 1,811,250  |

**Total Cost - Material Transportation**

**\$41,668,606**

**Unit cost of truck haul per m<sup>3</sup>**

**\$3.32**

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Scow/Truck Haul to T5**

| Item   | Unit      | Qty         | Price/Rate | Total | Comments   |
|--|-----------|-------------|------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |             |            |       |  |
| <b>General Parameters</b>  |           |             |            |       |  |
| Total Material to be Hauled by Truck (Wet Excavation)  | m3        | 7,279,264   |            |       |  |
| Time to transport material   | year      | 0.8         |            |       |  |
| Working Days per Year  | day/year  | 345         |            |       |  |
| Total Working Days   | day       | 276         |            |       |  |
| Calculated Target Production (total material/working days)   | m3/day    | 26,375      |            |       |  |
| ACP Production Rate - Wet  | m3/day    | 4,522       |            |       |  |
| Working Hours per day  | hr        | 24          |            |       | based on published average production rate of 30,000m3/week        |
| <b>Equipment Parameters</b>  |           |             |            |       |  |
| <b>3000m3 Scow</b>   |           |             |            |       |  |
| Scow Capacity  | m3        | 1,800       |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.       | 4,045       |            |       |  |
| Scow/Tug trips required per day  | no.       | 14.66       |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>  |           |             |            |       |  |
| Single Bucket Capacity   | m3        | 41.3        |            |       | used to calculate transport cycles                                 |
| Bucket Fill Factor   | no.       | 45%         |            |       |  |
| Factored Bucket Capacity   | m3        | 18.585      |            |       |  |
| Bucket Cycle Time  | sec       | 120         |            |       |  |
| Production Rate for 41m3 clamshell + crane   | m3/hr     | 557.55      |            |       | Compares with CEDEP (Corps of Engineers cost model)                |
| Daily Loading Rate (hourly rate x working hours)   | m3/day    | 13,381.20   |            |       |  |
| No. Cranes Required to maintain Target Rate  | no.       | 2.0         |            |       |  |
| Hourly Loading Rate for 2 dredge(s)  | m3/hr     | 1,115.1     |            |       | Indicates train loading rate                                       |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |             |            |       |  |
| Truck Capacity (Max.)  | m3        | 105         |            |       |  |
| Truck Capacity (Struck)  | m3        | 73          |            |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 99,716      |            |       |  |
| Calculated truck trips per day   | no.       | 362.0       |            |       |  |
| Max. load/unload time per truck *  | hr        | 0.066       |            |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |             |            |       |  |
| <b>Scow Transfer Cycle</b>   |           |             |            |       |  |
| Average one-way distance (dredge to unloading station)   | km        | 5.0         |            |       | Assume scows loaded by 41m3 clamshell dredge                       |
| Average Scow/Tug Travel Speed  | km/hr     | 9           |            |       | Ref: site plan   |
| Time to Load Scow  | hr        | 1.61        |            |       |  |
| Average Travel Time (round Trip)   | hr        | 1.11        |            |       |  |
| Time to Berth and Dump Scow  | hr        | 0.50        |            |       |  |
| <b>Total trip cycle time</b>   | <b>hr</b> | <b>3.23</b> |            |       |  |
| Max scow trips per day (assuming 24 operating hours)   | no.       | 7.44        |            |       |  |
| Calculated Scow(s) required  | no.       | 2.0         |            |       |  |
| Tow Tug(s) required  | no.       | 2.0         |            |       | equipment matching based on cycle time                             |
| <b>Truck Transportation Cycle</b>  |           |             |            |       |  |
| Average one-way distance (transfer station to disposal site)   | km        | 3.5         |            |       | Source: site plan  |
| Average Truck Travel Speed   |           | 25          |            |       |  |
| Estimated Load Time  | hr        | 0.065       |            |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.280       |            |       | Calculated round-trip distance of 7 km                             |
| Estimated Unload Time  | hr        | 0.050       |            |       | 3 minutes  |
| <b>Total Cycle Time</b>  | <b>hr</b> | <b>0.40</b> |            |       |  |
| Calculated Trips Per Truck per Day   | no.       | 60.7        |            |       |  |
| No. 105m3 Trucks Required (long haul)  | no.       | 6.0         |            |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 2.0         |            |       | Arbitrary no. used to maintain continuous flow at transfer station |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Costs**

**Scow/Tugs**

|  |        |         |        |  |
|--|--------|---------|--------|--|
| 3000m <sup>3</sup> scow (includes labor and operating costs) | \$/day | \$      | 2,333  |  |
| 3000HP towing tug (includes labor and operating costs)       | \$/day | \$      | 9,035  |  |
| Total cost for 2 scow(s)                                     | \$/day | 2.00 \$ | 4,665  |  |
| Total cost for 2 tow tug(s)                                  | \$/day | 2.00 \$ | 18,070 |  |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

**230t Manitowoc Crane + 41m<sup>3</sup> Clamshell Bucket**

|  |        |         |        |                      |
|--|--------|---------|--------|----------------------|
| Hourly Rate (inclusive)                              | \$/hr  | \$      | 500    |                      |
| Dail rate per crane                                  | \$/day | \$      | 12,000 |                      |
| Daily cost for 2 crane(s) (loading 24 hours per day) | \$/day | 2.00 \$ | 24,000 | 24 pay hours per day |

**CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)**

|                         |        |         |        |                      |
|-------------------------|--------|---------|--------|----------------------|
| Hourly Rate             | \$/hr  | \$      | 331.45 |                      |
| Daily Rate per truck    | \$/day | \$      | 7,955  |                      |
| Daily Rate for 6 trucks | \$/day | 6.00 \$ | 47,728 | 24 pay hours per day |

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |        |        |              |
|-------------------------|--------|--------|--------|--------------|
| Hourly Rate             | \$/hr  | \$     | 275.00 |              |
| Daily Rate per truck    | \$/day | \$     | 6,600  |              |
| Daily Rate for 2 trucks | \$/day | 2.0 \$ | 13,200 | 24 pay hours |

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                       |        |    |        |              |
|-----------------------|--------|----|--------|--------------|
| Hourly Rate           | \$/hr  | \$ | 600.00 |              |
| Daily Rate per loader | \$/day | \$ | 14,400 | 24 pay hours |

**Haul Roads**

|                                 |           |              |  |
|---------------------------------|-----------|--------------|--|
| Construction Cost per km        | \$/km     | \$250,000.00 |  |
| Maintenance Cost per km per day | \$/km/day | \$1,000.00   |  |
| Maintenance Cost per day        | \$/day    | \$3,500.00   |  |

**Transportation Costs**

| Equipment | Item                               | Unit | Qty   | Price/Rate | Total         | Comments |
|-----------|------------------------------------|------|-------|------------|---------------|----------|
|           | 3000m <sup>3</sup> Scow            | day  | 276.0 | \$ 4,665   | \$ 1,287,622  |          |
|           | 3000HP Tug                         | day  | 276.0 | \$ 18,070  | \$ 4,987,269  |          |
|           | 230t Crane                         | day  | 276.0 | \$ 24,000  | \$ 6,624,000  |          |
|           | 105m <sup>3</sup> Off-Road Trucks  | day  | 276.0 | \$ 47,728  | \$ 13,172,990 |          |
|           | 41.5m <sup>3</sup> Off-Road Trucks | day  | 276.0 | \$ 13,200  | \$ 3,643,200  |          |
|           | 20m <sup>3</sup> Front End Loader  | day  | 276.0 | \$ 14,400  | \$ 3,974,400  |          |
|           | <b>Haul Roads</b>                  |      |       |            |               |          |
|           | Construction                       | km   | 3.5   | \$ 250,000 | \$ 875,000    |          |
|           | Maintenance                        | day  | 276.0 | \$ 3,500   | \$ 966,000    |          |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$35,530,481</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$4.88</b>       |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Truck Haul to T5**

| Item   | Unit      | Qty       | Price/Rate   | Comments  |
|--|-----------|-----------|--------------|---|
| Cells requiring user input are highlighted thus:   |           |           |              |   |
| <b>General Parameters</b>  |           |           |              |   |
| Total Material to be Hauled by Truck   | m3        | 7,279,264 |              |   |
| Time to transport material   | year      | 0.80      |              |   |
| Working Days per Year  | day/year  | 345       |              |   |
| Total Working Days   | day       | 276       |              |   |
| ACP Production Rate - Dry  | m3/day    | 22,609    |              | based on published average production rate of 150,000m3/week      |
| Calculated Target Production (total material/working days)   | m3/day    | 26,375    |              |   |
| Working Hours per day  | hr        | 24        |              |   |
| <b>Equipment Parameters</b>  |           |           |              |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |           |              |   |
| Single Bucket Capacity   | m3        | 17.0      |              |   |
| Bucket Fill Factor   |           | 55%       |              |   |
| Factored Bucket Capacity   |           | 9.35      |              |   |
| Bucket Cycle Time  |           | 30.0      |              |   |
| Production Rate for Excavator  |           | 1122.0    |              | Comparison: Harza Report, 1200m3/hr                               |
| Daily Loading Rate per Excavator   |           | 26,928.00 |              |   |
| No. Excavators Required to maintain Target Rate  |           | 1.0       |              |   |
| Hourly Loading Rate for 1 Excavators   |           | 1,122.0   |              |   |
| <b>CAT 789 Off-Road Truck</b>  |           |           |              |   |
| Truck Capacity (Max.)  | m3        | 105       |              |   |
| Truck Capacity (Struck)  | m3        | 73        |              |   |
| Total Truck Trips Required to Meet Target  | no.       | 99,716    |              |   |
| Calculated truck trips per day   | no.       | 362.0     |              |   |
| Max. load/unload time per truck *  | hr        | 0.066     |              | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |           |              |   |
| <b>Truck Transportation Cycle</b>  |           |           |              |   |
| Average one-way distance (work face to disposal site)  | km        | 3.5       |              | Source: site plan   |
| Average Truck Travel Speed   |           | 25        |              |   |
| Estimated Load Time  | hr        | 0.065     |              | 3.9 minutes   |
| Estimated Travel Time (Round Trip)   | hr        | 0.280     |              | Calculated round-trip distance of 7 km                            |
| Estimated Unload Time  | hr        | 0.050     |              | 3 minutes   |
| Total Cycle Time   | hr        | 0.40      |              |   |
| Calculated Trips Per Truck per Day   | no.       | 60.7      |              |   |
| No. 105m3 Trucks Required (long haul)  | no.       | 6.0       |              |   |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 2.0       |              | Arbitrary no. used to maintain continuous flow at excavation site |
| <b>Equipment Costs</b>   |           |           |              |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |           |              |   |
| Hourly Rate  | \$/hr     |           | \$ 592.95    |   |
| Daily Rate per excavator   | \$/day    |           | \$ 14,231    | 24 pay hours  |
| Daily Rate for 1 excavators  | \$/day    | 1.0       | \$ 14,231    |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |           |              |   |
| Hourly Rate  | \$/hr     |           | \$ 331.45    |   |
| Daily Rate per truck   | \$/day    |           | \$ 7,955     | 24 pay hours per day  |
| Daily Rate for 6 trucks  | \$/day    | 6.0       | \$ 47,728    |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |           |           |              |   |
| Hourly Rate  | \$/hr     |           | \$ 275.00    |   |
| Daily Rate per truck   | \$/day    |           | \$ 6,600     | 24 pay hours  |
| Daily Rate for 2 trucks  | \$/day    | 2.0       | \$ 13,200    |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |           |           |              |   |
| Hourly Rate  | \$/hr     |           | \$ 600.00    |   |
| Daily Rate per loader  | \$/day    |           | \$ 14,400    | 24 pay hours  |
| <b>Haul Roads</b>  |           |           |              |   |
| Construction Cost per km   | \$/km     |           | \$250,000.00 |   |
| Maintenance Cost per km per day  | \$/km/day |           | \$1,000.00   |   |
| Maintenance Cost per day   | \$/day    |           | \$3,500.00   |   |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Comments      |
|------------------------|------|-------|------------|---------------|
| <b>Equipment</b>       |      |       |            |               |
| 105m3 Off-Road Trucks  | day  | 276.0 | \$ 47,728  | \$ 13,172,990 |
| 41.5m3 Off-Road Trucks | day  | 276.0 | \$ 13,200  | \$ 3,643,200  |
| 20m3 Front End Loader  | day  | 276.0 | \$ 14,400  | \$ 3,974,400  |
| <b>Haul Roads</b>      |      |       |            |               |
| Construction           | km   | 3.5   | \$ 250,000 | \$ 875,000    |
| Maintenance            | day  | 276.0 | \$ 3,500   | \$ 966,000    |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$22,631,590</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.11</b>       |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Scow/Truck Haul to T6**

| Item   | Unit      | Qty         | Price/Rate | Total | Comments   |
|--|-----------|-------------|------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |             |            |       |  |
| <b>General Parameters</b>  |           |             |            |       |  |
| Total Material to be Hauled by Scow/Truck (Wet Excavation)   | m3        | 34,524,112  |            |       |  |
| Time to transport material   | year      | 3.8         |            |       |  |
| Working Days per Year  | day/year  | 345         |            |       |  |
| Total Working Days   | day       | 1,311       |            |       |  |
| Target Production (total material/working days)  | m3/day    | 26,335      |            |       |  |
| ACP Production Rate - Wet  | m3/day    | 4,522       |            |       | based on published average production rate of 30,000m3/week        |
| Working Hours per day  | hr        | 24          |            |       |  |
| <b>Equipment Parameters</b>  |           |             |            |       |  |
| <b>3000m3 Scow</b>   |           |             |            |       |  |
| Scow Capacity  | m3        | 1,800       |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material   | no.       | 19,181      |            |       |  |
| Scow/Tug trips required per day  | no.       | 14.63       |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>  |           |             |            |       |  |
| Single Bucket Capacity   | m3        | 41.3        |            |       | used to calculate transport cycles                                 |
| Bucket Fill Factor   | no.       | 45%         |            |       |  |
| Factored Bucket Capacity   | m3        | 18,585      |            |       |  |
| Bucket Cycle Time  | sec       | 120         |            |       |  |
| Production Rate for 41m3 clamshell + crane   | m3/hr     | 557.55      |            |       | Compares with CEDEP (Corps of Engineers cost model)                |
| Daily Loading Rate (hourly rate x working hours)   | m3/day    | 13,381.20   |            |       |  |
| No. Cranes Required to maintain Target Rate  | no.       | 2.0         |            |       |  |
| Hourly Loading Rate for 2 dredge(s)  | m3/hr     | 1,115.1     |            |       | Indicates train loading rate                                       |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |           |             |            |       |  |
| Truck Capacity (Max.)  | m3        | 105         |            |       |  |
| Truck Capacity (Struck)  | m3        | 73          |            |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 472,933     |            |       |  |
| Calculated truck trips per day   | no.       | 361.0       |            |       |  |
| Max. load/unload time per truck *  | hr        | 0.066       |            |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |             |            |       |  |
| <b>Scow Transfer Cycle</b>   |           |             |            |       |  |
| Average distance (dredge to transfer station)  | km        | 5.0         |            |       | Assume scows loaded by 41m3 clamshell dredge                       |
| Average Scow/Tug Travel Speed  | km/hr     | 9           |            |       | Ref: site plan   |
| Time to Load Scow  | hr        | 1.61        |            |       |  |
| Average Travel Time (round Trip)   | hr        | 1.11        |            |       |  |
| Time to Berth and Dump Scow  | hr        | 0.50        |            |       |  |
| <b>Total trip cycle time</b>   | <b>hr</b> | <b>3.23</b> |            |       |  |
| Max scow trips per day (assuming 24 operating hours)   | no.       | 7.44        |            |       |  |
| Calculated Scow(s) required  | no.       | 2.0         |            |       |  |
| Tow Tug(s) required  | no.       | 2.0         |            |       | Tug estimate based on cycle time                                   |
| <b>Truck Transportation Cycle</b>  |           |             |            |       |  |
| Average one-way distance (transfer station to disposal site)   | km        | 2.0         |            |       | Source: site plan  |
| Average Truck Travel Speed   |           | 30          |            |       |  |
| Estimated Load Time  | hr        | 0.065       |            |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.133       |            |       | Calculated round-trip distance of 4 km                             |
| Estimated Unload Time  | hr        | 0.050       |            |       | 3 minutes  |
| <b>Total Cycle Time</b>  | <b>hr</b> | <b>0.25</b> |            |       |  |
| Calculated Trips Per Truck per Day   | no.       | 96.5        |            |       |  |
| No. 105m3 Trucks Required (long haul)  | no.       | 4.0         |            |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)  | no.       | 1.0         |            |       | Arbitrary no. used to maintain continuous flow at transfer station |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Equipment Costs**

**Scow/Tugs**

|  |        |         |        |
|--|--------|---------|--------|
| 3000m <sup>3</sup> scow (includes labor and operating costs) | \$/day | \$      | 2,333  |
| 3000HP towing tug (includes labor and operating costs)       | \$/day | \$      | 9,035  |
| Total cost for 2 scow(s)                                     | \$/day | 2.00 \$ | 4,665  |
| Total cost for 2 tow tug(s)                                  | \$/day | 2.00 \$ | 18,070 |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

**230t Manitowoc Crane + 41m<sup>3</sup> Clamshell Bucket**

|  |        |         |        |                      |
|--|--------|---------|--------|----------------------|
| Hourly Rate (inclusive)                              | \$/hr  | \$      | 500    |                      |
| Dail rate per crane                                  | \$/day | \$      | 12,000 | 24 pay hours per day |
| Daily cost for 2 crane(s) (loading 24 hours per day) | \$/day | 2.00 \$ | 24,000 |                      |

**CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)**

|                         |        |         |        |                      |
|-------------------------|--------|---------|--------|----------------------|
| Hourly Rate             | \$/hr  | \$      | 331.45 |                      |
| Daily Rate per truck    | \$/day | \$      | 7,955  | 24 pay hours per day |
| Daily Rate for 4 trucks | \$/day | 4.00 \$ | 31,819 |                      |

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |        |        |              |
|-------------------------|--------|--------|--------|--------------|
| Hourly Rate             | \$/hr  | \$     | 275.00 |              |
| Daily Rate per truck    | \$/day | \$     | 6,600  | 24 pay hours |
| Daily Rate for 1 trucks | \$/day | 1.0 \$ | 6,600  |              |

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                       |        |    |        |              |
|-----------------------|--------|----|--------|--------------|
| Hourly Rate           | \$/hr  | \$ | 600.00 |              |
| Daily Rate per loader | \$/day | \$ | 14,400 | 24 pay hours |

**Haul Roads**

|                                 |           |                |
|---------------------------------|-----------|----------------|
| Construction Cost per km        | \$/km     | \$250,000.00   |
| Maintenance Cost per km per day | \$/km/day | \$1,000.00     |
| Maintenance Cost per day        | \$/day    | 2.0 \$2,000.00 |

**Transportation Costs**

| Item                               | Unit | Qty     | Price/Rate | Total         | Comments |
|------------------------------------|------|---------|------------|---------------|----------|
| <b>Equipment</b>                   |      |         |            |               |          |
| 3000m <sup>3</sup> Scow            | day  | 1,311.0 | \$ 4,665   | \$ 6,116,205  |          |
| 3000HP Tug                         | day  | 1,311.0 | \$ 18,070  | \$ 23,689,528 |          |
| 230t Crane                         | day  | 1,311.0 | \$ 24,000  | \$ 31,464,000 |          |
| 105m <sup>3</sup> Off-Road Trucks  | day  | 1,311.0 | \$ 31,819  | \$ 41,714,468 |          |
| 41.5m <sup>3</sup> Off-Road Trucks | day  | 1,311.0 | \$ 6,600   | \$ 8,652,600  |          |
| 20m <sup>3</sup> Front End Loader  | day  | 1,311.0 | \$ 14,400  | \$ 18,878,400 |          |
| <b>Haul Roads</b>                  |      |         |            |               |          |
| Construction                       | km   | 2.0     | \$ 250,000 | \$ 500,000    |          |
| Maintenance                        | day  | 1,311.0 | \$ 2,000   | \$ 2,622,000  |          |

|  |                      |
|--|----------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$133,637,201</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.87</b>        |

**Panama - Material Disposal Alternatives Study**  
Back-up Calculations

**Backup Calculations**

**Project Specifications - Truck Haul to T6**

| Item  | Unit      | Qty        | Price/Rate   | Total | Comments   |
|---|-----------|------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:  |           |            |              |       |  |
| <b>General Parameters</b>   |           |            |              |       |  |
| Total Material to be Hauled by Truck (Dry Excavation)   | m3        | 32,900,678 |              |       |  |
| Time to transport material  | year      | 3.6        |              |       |  |
| Working Days per Year   | day/year  | 345        |              |       |  |
| Total Working Days  | day       | 1,242      |              |       |  |
| ACP Production Rate - Dry   | m3/day    | 22,609     |              |       | based on published average production rate of 150,000m3/week       |
| Calculated Target Production (total material/working days)  | m3/day    | 26,491     |              |       |  |
| Working Hours per day   | hr        | 24         |              |       |  |
| <b>Equipment Parameters</b>   |           |            |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>   |           |            |              |       |  |
| Truck Capacity (Max.)   | m3        | 105        |              |       |  |
| Truck Capacity (Struck)   | m3        | 73         |              |       |  |
| Total Truck Trips Required to Meet Target   | no.       | 450,694    |              |       |  |
| Calculated truck trips per day  | no.       | 363.0      |              |       |  |
| Max. load/unload time per truck *   | hr        | 0.066      |              |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion, or double-load trucks |           |            |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>  |           |            |              |       |  |
| Single Bucket Capacity  | m3        | 17.0       |              |       |  |
| Bucket Fill Factor  |           | 55%        |              |       |  |
| Factored Bucket Capacity  |           | 9.35       |              |       |  |
| Bucket Cycle Time   |           | 30.0       |              |       |  |
| Production Rate for Excavator   |           | 1122.0     |              |       | Comparison: Harza Report, 1200m3/hr                                |
| Daily Loading Rate per Excavator  |           | 26,928.0   |              |       |  |
| No. Excavators Required to maintain Target Rate   |           | 1.0        |              |       |  |
| Hourly Loading Rate for 1 Excavators  |           | 1,122.0    |              |       |  |
| <b>Truck Transportation Cycle</b>   |           |            |              |       |  |
| Average one-way distance (transfer station to disposal site)  | km        | 8.0        |              |       | Source: site plan  |
| Average Truck Travel Speed  |           | 30         |              |       |  |
| Estimated Load Time   | hr        | 0.065      |              |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)  | hr        | 0.533      |              |       | Calculated round-trip distance of 16 km                            |
| Estimated Unload Time   | hr        | 0.050      |              |       | 3 minutes  |
| Total Cycle Time  | hr        | 0.65       |              |       |  |
| Calculated Trips Per Truck per Day  | no.       | 37.0       |              |       |  |
| No. 105m3 Trucks Required (long haul)   | no.       | 10.0       |              |       |  |
| No. 41.5m3 Trucks Required (short haul < 1km)   | no.       | 3.0        |              |       | Arbitrary no. used to maintain continuous flow at transfer station |
| <b>Equipment Costs</b>  |           |            |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>   |           |            |              |       |  |
| Hourly Rate   | \$/hr     |            | \$ 331.45    |       |  |
| Daily Rate per truck  | \$/day    |            | \$ 7,955     |       | 24 pay hours per day   |
| Daily Rate for 10 trucks  | \$/day    | 10.0       | \$ 79,547    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>   |           |            |              |       |  |
| Hourly Rate   | \$/hr     |            | \$ 275.00    |       |  |
| Daily Rate per truck  | \$/day    |            | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 3 trucks   | \$/day    | 3.0        | \$ 19,800    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>   |           |            |              |       |  |
| Hourly Rate   | \$/hr     |            | \$ 600.00    |       |  |
| Daily Rate per loader   | \$/day    |            | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>   |           |            |              |       |  |
| Construction Cost per km  | \$/km     |            | \$250,000.00 |       |  |
| Maintenance Cost per km per day   | \$/km/day |            | \$1,000.00   |       |  |
| Maintenance Cost per day  | \$/day    | 8.0        | \$8,000.00   |       |  |

**Transportation Costs**

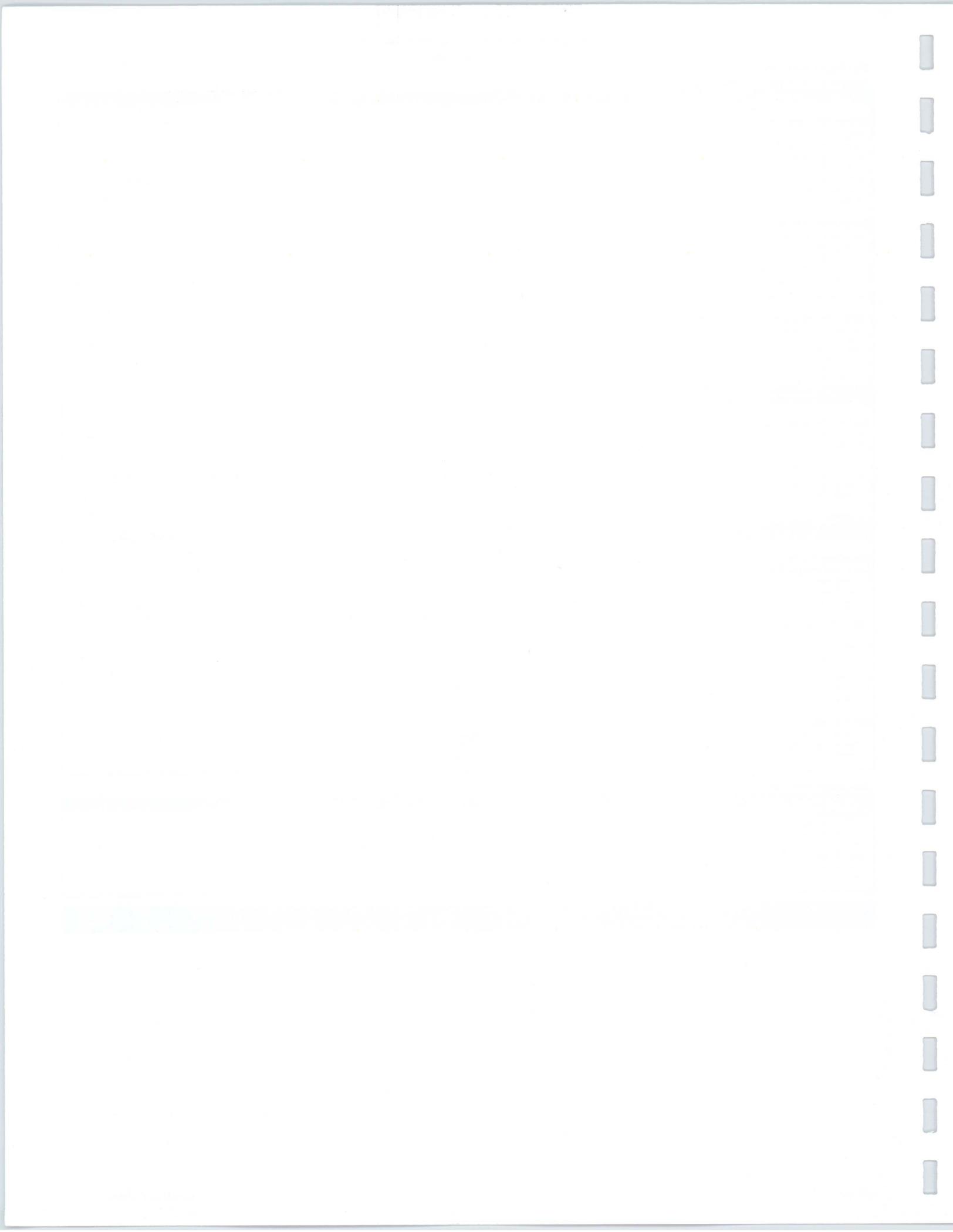
| Item                   | Unit | Qty     | Price/Rate | Total         | Comments |
|------------------------|------|---------|------------|---------------|----------|
| <b>Equipment</b>       |      |         |            |               |          |
| 105m3 Off-Road Trucks  | day  | 1,242.0 | \$ 79,547  | \$ 98,797,424 |          |
| 41.5m3 Off-Road Trucks | day  | 1,242.0 | \$ 19,800  | \$ 24,591,600 |          |
| 20m3 Front End Loader  | day  | 1,242.0 | \$ 14,400  | \$ 17,884,800 |          |
| <b>Haul Roads</b>      |      |         |            |               |          |
| Construction           | km   | 8.0     | \$ 250,000 | \$ 2,000,000  |          |
| Maintenance            | day  | 1,242.0 | \$ 8,000   | \$ 9,936,000  |          |

**Total Cost - Material Transportation**

**\$153,209,824**

**Unit cost of truck haul per m<sup>3</sup>**

**\$4.66**



| PRELIMINARY COST ESTIMATE                                     |                  |  |                   | DATE PREPARED<br>5-Nov-03 |
|---|------------------|--|-------------------|---------------------------|
| CLIENT<br>AUTORIDAD DEL CANAL DE PANAMA                       |                  | PROJECT NO.<br>4594-08                     |                   |                           |
| PROJECT TITLE<br>Material Disposal Alternatives Study         |                  | ESTIMATED BY<br>MOFFATT & NICHOL ENGINEERS |                   |                           |
|   |                  | STATUS OF DESIGN<br>Conceptual             |                   |                           |
| <b>Typical Transportation Costs to Various Disposal Sites</b> |                  |  |                   |                           |
| <b>Material Source: Third Locks Excavation</b>                |                  |  |                   |                           |
| Item  | Maximum Quantity | Unit                                       | Unit Cost (\$/m3) | Total                     |
| <b>Material Transportation to A1</b>                          |                  |  |                   |                           |
| Train Haul to Disposal Site - Dry Source                      | 33,500,000       | m <sup>3</sup>                             | \$12.72           | \$426,068,880             |
| Truck Haul to Disposal Site - Dry Source                      | 33,500,000       | m <sup>3</sup>                             | \$26.04           | \$872,296,451             |
| <b>Material Transportation to T6</b>                          |                  |  |                   |                           |
| Truck Haul to Disposal Site - Dry Source                      | 90,155,000       | m <sup>3</sup>                             | \$3.24            | \$292,476,118             |
| <b>Material Transportation to T7</b>                          |                  |  |                   |                           |
| Truck Haul to Disposal Site - Dry Source                      | 4,500,000        | m <sup>3</sup>                             | \$3.36            | \$15,132,984              |
| <b>Material Transportation to T8</b>                          |                  |  |                   |                           |
| Truck Haul to Disposal Site - Dry Source                      | 5,000,000        | m <sup>3</sup>                             | \$2.98            | \$14,908,099              |
| <b>Material Transportation to T9</b>                          |                  |  |                   |                           |
| Truck Haul to Disposal Site - Dry Source                      | 5,900,000        | m <sup>3</sup>                             | \$3.79            | \$22,338,094              |
| <b>Material Transportation to T10</b>                         |                  |  |                   |                           |
| Train Haul to Disposal Site - Dry Source                      | 87,557,333       | m <sup>3</sup>                             | \$5.42            | \$474,601,478             |
| Truck Haul to Disposal Site - Dry Source                      | 87,557,333       | m <sup>3</sup>                             | \$8.96            | \$784,143,828             |

Panama - Material Disposal Alternatives Study

**Backup Calculations**

**Project Specifications - Train Haul to A1**

| Item   | Unit       | Qty      | Price/Rate | Total | Comments                              |
|--|------------|----------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |          |            |       |                                       |
| Formation (Section) Length                     | m          | 60000    |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2        |            |       |                                       |
| Formation cut volume                           | m3         | 14510000 |            |       |                                       |
| Formation fill volume                          | m3         | 15440000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30       |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0.6      |            |       |                                       |
| Ballast Width                                  | m          | 6        |            |       |                                       |
| Spacing of ties                                | m          | 0.6      |            |       |                                       |
| Wood tie dimensions                            |            |          |            |       |                                       |
| width  | m          | 0.2      |            |       |                                       |
| depth  | m          | 0.15     |            |       |                                       |
| length   | m          | 2.6      |            |       |                                       |
| volume   | m3         | 0.078    |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$       | 40,000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |          |            |       |                                       |
| Total Track Length                             | m          | 130,000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 216,667  |            |       |                                       |
| Ballast volume                                 | m3         | 495,500  |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 891,900  |            |       |                                       |

**Construction Costs**

| Item                                   | Unit | Qty        | Price/Rate   | Total                 | Comments   |
|--|------|------------|--------------|-----------------------|--|
| <b>Track Laying on Formation</b>       |      |            |              |                       |  |
| Survey                                 | Ha   | 1200       | \$ 3,000.00  | \$ 3,600,000          | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea   | 120        | \$ 2,400.00  | \$ 288,000            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 180        | \$ 14,820.00 | \$ 2,667,600          | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 29,950,000 | \$ 1.10      | \$ 32,905,431         | Cut + Fill Volumes   |
| Ballast                                | t    | 891,900    | \$ 34.00     | \$ 30,324,600         | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 216,667    | \$ 58.00     | \$ 12,566,667         |  |
| Tie plates                             | ea   | 433,334    | \$ 8.60      | \$ 3,726,672          |  |
| 132lb Rail                             | m    | 260,000    | \$ 62.34     | \$ 16,207,349         |  |
| Track spikes                           | ea   | 866,667    | \$ 6.26      | \$ 5,425,333          |  |
| Rail anchors                           | ea   | 433,333    | \$ 5.90      | \$ 2,556,667          | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15         | \$ 30,000.00 | \$ 450,000            |  |
| <b>Total Cost - Track on Formation</b> |      |            |              | <b>\$ 110,718,319</b> |  |
| <b>Unit Cost per km</b>                |      |            |              | <b>851,700</b>        |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2,000,000.00 | \$ 2,000,000 |  |
| Culvert - crossings |      | 45  |                 |              |  |
| Pipe (Class 5)      | ea   | 180 | \$ 23,580.58    | \$ 4,244,504 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 90  | \$ 4,703.60     | \$ 423,324   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1,819.00     | \$ 12,733    | Assume 8m-wide roadway                                     |

|  |                       |
|--|-----------------------|
| <b>Total Cost - Formation + Track Laying</b> | <b>\$ 110,718,319</b> |
| <b>Total Cost - Railway Structures</b>       | <b>\$ 6,680,561</b>   |
| <b>Total Cost - Railway Construction</b>     | <b>\$ 117,398,880</b> |

**MATERIAL TRANSPORTATION**

**General Specifications**

| Item   | Unit     | Qty        | Price/Rate | Total | Comments |
|--|----------|------------|------------|-------|----------|
| <b>General Parameters</b>                                  |          |            |            |       |          |
| Total Material to be Hauled                                | m3       | 33,500,000 |            |       |          |
| Time to transport material                                 | year     | 2.5        |            |       |          |
| Working Days   | day/year | 345        |            |       |          |
| Total Working Days   | day      | 863        |            |       |          |
| Calculated Target Production (total material/working days) | m3/day   | 38,841     |            |       |          |
| Working Hours per day                                      | hr       | 24.0       |            |       |          |

## Panama - Material Disposal Alternatives Study

### Equipment Parameters

#### CAT 5230B Mass Excavator/Shovel (17m3 bucket)

|  |              |                |                                     |
|--|--------------|----------------|-------------------------------------|
| Single Bucket Capacity                                 | m3           | 17.0           |                                     |
| Bucket Fill Factor                                     | no.          | 55%            |                                     |
| Factored Bucket Capacity                               | m3           | 9.35           |                                     |
| Bucket Cycle Time                                      | sec          | 30.0           |                                     |
| Production Rate for Excavator                          | m3/hr        | 1122.0         |                                     |
| Daily Loading Rate per Excavator                       | m3/day       | 26,928.00      | Comparison: Harza Report, 1200m3/hr |
| <b>No. Excavators Required to maintain Target Rate</b> | <b>no.</b>   | <b>2.0</b>     |                                     |
| <b>Hourly Loading Rate for 2 Excavators</b>            | <b>m3/hr</b> | <b>2,244.0</b> |                                     |

#### CAT 994D Front End Loader (20m<sup>3</sup> Capacity)

|   |              |                |                                     |
|---|--------------|----------------|-------------------------------------|
| Single Bucket Capacity                              | m3           | 20.0           |                                     |
| Bucket Fill Factor                                  | no.          | 70%            |                                     |
| Factored Bucket Capacity                            | m3           | 14             |                                     |
| Dig/Load Cycle Time                                 | sec          | 45.0           |                                     |
| Production Rate for Loader                          | m3/hr        | 1120.0         |                                     |
| Daily Loading Rate per Loader                       | m3/day       | 26,880.00      | Comparison: Harza Report, 1200m3/hr |
| <b>No. Loaders Required to maintain Target Rate</b> | <b>no.</b>   | <b>2.0</b>     |                                     |
| <b>Hourly Loading Rate for 2 Loaders</b>            | <b>m3/hr</b> | <b>2,240.0</b> |                                     |

#### CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)

|   |     |           |  |
|---|-----|-----------|--|
| Design Truck Capacity                     | m3  | 41.5      |  |
| Truck Fill Factor                         | no. | 80%       |  |
| Factored Truck Capacity                   | m3  | 33        |  |
| Total Truck Trips Required to Meet Target | no. | 1,009,036 |  |
| Calculated truck trips per day            | no. | 1,170.0   |  |
| Max. load/unload time per truck *         | hr  | 0.021     | Note: logistics check, indicates maximum in order to maintain production |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

### Trains

|   |          |       |   |
|---|----------|-------|---|
| Rail Car Capacity                           | m3       | 40    |   |
| Rail Cars Per Train                         | no.      | 50    |   |
| Locos per Train                             | no.      | 2     | Ruling Grade @ 1.5%                                 |
| Total Train Capacity                        | m3       | 2,000 |   |
| Train Trips Required Per Day to Meet Target | no.      | 20    | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *           | hr/train | 1.231 | Note: logistics check                               |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

### Truck Transportation Cycle

|  |            |             |  |
|--|------------|-------------|--|
| Average one-way distance (excavation to stockpile)                 | km         | 1.0         | Source: site plan                      |
| Average Truck Travel Speed   |            | 25          |  |
| Estimated Load Time  | hr         | 0.015       | 0.9 minutes                            |
| Estimated Travel Time (Round Trip)                                 | hr         | 0.080       | Calculated round-trip distance of 2 km |
| Estimated Unload Time  | hr         | 0.017       | 1 minutes per truck                    |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.11</b> |  |
| Calculated Trips Per Truck per Day                                 | no.        | 215.3       |  |
| <b>No. 41.5m<sup>3</sup> Trucks Required (short haul &lt; 1km)</b> | <b>no.</b> | <b>6.0</b>  |  |

### Rail Transportation Cycle

|  |            |              |   |
|--|------------|--------------|---|
| Avg. track distance (material transfer to disposal site) | km         | 60.0         |   |
| Average Train Speed                                      | km/hr      | 15           | factors included for train movements and delays                     |
| Time to Load Train                                       | hr         | 0.89         |   |
| Average Travel Time (Round Trip)                         | hr         | 8.00         |   |
| Time to Unload Train                                     | hr         | 0.83         | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | <b>hr</b>  | <b>9.73</b>  |   |
| No. trains loading/dumping simultaneously                | no.        | 0.70         | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.        | 2.5          |   |
| <b>No. of Train Consists Required</b>                    | <b>no.</b> | <b>8.0</b>   |   |
| <b>No. Rail Cars Required</b>                            | <b>no.</b> | <b>400.0</b> |   |
| <b>No. Locos Required</b>                                | <b>no.</b> | <b>16.0</b>  |   |

### Equipment Costs

#### CAT 5230B Mass Excavator/Shovel (17m3 bucket)

|                             |        |               |              |
|-----------------------------|--------|---------------|--------------|
| Hourly Rate                 | \$/hr  | \$ 592.95     |              |
| Daily Rate per Excavator    | \$/day | \$ 14,231     | 24 pay hours |
| Daily Rate for 2 Excavators | \$/day | 2.0 \$ 28,461 |              |

#### CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)

|                         |        |               |              |
|-------------------------|--------|---------------|--------------|
| Hourly Rate             | \$/hr  | \$ 275.00     | confirm rate |
| Daily Rate per truck    | \$/day | \$ 6,600      | 24 pay hours |
| Daily Rate for 6 trucks | \$/day | 6.0 \$ 39,600 |              |

#### CAT 994D Front End Loader (20m<sup>3</sup> Capacity)

|                          |        |               |              |
|--------------------------|--------|---------------|--------------|
| Hourly Rate              | \$/hr  | \$ 600.00     | confirm rate |
| Daily Rate per loader    | \$/day | \$ 14,400     | 24 pay hours |
| Daily Rate for 2 loaders | \$/day | 2.0 \$ 28,800 |              |

### Rollingstock

|  |             |              |                  |
|--|-------------|--------------|------------------|
| Locomotive - Purchase Cost                 | ea          | \$ 2,200,000 | Research results |
| Locomotive - Salvage Value (@ 20%)         | ea          | \$ 440,000   | Research results |
| Side-dump rail car - Purchase Cost         | ea          | \$ 80,000    | Research results |
| Side-dump rail car - Salvage Value (@ 20%) | ea          | \$ 16,000    | Research results |
| Locomotive operational cost                | \$/day/unit | \$ 1,500     | Research results |
| Locomotive maintenance cost                | \$/day/unit | \$ 1,000     | Research results |
| Rail car maintenance cost                  | \$/day/unit | \$ 100       | Research results |

**Panama - Material Disposal Alternatives Study**

**Railway Operation and Maintenance Costs**

|  |           |     |    |        |           |
|--|-----------|-----|----|--------|-----------|
| <b>Rollingstock</b>                      |           |     |    |        |           |
| Daily Operations Cost for 16 Locos       | \$/day    | 16  | \$ | 24,000 |           |
| Daily Maintenance Cost for 16 Locos      | \$/day    | 16  | \$ | 16,000 |           |
| Daily Maintenance Cost for 400 Rail Cars | \$/day    | 400 | \$ | 40,000 |           |
| <b>Track</b>                             |           |     |    |        |           |
| No. Mainline Tracks                      | no.       | 2   |    |        |           |
| Daily maintenance cost                   | \$/km/day | 120 | \$ | 100.00 | \$ 12,000 |

**Haul Roads**

|  |           |     |  |              |  |
|--|-----------|-----|--|--------------|--|
| Construction Cost per km                     | \$/km     |     |  | \$250,000.00 |  |
| Maintenance Cost per km per day              | \$/km/day |     |  | \$1,000.00   |  |
| Daily maintenance cost for 2 km of haul road | \$/day    | 2.0 |  | \$2,000.00   |  |

**Conveyors**

|                                |        |   |  |             |  |
|--------------------------------|--------|---|--|-------------|--|
| Maintenance and operation      | \$/km  |   |  | \$4,000.00  |  |
| Daily cost for 5km of conveyor | \$/day | 5 |  | \$20,000.00 |  |

**Train Loading and Transportation Costs**

| Item                               | Unit     | Qty           | Price/Rate     | Total          | Comments  |
|------------------------------------|----------|---------------|----------------|----------------|---|
| <b>Rail Transportation Costs</b>   |          |               |                |                |   |
| 41.5m3 Truck(s)                    | no.      | 863           | \$ 39,600      | \$ 34,155,000  |   |
| 20m3 Front End Loader              | no.      | 863           | \$ 28,800      | \$ 24,840,000  |   |
| Conveyor/Railcar Loading System    | LS       | 1             | \$ 43,000,000  | \$ 43,000,000  | Source: EDC report April 2003                             |
| Railway Equipment/Operation        | tonne.km | 3,417,000,000 | \$ 0.050       | \$ 170,850,000 | ** Cost comparison provided by 'Rollingstock Costs' below |
| Railway Construction               | LS       | 1             | \$ 117,398,880 | \$ 117,398,880 |   |
| Track Maintenance                  | day      | 863           | \$ 12,000      | \$ 10,350,000  |   |
| Railcar dumper + stacker conveyor  | no.      | 2             | \$ 3,000,000   | \$ 6,000,000   |   |
| <b>Haul Roads and Conveyor</b>     |          |               |                |                |   |
| Haul Road Construction             | km       | 2.0           | \$ 250,000     | \$ 500,000     |   |
| Haul Road Maintenance              | day      | 863           | \$ 2,000       | \$ 1,725,000   |   |
| Conveyor maintenance and operation | day      | 863           | \$ 20,000      | \$ 17,250,000  |   |

|   |                      |
|---|----------------------|
| <b>Total Cost - Material Transportation</b>     | <b>\$426,068,880</b> |
| <b>Unit cost of transport per m<sup>3</sup></b> | <b>\$12.72</b>       |

**\*\*Rollingstock Costs**

| Item                               | Unit | Qty | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|-----|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |     |              |                |                           |
| Locomotives                        | no.  | 18  | \$ 2,200,000 | \$ 39,600,000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 410 | \$ 80,000    | \$ 32,800,000  | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |     |              |                |                           |
| Operational cost of locomotives    | day  | 863 | \$ 24,000    | \$ 20,700,000  |                           |
| Maintenance cost of locomotives    | day  | 863 | \$ 16,000    | \$ 13,800,000  |                           |
| Maintenance cost of rail cars      | day  | 863 | \$ 40,000    | \$ 34,500,000  |                           |
| <b>Salvage Value</b>               |      |     |              |                |                           |
| Locomotives                        | no.  | 18  | \$ 440,000   | \$ (7,920,000) |                           |
| Rail cars                          | no.  | 410 | \$ 16,000    | \$ (6,560,000) |                           |

|                                     |                      |
|-------------------------------------|----------------------|
| <b>** Total Cost - Rollingstock</b> | <b>\$126,920,000</b> |
|-------------------------------------|----------------------|

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Truck Haul to A1**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 33,500,000     |              |       |  |
| Time to transport material   | year       | 3.9            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 1,346          |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 24,898         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for 41m3 clamshell + crane   |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>1.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 1 Excavators</b>  |            | <b>1,122.0</b> |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 458,904        |              |       |  |
| Calculated truck trips per day   | no.        | 342.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.070          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 60.0           |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 30             |              |       |  |
| Estimated Load Time  | hr         | 0.065          |              |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 4.000          |              |       | Calculated round-trip distance of 120 km                                 |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>4.10</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 5.9            |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>59.0</b>    |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>12.0</b>    |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 1 excavators  | \$/day     | 1.0            | \$ 14,231    |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 59 trucks   | \$/day     | 59.0           | \$ 469,328   |       |  |
| <b>CAT 775E Off-Road Truck (41.5m3 Capacity)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 12 trucks   | \$/day     | 12.0           | \$ 79,200    |       |  |
| <b>CAT 994D Front End Loader (20m3 Capacity)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$60,000.00  |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total          | Comments |
|------------------------|------|---------|------------|----------------|----------|
| <b>Equipment</b>       |      |         |            |                |          |
| Excavators             | day  | 1,345.5 | \$ 14,231  | \$ 19,147,451  |          |
| 105m3 Off-Road Trucks  | day  | 1,345.5 | \$ 469,328 | \$ 631,480,200 |          |
| 41.5m3 Off-Road Trucks | day  | 1,345.5 | \$ 79,200  | \$ 106,563,600 |          |
| 20m3 Front End Loader  | day  | 1,345.5 | \$ 14,400  | \$ 19,375,200  |          |
| <b>Haul Roads</b>      |      |         |            |                |          |
| Construction           | km   | 60.0    | \$ 250,000 | \$ 15,000,000  |          |
| Maintenance            | day  | 1,345.5 | \$ 60,000  | \$ 80,730,000  |          |

**Total Cost - Material Transportation**

**\$872,296,451**

**Unit cost of truck haul per m<sup>3</sup>**

**\$26.04**

**Backup Calculations**

**Project Specifications - Truck Haul to T6**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 90,155,000     |              |       |  |
| Time to transport material   | year       | 7.5            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 2,588          |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 34,843         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for Excavator  |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>2.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  |            | <b>2,244.0</b> |              |       |  |
| <b>CAT 789 Off-Road Truck</b>  |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 1,235,000      |              |       |  |
| Calculated truck trips per day   | no.        | 478.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.050          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 3.0            |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 25             |              |       |  |
| Estimated Load Time  | hr         | 0.033          |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 0.240          |              |       | Calculated round-trip distance of 6 km                                   |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.31</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 78.5           |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>7.0</b>     |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>2.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 2 excavators  | \$/day     | 2.0            | \$ 28,461    |       |  |
| <b>CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 7 trucks  | \$/day     | 7.0            | \$ 55,683    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 2 trucks  | \$/day     | 2.0            | \$ 13,200    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$3,000.00   |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total          | Comments |
|------------------------|------|---------|------------|----------------|----------|
| <b>Equipment</b>       |      |         |            |                |          |
| Excavators             | day  | 2,587.5 | \$ 28,461  | \$ 73,644,042  |          |
| 105m3 Off-Road Trucks  | day  | 2,587.5 | \$ 55,683  | \$ 144,079,576 |          |
| 41.5m3 Off-Road Trucks | day  | 2,587.5 | \$ 13,200  | \$ 34,155,000  |          |
| 20m3 Front End Loader  | day  | 2,587.5 | \$ 14,400  | \$ 37,260,000  |          |
| <b>Haul Roads</b>      |      |         |            |                |          |
| Construction           | km   | 3.0     | \$ 250,000 | \$ 750,000     |          |
| Maintenance            | day  | 2,587.5 | \$ 1,000   | \$ 2,587,500   |          |

**Total Cost - Material Transportation** \$292,476,118  
**Unit cost of truck haul per m<sup>3</sup>** \$3.24

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Truck Haul to T7**

| Item   | Unit       | Qty         | Price/Rate   | Total | Comments   |
|--|------------|-------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |             |              |       |  |
| <b>General Parameters</b>  |            |             |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 4,500,000   |              |       |  |
| Time to transport material   | year       | 0.5         |              |       |  |
| Working Days per Year  | day/year   | 345         |              |       |  |
| Total Working Days   | day        | 173         |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 26,087      |              |       |  |
| Working Hours per day  | hr         | 24          |              |       |  |
| <b>Equipment Parameters</b>  |            |             |              |       |  |
| CAT 5230B Mass Excavator/Shovel (17m3 bucket)  |            |             |              |       |  |
| Single Bucket Capacity   | m3         | 17.0        |              |       |  |
| Bucket Fill Factor   |            | 55%         |              |       |  |
| Factored Bucket Capacity   |            | 9.35        |              |       |  |
| Bucket Cycle Time  |            | 30.0        |              |       |  |
| Production Rate for Excavator  |            | 1122.0      |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00   |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>1.0</b>  |              |       |  |
| Hourly Loading Rate for 1 Excavators   |            | 1,122.0     |              |       |  |
| CAT 789 Off-Road Truck   |            |             |              |       |  |
| Truck Capacity (Max.)  | m3         | 105         |              |       |  |
| Truck Capacity (Struck)  | m3         | 73          |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 61,644      |              |       |  |
| Calculated truck trips per day   | no.        | 358.0       |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.067       |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |             |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |             |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 2.5         |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 25          |              |       |  |
| Estimated Load Time  | hr         | 0.065       |              |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 0.200       |              |       | Calculated round-trip distance of 5 km                                   |
| Estimated Unload Time  | hr         | 0.033       |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.30</b> |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 80.4        |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>5.0</b>  |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>2.0</b>  |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |             |              |       |  |
| CAT 5230B Mass Excavator/Shovel (17m3 bucket)  |            |             |              |       |  |
| Hourly Rate  | \$/hr      |             | \$ 592.95    |       |  |
| Daily Rate per Excavator   | \$/day     |             | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 1 Excavators  | \$/day     | 1.0         | \$ 14,231    |       |  |
| CAT 789 Off-Road Truck (105m <sup>3</sup> Capacity)  |            |             |              |       |  |
| Hourly Rate  | \$/hr      |             | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |             | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 5 trucks  | \$/day     | 5.0         | \$ 39,774    |       |  |
| CAT 775E Off-Road Truck (41.5m <sup>3</sup> Capacity)  |            |             |              |       |  |
| Hourly Rate  | \$/hr      |             | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |             | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 2 trucks  | \$/day     | 2.0         | \$ 13,200    |       |  |
| CAT 994D Front End Loader (20m <sup>3</sup> Capacity)  |            |             |              |       |  |
| Hourly Rate  | \$/hr      |             | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |             | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |             |              |       |  |
| Construction Cost per km   | \$/km      |             | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |             | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |             | \$2,500.00   |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Total        | Comments |
|------------------------|------|-------|------------|--------------|----------|
| <b>Equipment</b>       |      |       |            |              |          |
| Excavators             | day  | 172.5 | \$ 14,231  | \$ 2,454,801 |          |
| 105m3 Off-Road Trucks  | day  | 172.5 | \$ 39,774  | \$ 6,860,932 |          |
| 41.5m3 Off-Road Trucks | day  | 172.5 | \$ 13,200  | \$ 2,277,000 |          |
| 20m3 Front End Loader  | day  | 172.5 | \$ 14,400  | \$ 2,484,000 |          |
| <b>Haul Roads</b>      |      |       |            |              |          |
| Construction           | km   | 2.5   | \$ 250,000 | \$ 625,000   |          |
| Maintenance            | day  | 172.5 | \$ 2,500   | \$ 431,250   |          |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$15,132,984</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.36</b>       |

**Backup Calculations**

**Project Specifications - Truck Haul to T8**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 5,000,000      |              |       |  |
| Time to transport material   | year       | 0.5            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 173            |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 28,986         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for Excavator  |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>2.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  |            | <b>2,244.0</b> |              |       |  |
| <b>CAT 789 Off-Road Truck</b>  |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 68,493         |              |       |  |
| Calculated truck trips per day   | no.        | 398.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.060          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 2.1            |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 25             |              |       |  |
| Estimated Load Time  | hr         | 0.033          |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 0.168          |              |       | Calculated round-trip distance of 4.2 km                                 |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.23</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 102.6          |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>4.0</b>     |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>1.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per Excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 2 Excavators  | \$/day     | 2.0            | \$ 28,461    |       |  |
| <b>CAT 789 Off-Road Truck (105m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 4 trucks  | \$/day     | 4.0            | \$ 31,819    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 1 trucks  | \$/day     | 1.0            | \$ 6,600     |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$2,100.00   |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Total        | Comments |
|------------------------|------|-------|------------|--------------|----------|
| <b>Equipment</b>       |      |       |            |              |          |
| Excavators             | day  | 172.5 | \$ 28,461  | \$ 4,909,603 |          |
| 105m3 Off-Road Trucks  | day  | 172.5 | \$ 31,819  | \$ 5,488,746 |          |
| 41.5m3 Off-Road Trucks | day  | 172.5 | \$ 6,600   | \$ 1,138,500 |          |
| 20m3 Front End Loader  | day  | 172.5 | \$ 14,400  | \$ 2,484,000 |          |
| <b>Haul Roads</b>      |      |       |            |              |          |
| Construction           | km   | 2.1   | \$ 250,000 | \$ 525,000   |          |
| Maintenance            | day  | 172.5 | \$ 2,100   | \$ 362,250   |          |

**Total Cost - Material Transportation** \$14,908,099  
**Unit cost of truck haul per m<sup>3</sup>** \$2.98

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Truck Haul to T9**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 5,900,000      |              |       |  |
| Time to transport material   | year       | 0.5            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 173            |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 34,203         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for Excavator  |            | 1122.0         |              |       |  |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>2.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  |            | <b>2,244.0</b> |              |       |  |
| <b>CAT 789 Off-Road Truck</b>  |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 80,822         |              |       |  |
| Calculated truck trips per day   | no.        | 469.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.051          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 4.0            |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 25             |              |       |  |
| Estimated Load Time  | hr         | 0.033          |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 0.320          |              |       | Calculated round-trip distance of 8 km                                   |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | hr         | <b>0.39</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 62.2           |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>8.0</b>     |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>2.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per Excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 2 Excavators  | \$/day     | 2.0            | \$ 28,461    |       |  |
| <b>CAT 789 Off-Road Truck (105m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 8 trucks  | \$/day     | 8.0            | \$ 63,638    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 2 trucks  | \$/day     | 2.0            | \$ 13,200    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$4,000.00   |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Total         | Comments |
|------------------------|------|-------|------------|---------------|----------|
| <b>Equipment</b>       |      |       |            |               |          |
| Excavators             | day  | 172.5 | \$ 28,461  | \$ 4,909,603  |          |
| 105m3 Off-Road Trucks  | day  | 172.5 | \$ 63,638  | \$ 10,977,492 |          |
| 41.5m3 Off-Road Trucks | day  | 172.5 | \$ 13,200  | \$ 2,277,000  |          |
| 20m3 Front End Loader  | day  | 172.5 | \$ 14,400  | \$ 2,484,000  |          |
| <b>Haul Roads</b>      |      |       |            |               |          |
| Construction           | km   | 4.0   | \$ 250,000 | \$ 1,000,000  |          |
| Maintenance            | day  | 172.5 | \$ 4,000   | \$ 690,000    |          |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$22,338,094</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.79</b>       |

**Backup Calculations**

**Project Specifications - Truck Haul to T10**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 87,557,333     |              |       |  |
| Time to transport material   | year       | 5.2            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 1,794          |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 48,806         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for 41m3 clamshell + crane   |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>2.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  |            | <b>2,244.0</b> |              |       |  |
| <b>CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)</b>   |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 1,199,416      |              |       |  |
| Calculated truck trips per day   | no.        | 669.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.036          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 20.4           |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 30             |              |       |  |
| Estimated Load Time  | hr         | 0.033          |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 1.360          |              |       | Calculated round-trip distance of 40.8 km                                |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>1.43</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 16.8           |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>40.0</b>    |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>8.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 2 excavators  | \$/day     | 2.0            | \$ 28,461    |       |  |
| <b>CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 40 trucks   | \$/day     | 40.0           | \$ 318,188   |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 8 trucks  | \$/day     | 8.0            | \$ 52,800    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$20,400.00  |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total          | Comments |
|------------------------|------|---------|------------|----------------|----------|
| <b>Equipment</b>       |      |         |            |                |          |
| Excavators             | day  | 1,794.0 | \$ 28,461  | \$ 51,059,869  |          |
| 105m3 Off-Road Trucks  | day  | 1,794.0 | \$ 318,188 | \$ 570,829,559 |          |
| 41.5m3 Off-Road Trucks | day  | 1,794.0 | \$ 52,800  | \$ 94,723,200  |          |
| 20m3 Front End Loader  | day  | 1,794.0 | \$ 14,400  | \$ 25,833,600  |          |
| <b>Haul Roads</b>      |      |         |            |                |          |
| Construction           | km   | 20.4    | \$ 250,000 | \$ 5,100,000   |          |
| Maintenance            | day  | 1,794.0 | \$ 20,400  | \$ 36,597,600  |          |

**Total Cost - Material Transportation** **\$784,143,828**  
**Unit cost of truck haul per m<sup>3</sup>** **\$8.96**

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Train Haul to T10**

| Item   | Unit       | Qty     | Price/Rate | Total | Comments                              |
|--|------------|---------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |         |            |       |                                       |
| Formation (Section) Length                     | m          | 23000   |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2       |            |       |                                       |
| Formation cut volume                           | m3         | 9350000 |            |       |                                       |
| Formation fill volume                          | m3         | 6300000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30      |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0.6     |            |       |                                       |
| Ballast Width                                  | m          | 6       |            |       |                                       |
| Spacing of ties                                | m          | 0.6     |            |       |                                       |
| Wood tie dimensions                            |            |         |            |       |                                       |
| width  | m          | 0.2     |            |       |                                       |
| depth  | m          | 0.15    |            |       |                                       |
| length   | m          | 2.6     |            |       |                                       |
| volume   | m3         | 0.078   |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$      | 40,000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |         |            |       |                                       |
| Total Track Length                             | m          | 56,000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 93,333  |            |       |                                       |
| Ballast volume                                 | m3         | 234,280 |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 421,704 |            |       |                                       |

**Construction Costs**

| Item                                   | Unit | Qty        | Price/Rate   | Total                | Comments   |
|--|------|------------|--------------|----------------------|--|
| <b>Track Laying on Formation</b>       |      |            |              |                      |  |
| Survey                                 | Ha   | 460        | \$ 3,000.00  | \$ 1,380,000         | 200m Corridor  |
| Boreholes                              | ea   | 46         | \$ 2,400.00  | \$ 110,400           | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 69         | \$ 14,820.00 | \$ 1,022,580         | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 15,650,000 | \$ 1.10      | \$ 17,194,324        | Cut + Fill Volumes   |
| Ballast                                | t    | 421,704    | \$ 34.00     | \$ 14,337,936        | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 93,333     | \$ 58.00     | \$ 5,413,333         |  |
| Tie plates                             | ea   | 186,666    | \$ 8.60      | \$ 1,605,328         |  |
| 132lb Rail                             | m    | 112,000    | \$ 62.34     | \$ 6,981,627         |  |
| Track spikes                           | ea   | 373,333    | \$ 6.26      | \$ 2,337,067         |  |
| Rail anchors                           | ea   | 186,667    | \$ 5.90      | \$ 1,101,333         | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15         | \$ 30,000.00 | \$ 450,000           |  |
| <b>Total Cost - Track on Formation</b> |      |            |              | <b>\$ 51,933,928</b> |  |
| <b>Unit Cost per km</b>                |      |            |              | <b>\$ 927,400</b>    |  |

| Item               | Unit | Qty | Price/Rate      | Total        | Comments   |
|--------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>  |      |     |                 |              |  |
| Bridges            | ea   | 1   | \$ 2,000,000.00 | \$ 2,000,000 |  |
| Culverts           |      |     |                 |              |  |
| Waterway crossings |      | 23  |                 |              |  |
| Pipe (Class 5)     | ea   | 92  | \$ 23,580.58    | \$ 2,169,413 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall           | ea   | 46  | \$ 4,703.60     | \$ 216,366   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings     | ea   | 15  | \$ 1,819.00     | \$ 27,285    | Assume 8m-wide roadway                                     |

|  |  |  |  |                      |  |
|--|--|--|--|----------------------|--|
| <b>Total Cost - Formation + Track Laying</b> |  |  |  | <b>\$ 51,933,928</b> |  |
| <b>Total Cost - Railway Structures</b>       |  |  |  | <b>\$ 4,413,064</b>  |  |
| <b>Total Cost - Railway Construction</b>     |  |  |  | <b>\$ 56,346,992</b> |  |

**MATERIAL TRANSPORTATION**

**General Specifications**

| Item   | Unit     | Qty        | Price/Rate | Total | Comments |
|--|----------|------------|------------|-------|----------|
| <b>General Parameters</b>                                  |          |            |            |       |          |
| Total Material to be Hauled                                | m3       | 87,557,333 |            |       |          |
| Time to transport material                                 | year     | 5.7        |            |       |          |
| Working Days   | day/year | 345        |            |       |          |
| Total Working Days   | day      | 1,967      |            |       |          |
| Calculated Target Production (total material/working days) | m3/day   | 44,525     |            |       |          |
| Working Hours per day                                      | hr       | 24.0       |            |       |          |

# Panama - Material Disposal Alternatives Study

## Equipment Parameters

|   |        |           |  |
|---|--------|-----------|--|
| <b>CAT 5230B Mass Excavator/Shovel (17m<sup>3</sup> bucket)</b> |        |           |  |
| Single Bucket Capacity  | m3     | 17.0      |  |
| Bucket Fill Factor  | no.    | 55%       |  |
| Factored Bucket Capacity  | m3     | 9.35      |  |
| Bucket Cycle Time   | sec    | 30.0      |  |
| Production Rate for Excavator                                   | m3/hr  | 1122.0    | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator                                | m3/day | 26,928.00 |  |
| <b>No. Excavators Required to maintain Target Rate</b>          | no.    | 2.0       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>                     | m3/hr  | 2,244.0   |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>     |        |           |  |
| Single Bucket Capacity  | m3     | 20.0      |  |
| Bucket Fill Factor  | no.    | 70%       |  |
| Factored Bucket Capacity  | m3     | 14        |  |
| Dig/Load Cycle Time   | sec    | 45.0      |  |
| Production Rate for Loader                                      | m3/hr  | 1120.0    | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Loader                                   | m3/day | 26,880.00 |  |
| <b>No. Loaders Required to maintain Target Rate</b>             | no.    | 2.0       |  |
| <b>Hourly Loading Rate for 2 Loaders</b>                        | m3/hr  | 2,240.0   |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>     |        |           |  |
| Design Truck Capacity   | m3     | 41.5      |  |
| Truck Fill Factor   | no.    | 80%       |  |
| Factored Truck Capacity   | m3     | 33        |  |
| Total Truck Trips Required to Meet Target                       | no.    | 2,637,269 |  |
| Calculated truck trips per day                                  | no.    | 1,342.0   |  |
| Max. load/unload time per truck *                               | hr     | 0.018     | Note: logistics check, indicates maximum in order to maintain production |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

|   |          |       |   |
|---|----------|-------|---|
| <b>Trains</b>                               |          |       |   |
| Rail Car Capacity                           | m3       | 40    |   |
| Rail Cars Per Train                         | no.      | 50    |   |
| Locos per Train                             | no.      | 2     | Ruling Grade @ 1.5%                                 |
| Total Train Capacity                        | m3       | 2,000 |   |
| Train Trips Required Per Day to Meet Target | no.      | 22    | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *           | hr/train | 1.076 | Note: logistics check                               |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

## Truck Transportation Cycle

|   |     |             |  |
|---|-----|-------------|--|
| Average one-way distance (excavation to stockpile)                  | km  | 1           | Source: site plan                      |
| Average Truck Travel Speed  |     | 25          |  |
| Estimated Load Time   | hr  | 0.015       | 0.9 minutes                            |
| Estimated Travel Time (Round Trip)                                  | hr  | 0.080       | Calculated round-trip distance of 2 km |
| Estimated Unload Time   | hr  | 0.017       | 1 minutes per truck                    |
| <b>Total Cycle Time</b>   | hr  | <b>0.11</b> |  |
| Calculated Trips Per Truck per Day                                  | no. | 215.3       |  |
| <b>No. 41.5m<sup>3</sup> Trucks Required (short haul &lt; 1 km)</b> | no. | <b>7.0</b>  |  |

## Rail Transportation Cycle

|  |       |              |   |
|--|-------|--------------|---|
| Avg. track distance (material transfer to disposal site) | km    | 20.4         |   |
| Average Train Speed                                      | km/hr | 15           | factors included for train movements and delays                     |
| Time to Load Train                                       | hr    | 0.89         |   |
| Average Travel Time (Round Trip)                         | hr    | 2.72         |   |
| Time to Unload Train                                     | hr    | 0.83         | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | hr    | <b>4.45</b>  |   |
| No. trains loading/dumping simultaneously                | no.   | 0.80         | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.   | 5.4          |   |
| <b>No. of Train Consists Required</b>                    | no.   | <b>5.0</b>   |   |
| <b>No. Rail Cars Required</b>                            | no.   | <b>250.0</b> |   |
| <b>No. Locos Required</b>                                | no.   | <b>10.0</b>  |   |

## Equipment Costs

|   |             |               |                  |
|---|-------------|---------------|------------------|
| <b>CAT 5230B Mass Excavator/Shovel (17m<sup>3</sup> bucket)</b> |             |               |                  |
| Hourly Rate   | \$/hr       | \$ 592.95     |                  |
| Daily Rate per Excavator  | \$/day      | \$ 14,231     | 24 pay hours     |
| Daily Rate for 2 Excavators                                     | \$/day      | 2.0 \$ 28,461 |                  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>     |             |               |                  |
| Hourly Rate   | \$/hr       | \$ 275.00     | confirm rate     |
| Daily Rate per truck  | \$/day      | \$ 6,600      | 24 pay hours     |
| Daily Rate for 7 trucks   | \$/day      | 7.0 \$ 46,200 |                  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>     |             |               |                  |
| Hourly Rate   | \$/hr       | \$ 600.00     | confirm rate     |
| Daily Rate per loader   | \$/day      | \$ 14,400     | 24 pay hours     |
| Daily Rate for 2 loaders  | \$/day      | 2.0 \$ 28,800 |                  |
| <b>Rollingstock</b>   |             |               |                  |
| Locomotive - Purchase Cost                                      | ea          | \$ 2,200,000  | Research results |
| Locomotive - Salvage Value (@ 20%)                              | ea          | \$ 440,000    | Research results |
| Side-dump rail car - Purchase Cost                              | ea          | \$ 80,000     | Research results |
| Side-dump rail car - Salvage Value (@ 20%)                      | ea          | \$ 16,000     | Research results |
| Locomotive operational cost                                     | \$/day/unit | \$ 1,500      | Research results |
| Locomotive maintenance cost                                     | \$/day/unit | \$ 1,000      | Research results |
| Rail car maintenance cost                                       | \$/day/unit | \$ 100        | Research results |

## Panama - Material Disposal Alternatives Study

### Railway Operation and Maintenance Costs

|  |           |     |    |                 |
|--|-----------|-----|----|-----------------|
| <b>Rollingstock</b>                      |           |     |    |                 |
| Daily Operations Cost for 10 Locos       | \$/day    | 10  | \$ | 15,000          |
| Daily Maintenance Cost for 10 Locos      | \$/day    | 10  | \$ | 10,000          |
| Daily Maintenance Cost for 250 Rail Cars | \$/day    | 250 | \$ | 25,000          |
| <b>Track</b>                             |           |     |    |                 |
| No. Mainline Tracks                      | no.       | 2   |    |                 |
| Daily maintenance cost                   | \$/km/day | 46  | \$ | 100.00 \$ 4,600 |

### Haul Roads

|  |           |     |  |              |
|--|-----------|-----|--|--------------|
| Construction Cost per km                     | \$/km     |     |  | \$250,000.00 |
| Maintenance Cost per km per day              | \$/km/day |     |  | \$1,000.00   |
| Daily maintenance cost for 1 km of haul road | \$/day    | 1.0 |  | \$1,000.00   |

### Conveyors

|                                |           |   |  |             |
|--------------------------------|-----------|---|--|-------------|
| Maintenance and operation      | \$/km/day |   |  | \$4,000.00  |
| Daily cost for 5km of conveyor | \$/day    | 5 |  | \$20,000.00 |

### Transportation Costs

| Item  | Unit     | Qty           | Price/Rate    | Total          | Comments  |
|---|----------|---------------|---------------|----------------|---|
| <b>Material Transfer and Transportation</b> |          |               |               |                |   |
| 41.5m3 Truck(s)                             | no.      | 1,967         | \$ 46,200     | \$ 90,852,300  |   |
| 20m3 Front End Loader                       | no.      | 1,967         | \$ 28,800     | \$ 56,635,200  |   |
| Conveyor/Railcar Loading System             | LS       | 1             | \$ 43,000,000 | \$ 43,000,000  | Source: EDC report April 2003                             |
| Railway Equipment/Operation                 | tonne.km | 3,423,491,720 | \$ 0.050      | \$ 171,174,586 | ** Cost comparison provided by 'Rollingstock Costs' below |
| Railway Construction                        | LS       | 1             | \$ 56,346,992 | \$ 56,346,992  |   |
| Track Maintenance                           | day      | 1,967         | \$ 4,600      | \$ 9,045,900   |   |
| Railcar dumper + stacker conveyor           | no.      | 2             | \$ 3,000,000  | \$ 6,000,000   |   |
| <b>Haul Roads and Conveyor</b>              |          |               |               |                |   |
| Haul Road Construction                      | km       | 1.0           | \$ 250,000    | \$ 250,000     |   |
| Haul Road Maintenance                       | day      | 1,967         | \$ 1,000      | \$ 1,966,500   |   |
| Conveyor maintenance and operation          | day      | 1,967         | \$ 20,000     | \$ 39,330,000  |   |

**Total Cost - Material Transportation**

**\$474,601,478**

**Unit cost of transport per m<sup>3</sup>**

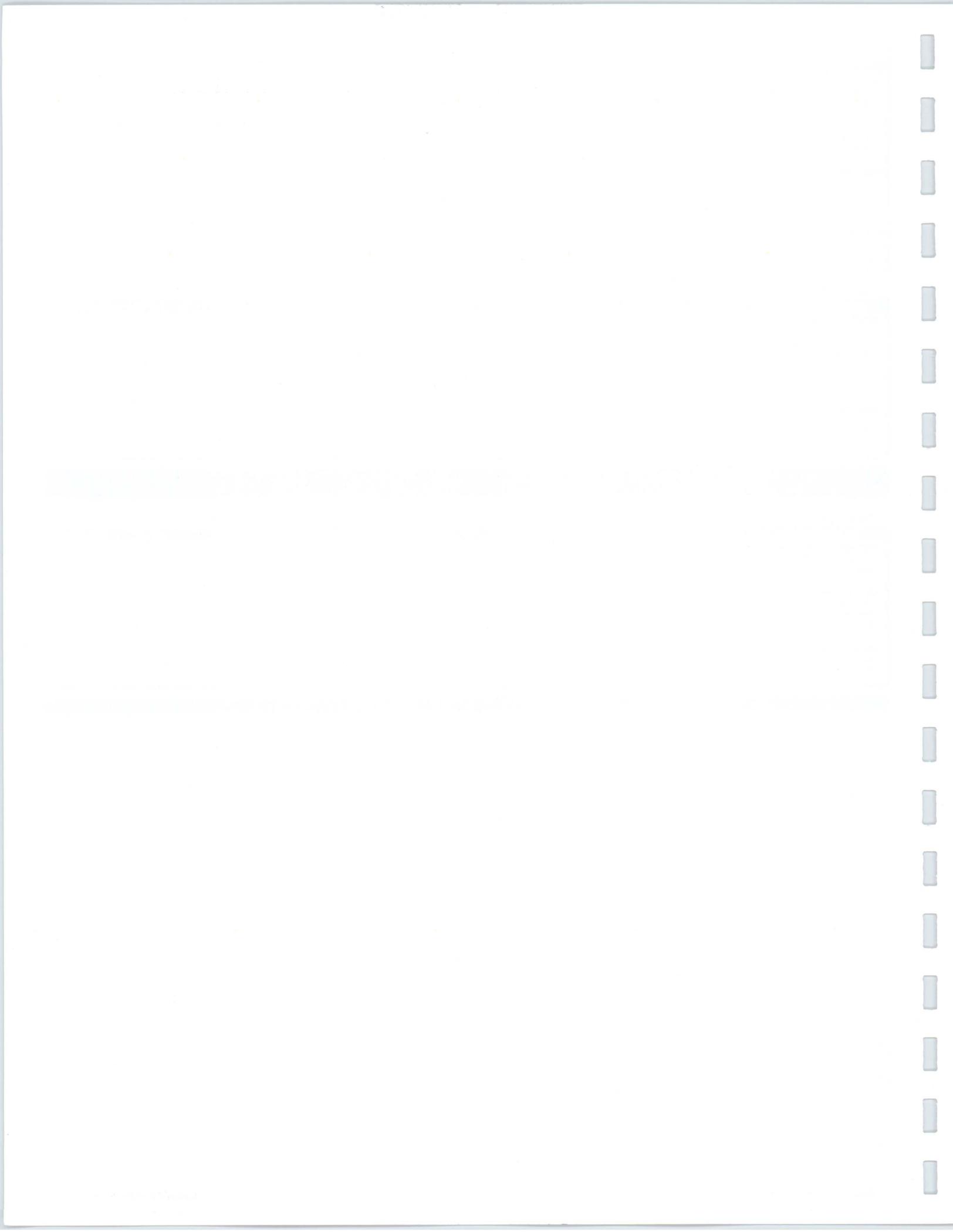
**\$5.42**

### \*\*Rollingstock Costs

| Item                               | Unit | Qty  | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|------|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |      |              |                |                           |
| Locomotives                        | no.  | 12   | \$ 2,200,000 | \$ 26,400,000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 260  | \$ 80,000    | \$ 20,800,000  | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |      |              |                |                           |
| Operational cost of locomotives    | day  | 1967 | \$ 15,000    | \$ 29,497,500  |                           |
| Maintenance cost of locomotives    | day  | 1967 | \$ 10,000    | \$ 19,665,000  |                           |
| Maintenance cost of rail cars      | day  | 1967 | \$ 25,000    | \$ 49,162,500  |                           |
| <b>Salvage Value</b>               |      |      |              |                |                           |
| Locomotives                        | no.  | 12   | \$ 440,000   | \$ (5,280,000) |                           |
| Rail cars                          | no.  | 260  | \$ 16,000    | \$ (4,160,000) |                           |

**\*\* Total Cost - Rollingstock**

**\$136,085,000**



| PRELIMINARY COST ESTIMATE                                     |                  |  | DATE PREPARED<br>5-Nov-03 |               |
|---|------------------|--|---------------------------|---------------|
| CLIENT<br>AUTORIDAD DEL CANAL DE PANAMA                       |                  | PROJECT NO.<br>4594-08                     |                           |               |
| PROJECT TITLE<br>Material Disposal Alternatives Study         |                  | ESTIMATED BY<br>MOFFATT & NICHOL ENGINEERS |                           |               |
|   |                  | STATUS OF DESIGN<br>Conceptual             |                           |               |
| <b>Typical Transportation Costs to Various Disposal Sites</b> |                  |  |                           |               |
| <b>Material Source: Third Locks Excavation</b>                |                  |  |                           |               |
| Item  | Maximum Quantity | Unit                                       | Unit Cost (\$/m3)         | Total         |
| <b>Material Transportation to A1</b>                          |                  |  |                           |               |
| Train Haul to Disposal Site - Dry Source                      | 33,500,000       | m <sup>3</sup>                             | \$12.72                   | \$426,068,880 |
| Truck Haul to Disposal Site - Dry Source                      | 33,500,000       | m <sup>3</sup>                             | \$26.04                   | \$872,296,451 |
| <b>Material Transportation to T6</b>                          |                  |  |                           |               |
| Truck Haul to Disposal Site - Dry Source                      | 90,155,000       | m <sup>3</sup>                             | \$3.24                    | \$292,476,118 |
| <b>Material Transportation to T7</b>                          |                  |  |                           |               |
| Truck Haul to Disposal Site - Dry Source                      | 4,500,000        | m <sup>3</sup>                             | \$3.36                    | \$15,132,984  |
| <b>Material Transportation to T8</b>                          |                  |  |                           |               |
| Truck Haul to Disposal Site - Dry Source                      | 5,000,000        | m <sup>3</sup>                             | \$2.98                    | \$14,908,099  |
| <b>Material Transportation to T9</b>                          |                  |  |                           |               |
| Truck Haul to Disposal Site - Dry Source                      | 5,900,000        | m <sup>3</sup>                             | \$3.79                    | \$22,338,094  |
| <b>Material Transportation to T10</b>                         |                  |  |                           |               |
| Train Haul to Disposal Site - Dry Source                      | 87,557,333       | m <sup>3</sup>                             | \$5.42                    | \$474,601,478 |
| Truck Haul to Disposal Site - Dry Source                      | 87,557,333       | m <sup>3</sup>                             | \$8.96                    | \$784,143,828 |

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Train Haul to A1**

| Item   | Unit       | Qty      | Price/Rate | Total | Comments                              |
|--|------------|----------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |          |            |       |                                       |
| Formation (Section) Length                     | m          | 60000    |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2        |            |       |                                       |
| Formation cut volume                           | m3         | 14510000 |            |       |                                       |
| Formation fill volume                          | m3         | 15440000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30       |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0.6      |            |       |                                       |
| Ballast Width                                  | m          | 6        |            |       |                                       |
| Spacing of ties                                | m          | 0.6      |            |       |                                       |
| Wood tie dimensions                            |            |          |            |       |                                       |
| width  | m          | 0.2      |            |       |                                       |
| depth  | m          | 0.15     |            |       |                                       |
| length   | m          | 2.6      |            |       |                                       |
| volume   | m3         | 0.078    |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$       | 40,000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |          |            |       |                                       |
| Total Track Length                             | m          | 130,000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 216,667  |            |       |                                       |
| Ballast volume                                 | m3         | 495,500  |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 891,900  |            |       |                                       |

**Construction Costs**

| Item                                   | Unit | Qty        | Price/Rate   | Total                 | Comments   |
|--|------|------------|--------------|-----------------------|--|
| <b>Track Laying on Formation</b>       |      |            |              |                       |  |
| Survey                                 | Ha   | 1200       | \$ 3,000.00  | \$ 3,600,000          | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea   | 120        | \$ 2,400.00  | \$ 288,000            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 180        | \$ 14,820.00 | \$ 2,667,600          | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 29,950,000 | \$ 1.10      | \$ 32,905,431         | Cut + Fill Volumes   |
| Ballast                                | t    | 891,900    | \$ 34.00     | \$ 30,324,600         | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 216,667    | \$ 58.00     | \$ 12,566,667         |  |
| Tie plates                             | ea   | 433,334    | \$ 8.60      | \$ 3,726,672          |  |
| 132lb Rail                             | m    | 260,000    | \$ 62.34     | \$ 16,207,349         |  |
| Track spikes                           | ea   | 866,667    | \$ 6.26      | \$ 5,425,333          |  |
| Rail anchors                           | ea   | 433,333    | \$ 5.90      | \$ 2,556,667          | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15         | \$ 30,000.00 | \$ 450,000            |  |
| <b>Total Cost - Track on Formation</b> |      |            |              | <b>\$ 110,718,319</b> |  |
| <b>Unit Cost per km</b>                |      |            |              | <b>851,700</b>        |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2,000,000.00 | \$ 2,000,000 |  |
| Culvert - crossings |      | 45  |                 |              |  |
| Pipe (Class 5)      | ea   | 180 | \$ 23,580.58    | \$ 4,244,504 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 90  | \$ 4,703.60     | \$ 423,324   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1,819.00     | \$ 12,733    | Assume 8m-wide roadway                                     |

|  |  |  |  |                       |  |
|--|--|--|--|-----------------------|--|
| <b>Total Cost - Formation + Track Laying</b> |  |  |  | <b>\$ 110,718,319</b> |  |
| <b>Total Cost - Railway Structures</b>       |  |  |  | <b>\$ 6,680,561</b>   |  |
| <b>Total Cost - Railway Construction</b>     |  |  |  | <b>\$ 117,398,880</b> |  |

**MATERIAL TRANSPORTATION**

**General Specifications**

| Item   | Unit     | Qty        | Price/Rate | Total | Comments |
|--|----------|------------|------------|-------|----------|
| <b>General Parameters</b>                                  |          |            |            |       |          |
| Total Material to be Hauled                                | m3       | 33,500,000 |            |       |          |
| Time to transport material                                 | year     | 2.5        |            |       |          |
| Working Days   | day/year | 345        |            |       |          |
| Total Working Days   | day      | 863        |            |       |          |
| Calculated Target Production (total material/working days) | m3/day   | 38,841     |            |       |          |
| Working Hours per day                                      | hr       | 24.0       |            |       |          |

## Panama - Material Disposal Alternatives Study

### Equipment Parameters

#### CAT 5230B Mass Excavator/Shovel (17m3 bucket)

|  |        |           |                                     |
|--|--------|-----------|-------------------------------------|
| Single Bucket Capacity                                 | m3     | 17.0      |                                     |
| Bucket Fill Factor                                     | no.    | 55%       |                                     |
| Factored Bucket Capacity                               | m3     | 9.35      |                                     |
| Bucket Cycle Time                                      | sec    | 30.0      |                                     |
| Production Rate for Excavator                          | m3/hr  | 1122.0    | Comparison: Harza Report, 1200m3/hr |
| Daily Loading Rate per Excavator                       | m3/day | 26,928.00 |                                     |
| <b>No. Excavators Required to maintain Target Rate</b> | no.    | 2.0       |                                     |
| <b>Hourly Loading Rate for 2 Excavators</b>            | m3/hr  | 2,244.0   |                                     |

#### CAT 994D Front End Loader (20m<sup>3</sup> Capacity)

|   |        |           |                                     |
|---|--------|-----------|-------------------------------------|
| Single Bucket Capacity                              | m3     | 20.0      |                                     |
| Bucket Fill Factor                                  | no.    | 70%       |                                     |
| Factored Bucket Capacity                            | m3     | 14        |                                     |
| Dig/Load Cycle Time                                 | sec    | 45.0      |                                     |
| Production Rate for Loader                          | m3/hr  | 1120.0    | Comparison: Harza Report, 1200m3/hr |
| Daily Loading Rate per Loader                       | m3/day | 26,880.00 |                                     |
| <b>No. Loaders Required to maintain Target Rate</b> | no.    | 2.0       |                                     |
| <b>Hourly Loading Rate for 2 Loaders</b>            | m3/hr  | 2,240.0   |                                     |

#### CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)

|   |     |           |  |
|---|-----|-----------|--|
| Design Truck Capacity                     | m3  | 41.5      |  |
| Truck Fill Factor                         | no. | 80%       |  |
| Factored Truck Capacity                   | m3  | 33        |  |
| Total Truck Trips Required to Meet Target | no. | 1,009,036 |  |
| Calculated truck trips per day            | no. | 1,170.0   |  |
| Max. load/unload time per truck *         | hr  | 0.021     | Note: logistics check, indicates maximum in order to maintain production |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

#### Trains

|   |          |       |   |
|---|----------|-------|---|
| Rail Car Capacity                           | m3       | 40    |   |
| Rail Cars Per Train                         | no.      | 50    |   |
| Locos per Train                             | no.      | 2     | Ruling Grade @ 1.5%                                 |
| Total Train Capacity                        | m3       | 2,000 |   |
| Train Trips Required Per Day to Meet Target | no.      | 20    | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *           | hr/train | 1.231 | Note: logistics check                               |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

#### Truck Transportation Cycle

|  |     |       |  |
|--|-----|-------|--|
| Average one-way distance (excavation to stockpile)                 | km  | 1.0   | Source: site plan                      |
| Average Truck Travel Speed   |     | 25    |  |
| Estimated Load Time  | hr  | 0.015 | 0.9 minutes                            |
| Estimated Travel Time (Round Trip)                                 | hr  | 0.080 | Calculated round-trip distance of 2 km |
| Estimated Unload Time  | hr  | 0.017 | 1 minutes per truck                    |
| <b>Total Cycle Time</b>  | hr  | 0.11  |  |
| Calculated Trips Per Truck per Day                                 | no. | 215.3 |  |
| <b>No. 41.5m<sup>3</sup> Trucks Required (short haul &lt; 1km)</b> | no. | 6.0   |  |

#### Rail Transportation Cycle

|  |       |       |   |
|--|-------|-------|---|
| Avg. track distance (material transfer to disposal site) | km    | 60.0  |   |
| Average Train Speed                                      | km/hr | 15    | factors included for train movements and delays                     |
| Time to Load Train                                       | hr    | 0.89  |   |
| Average Travel Time (Round Trip)                         | hr    | 8.00  |   |
| Time to Unload Train                                     | hr    | 0.83  | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | hr    | 9.73  |   |
| No. trains loading/dumping simultaneously                | no.   | 0.70  | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.   | 2.5   |   |
| <b>No. of Train Consists Required</b>                    | no.   | 8.0   |   |
| <b>No. Rail Cars Required</b>                            | no.   | 400.0 |   |
| <b>No. Locos Required</b>                                | no.   | 16.0  |   |

#### Equipment Costs

##### CAT 5230B Mass Excavator/Shovel (17m3 bucket)

|                             |        |               |              |
|-----------------------------|--------|---------------|--------------|
| Hourly Rate                 | \$/hr  | \$ 592.95     |              |
| Daily Rate per Excavator    | \$/day | \$ 14,231     | 24 pay hours |
| Daily Rate for 2 Excavators | \$/day | 2.0 \$ 28,461 |              |

##### CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)

|                         |        |               |              |
|-------------------------|--------|---------------|--------------|
| Hourly Rate             | \$/hr  | \$ 275.00     | confirm rate |
| Daily Rate per truck    | \$/day | \$ 6,600      | 24 pay hours |
| Daily Rate for 6 trucks | \$/day | 6.0 \$ 39,600 |              |

##### CAT 994D Front End Loader (20m<sup>3</sup> Capacity)

|                          |        |               |              |
|--------------------------|--------|---------------|--------------|
| Hourly Rate              | \$/hr  | \$ 600.00     | confirm rate |
| Daily Rate per loader    | \$/day | \$ 14,400     | 24 pay hours |
| Daily Rate for 2 loaders | \$/day | 2.0 \$ 28,800 |              |

#### Rollingstock

|  |             |              |                  |
|--|-------------|--------------|------------------|
| Locomotive - Purchase Cost                 | ea          | \$ 2,200,000 | Research results |
| Locomotive - Salvage Value (@ 20%)         | ea          | \$ 440,000   | Research results |
| Side-dump rail car - Purchase Cost         | ea          | \$ 80,000    | Research results |
| Side-dump rail car - Salvage Value (@ 20%) | ea          | \$ 16,000    | Research results |
| Locomotive operational cost                | \$/day/unit | \$ 1,500     | Research results |
| Locomotive maintenance cost                | \$/day/unit | \$ 1,000     | Research results |
| Rail car maintenance cost                  | \$/day/unit | \$ 100       | Research results |

**Panama - Material Disposal Alternatives Study**

**Railway Operation and Maintenance Costs**

|  |           |     |    |                  |
|--|-----------|-----|----|------------------|
| <b>Rollingstock</b>                      |           |     |    |                  |
| Daily Operations Cost for 16 Locos       | \$/day    | 16  | \$ | 24,000           |
| Daily Maintenance Cost for 16 Locos      | \$/day    | 16  | \$ | 16,000           |
| Daily Maintenance Cost for 400 Rail Cars | \$/day    | 400 | \$ | 40,000           |
| <b>Track</b>                             |           |     |    |                  |
| No. Mainline Tracks                      | no.       | 2   |    |                  |
| Daily maintenance cost                   | \$/km/day | 120 | \$ | 100.00 \$ 12,000 |

**Haul Roads**

|  |           |     |  |              |
|--|-----------|-----|--|--------------|
| Construction Cost per km                     | \$/km     |     |  | \$250,000.00 |
| Maintenance Cost per km per day              | \$/km/day |     |  | \$1,000.00   |
| Daily maintenance cost for 2 km of haul road | \$/day    | 2.0 |  | \$2,000.00   |

**Conveyors**

|                                |        |   |  |             |
|--------------------------------|--------|---|--|-------------|
| Maintenance and operation      | \$/km  |   |  | \$4,000.00  |
| Daily cost for 5km of conveyor | \$/day | 5 |  | \$20,000.00 |

**Train Loading and Transportation Costs**

| Item                               | Unit     | Qty           | Price/Rate     | Total          | Comments  |
|------------------------------------|----------|---------------|----------------|----------------|---|
| <b>Rail Transportation Costs</b>   |          |               |                |                |   |
| 41.5m3 Truck(s)                    | no.      | 863           | \$ 39,600      | \$ 34,155,000  |   |
| 20m3 Front End Loader              | no.      | 863           | \$ 28,800      | \$ 24,840,000  |   |
| Conveyor/Railcar Loading System    | LS       | 1             | \$ 43,000,000  | \$ 43,000,000  | Source: EDC report April 2003                             |
| Railway Equipment/Operation        | tonne.km | 3,417,000,000 | \$ 0.050       | \$ 170,850,000 | ** Cost comparison provided by 'Rollingstock Costs' below |
| Railway Construction               | LS       | 1             | \$ 117,398,880 | \$ 117,398,880 |   |
| Track Maintenance                  | day      | 863           | \$ 12,000      | \$ 10,350,000  |   |
| Railcar dumper + stacker conveyor  | no.      | 2             | \$ 3,000,000   | \$ 6,000,000   |   |
| <b>Haul Roads and Conveyor</b>     |          |               |                |                |   |
| Haul Road Construction             | km       | 2.0           | \$ 250,000     | \$ 500,000     |   |
| Haul Road Maintenance              | day      | 863           | \$ 2,000       | \$ 1,725,000   |   |
| Conveyor maintenance and operation | day      | 863           | \$ 20,000      | \$ 17,250,000  |   |

|   |                      |
|---|----------------------|
| <b>Total Cost - Material Transportation</b>     | <b>\$426,068,880</b> |
| <b>Unit cost of transport per m<sup>3</sup></b> | <b>\$12.72</b>       |

**\*\*Rollingstock Costs**

| Item                               | Unit | Qty | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|-----|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |     |              |                |                           |
| Locomotives                        | no.  | 18  | \$ 2,200,000 | \$ 39,600,000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 410 | \$ 80,000    | \$ 32,800,000  | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |     |              |                |                           |
| Operational cost of locomotives    | day  | 863 | \$ 24,000    | \$ 20,700,000  |                           |
| Maintenance cost of locomotives    | day  | 863 | \$ 16,000    | \$ 13,800,000  |                           |
| Maintenance cost of rail cars      | day  | 863 | \$ 40,000    | \$ 34,500,000  |                           |
| <b>Salvage Value</b>               |      |     |              |                |                           |
| Locomotives                        | no.  | 18  | \$ 440,000   | \$ (7,920,000) |                           |
| Rail cars                          | no.  | 410 | \$ 16,000    | \$ (6,560,000) |                           |

|                                     |                      |
|-------------------------------------|----------------------|
| <b>** Total Cost - Rollingstock</b> | <b>\$126,920,000</b> |
|-------------------------------------|----------------------|

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Truck Haul to A1**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 33,500,000     |              |       |  |
| Time to transport material   | year       | 3.9            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 1,346          |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 24,898         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for 41m3 clamshell + crane   |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>1.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 1 Excavators</b>  |            | <b>1,122.0</b> |              |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 458,904        |              |       |  |
| Calculated truck trips per day   | no.        | 342.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.070          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 60.0           |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 30             |              |       |  |
| Estimated Load Time  | hr         | 0.065          |              |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 4.000          |              |       | Calculated round-trip distance of 120 km                                 |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>4.10</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 5.9            |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>59.0</b>    |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>12.0</b>    |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 1 excavators  | \$/day     | 1.0            | \$ 14,231    |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 59 trucks   | \$/day     | 59.0           | \$ 469,328   |       |  |
| <b>CAT 775E Off-Road Truck (41.5m3 Capacity)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 12 trucks   | \$/day     | 12.0           | \$ 79,200    |       |  |
| <b>CAT 994D Front End Loader (20m3 Capacity)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$60,000.00  |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total          | Comments |
|------------------------|------|---------|------------|----------------|----------|
| <b>Equipment</b>       |      |         |            |                |          |
| Excavators             | day  | 1,345.5 | \$ 14,231  | \$ 19,147,451  |          |
| 105m3 Off-Road Trucks  | day  | 1,345.5 | \$ 469,328 | \$ 631,480,200 |          |
| 41.5m3 Off-Road Trucks | day  | 1,345.5 | \$ 79,200  | \$ 106,563,600 |          |
| 20m3 Front End Loader  | day  | 1,345.5 | \$ 14,400  | \$ 19,375,200  |          |
| <b>Haul Roads</b>      |      |         |            |                |          |
| Construction           | km   | 60.0    | \$ 250,000 | \$ 15,000,000  |          |
| Maintenance            | day  | 1,345.5 | \$ 60,000  | \$ 80,730,000  |          |

**Total Cost - Material Transportation**

**\$872,296,451**

**Unit cost of truck haul per m<sup>3</sup>**

**\$26.04**

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Truck Haul to T6**

| Item   | Unit      | Qty            | Price/Rate   | Total | Comments   |
|--|-----------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |                |              |       |  |
| <b>General Parameters</b>  |           |                |              |       |  |
| Total Material to be Hauled by Truck   | m3        | 90,155,000     |              |       |  |
| Time to transport material   | year      | 7.5            |              |       |  |
| Working Days per Year  | day/year  | 345            |              |       |  |
| Total Working Days   | day       | 2,588          |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day    | 34,843         |              |       |  |
| Working Hours per day  | hr        | 24             |              |       |  |
| <b>Equipment Parameters</b>  |           |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |                |              |       |  |
| Single Bucket Capacity   | m3        | 17.0           |              |       |  |
| Bucket Fill Factor   |           | 55%            |              |       |  |
| Factored Bucket Capacity   |           | 9.35           |              |       |  |
| Bucket Cycle Time  |           | 30.0           |              |       |  |
| Production Rate for Excavator  |           | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |           | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |           | <b>2.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  |           | <b>2,244.0</b> |              |       |  |
| <b>CAT 789 Off-Road Truck</b>  |           |                |              |       |  |
| Truck Capacity (Max.)  | m3        | 105            |              |       |  |
| Truck Capacity (Struck)  | m3        | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 1,235,000      |              |       |  |
| Calculated truck trips per day   | no.       | 478.0          |              |       |  |
| Max. load/unload time per truck *  | hr        | 0.050          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |           |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km        | 3.0            |              |       | Source: site plan  |
| Average Truck Travel Speed   |           | 25             |              |       |  |
| Estimated Load Time  | hr        | 0.033          |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.240          |              |       | Calculated round-trip distance of 6 km                                   |
| Estimated Unload Time  | hr        | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | hr        | <b>0.31</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.       | 78.5           |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | no.       | <b>7.0</b>     |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | no.       | <b>2.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |           |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 592.95    |       |  |
| Daily Rate per excavator   | \$/day    |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 2 excavators  | \$/day    | 2.0            | \$ 28,461    |       |  |
| <b>CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)</b>   |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day    |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 7 trucks  | \$/day    | 7.0            | \$ 55,683    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day    |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 2 trucks  | \$/day    | 2.0            | \$ 13,200    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day    |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |           |                |              |       |  |
| Construction Cost per km   | \$/km     |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day    |                | \$3,000.00   |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total          | Comments |
|------------------------|------|---------|------------|----------------|----------|
| <b>Equipment</b>       |      |         |            |                |          |
| Excavators             | day  | 2,587.5 | \$ 28,461  | \$ 73,644,042  |          |
| 105m3 Off-Road Trucks  | day  | 2,587.5 | \$ 55,683  | \$ 144,079,576 |          |
| 41.5m3 Off-Road Trucks | day  | 2,587.5 | \$ 13,200  | \$ 34,155,000  |          |
| 20m3 Front End Loader  | day  | 2,587.5 | \$ 14,400  | \$ 37,260,000  |          |
| <b>Haul Roads</b>      |      |         |            |                |          |
| Construction           | km   | 3.0     | \$ 250,000 | \$ 750,000     |          |
| Maintenance            | day  | 2,587.5 | \$ 1,000   | \$ 2,587,500   |          |

|  |                      |
|--|----------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$292,476,118</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.24</b>        |

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Truck Haul to T7**

| Item   | Unit      | Qty            | Price/Rate   | Total | Comments   |
|--|-----------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |           |                |              |       |  |
| <b>General Parameters</b>  |           |                |              |       |  |
| Total Material to be Hauled by Truck   | m3        | 4,500,000      |              |       |  |
| Time to transport material   | year      | 0.5            |              |       |  |
| Working Days per Year  | day/year  | 345            |              |       |  |
| Total Working Days   | day       | 173            |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day    | 26,087         |              |       |  |
| Working Hours per day  | hr        | 24             |              |       |  |
| <b>Equipment Parameters</b>  |           |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |                |              |       |  |
| Single Bucket Capacity   | m3        | 17.0           |              |       |  |
| Bucket Fill Factor   |           | 55%            |              |       |  |
| Factored Bucket Capacity   |           | 9.35           |              |       |  |
| Bucket Cycle Time  |           | 30.0           |              |       |  |
| Production Rate for Excavator  |           | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |           | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |           | <b>1.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 1 Excavators</b>  |           | <b>1,122.0</b> |              |       |  |
| <b>CAT 789 Off-Road Truck</b>  |           |                |              |       |  |
| Truck Capacity (Max.)  | m3        | 105            |              |       |  |
| Truck Capacity (Struck)  | m3        | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.       | 61,644         |              |       |  |
| Calculated truck trips per day   | no.       | 358.0          |              |       |  |
| Max. load/unload time per truck *  | hr        | 0.067          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |           |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |           |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km        | 2.5            |              |       | Source: site plan  |
| Average Truck Travel Speed   |           | 25             |              |       |  |
| Estimated Load Time  | hr        | 0.065          |              |       | 3.9 minutes  |
| Estimated Travel Time (Round Trip)   | hr        | 0.200          |              |       | Calculated round-trip distance of 5 km                                   |
| Estimated Unload Time  | hr        | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | hr        | <b>0.30</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.       | 80.4           |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | no.       | <b>5.0</b>     |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | no.       | <b>2.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |           |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 592.95    |       |  |
| Daily Rate per Excavator   | \$/day    |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 1 Excavators  | \$/day    | 1.0            | \$ 14,231    |       |  |
| <b>CAT 789 Off-Road Truck (105m<sup>3</sup> Capacity)</b>  |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day    |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 5 trucks  | \$/day    | 5.0            | \$ 39,774    |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day    |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 2 trucks  | \$/day    | 2.0            | \$ 13,200    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |           |                |              |       |  |
| Hourly Rate  | \$/hr     |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day    |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |           |                |              |       |  |
| Construction Cost per km   | \$/km     |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day    |                | \$2,500.00   |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Total        | Comments |
|------------------------|------|-------|------------|--------------|----------|
| <b>Equipment</b>       |      |       |            |              |          |
| Excavators             | day  | 172.5 | \$ 14,231  | \$ 2,454,801 |          |
| 105m3 Off-Road Trucks  | day  | 172.5 | \$ 39,774  | \$ 6,860,932 |          |
| 41.5m3 Off-Road Trucks | day  | 172.5 | \$ 13,200  | \$ 2,277,000 |          |
| 20m3 Front End Loader  | day  | 172.5 | \$ 14,400  | \$ 2,484,000 |          |
| <b>Haul Roads</b>      |      |       |            |              |          |
| Construction           | km   | 2.5   | \$ 250,000 | \$ 625,000   |          |
| Maintenance            | day  | 172.5 | \$ 2,500   | \$ 431,250   |          |

**Total Cost - Material Transportation**

**\$15,132,984**

**Unit cost of truck haul per m<sup>3</sup>**

**\$3.36**

**Backup Calculations**

**Project Specifications - Truck Haul to T8**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 5,000,000      |              |       |  |
| Time to transport material   | year       | 0.5            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 173            |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 28,986         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| CAT 5230B Mass Excavator/Shovel (17m3 bucket)  |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for Excavator  |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>2.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  |            | <b>2,244.0</b> |              |       |  |
| CAT 789 Off-Road Truck   |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 68,493         |              |       |  |
| Calculated truck trips per day   | no.        | 398.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.060          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 2.1            |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 25             |              |       |  |
| Estimated Load Time  | hr         | 0.033          |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 0.168          |              |       | Calculated round-trip distance of 4.2 km                                 |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.23</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 102.6          |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>4.0</b>     |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>1.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| CAT 5230B Mass Excavator/Shovel (17m3 bucket)  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per Excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 2 Excavators  | \$/day     | 2.0            | \$ 28,461    |       |  |
| CAT 789 Off-Road Truck (105m <sup>3</sup> Capacity)  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 4 trucks  | \$/day     | 4.0            | \$ 31,819    |       |  |
| CAT 775E Off-Road Truck (41.5m <sup>3</sup> Capacity)  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 1 trucks  | \$/day     | 1.0            | \$ 6,600     |       |  |
| CAT 994D Front End Loader (20m <sup>3</sup> Capacity)  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   |            |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$2,100.00   |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Total        | Comments |
|------------------------|------|-------|------------|--------------|----------|
| <b>Equipment</b>       |      |       |            |              |          |
| Excavators             | day  | 172.5 | \$ 28,461  | \$ 4,909,603 |          |
| 105m3 Off-Road Trucks  | day  | 172.5 | \$ 31,819  | \$ 5,488,746 |          |
| 41.5m3 Off-Road Trucks | day  | 172.5 | \$ 6,600   | \$ 1,138,500 |          |
| 20m3 Front End Loader  | day  | 172.5 | \$ 14,400  | \$ 2,484,000 |          |
| <b>Haul Roads</b>      |      |       |            |              |          |
| Construction           | km   | 2.1   | \$ 250,000 | \$ 525,000   |          |
| Maintenance            | day  | 172.5 | \$ 2,100   | \$ 362,250   |          |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$14,908,099</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$2.98</b>       |

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Truck Haul to T9**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments  |
|--|------------|----------------|--------------|-------|---|
| Cells requiring user input are highlighted thus:   |            |                |              |       |   |
| <b>General Parameters</b>  |            |                |              |       |   |
| Total Material to be Hauled by Truck   | m3         | 5,900,000      |              |       |   |
| Time to transport material   | year       | 0.5            |              |       |   |
| Working Days per Year  | day/year   | 345            |              |       |   |
| Total Working Days   | day        | 173            |              |       |   |
| Calculated Target Production (total material/working days)   | m3/day     | 34,203         |              |       |   |
| Working Hours per day  | hr         | 24             |              |       |   |
| <b>Equipment Parameters</b>  |            |                |              |       |   |
| CAT 5230B Mass Excavator/Shovel (17m3 bucket)  |            |                |              |       |   |
| Single Bucket Capacity   | m3         | 17.0           |              |       |   |
| Bucket Fill Factor   |            | 55%            |              |       |   |
| Factored Bucket Capacity   |            | 9.35           |              |       |   |
| Bucket Cycle Time  |            | 30.0           |              |       |   |
| Production Rate for Excavator  |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr   |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |   |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>2.0</b>     |              |       |   |
| <b>Hourly Loading Rate for 2 Excavators</b>  |            | <b>2,244.0</b> |              |       |   |
| CAT 789 Off-Road Truck   |            |                |              |       |   |
| Truck Capacity (Max.)  | m3         | 105            |              |       |   |
| Truck Capacity (Struck)  | m3         | 73             |              |       |   |
| Total Truck Trips Required to Meet Target  | no.        | 80,822         |              |       |   |
| Calculated truck trips per day   | no.        | 469.0          |              |       |   |
| Max. load/unload time per truck *  | hr         | 0.051          |              |       | Note: logistics check, indicates maximum in order to maintain production completion |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |   |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |   |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 4.0            |              |       | Source: site plan   |
| Average Truck Travel Speed   |            | 25             |              |       |   |
| Estimated Load Time  | hr         | 0.033          |              |       | 2 minutes   |
| Estimated Travel Time (Round Trip)   | hr         | 0.320          |              |       | Calculated round-trip distance of 8 km  |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck   |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.39</b>    |              |       |   |
| Calculated Trips Per Truck per Day   | no.        | 62.2           |              |       |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>8.0</b>     |              |       |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>2.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site                   |
| <b>Equipment Costs</b>   |            |                |              |       |   |
| CAT 5230B Mass Excavator/Shovel (17m3 bucket)  |            |                |              |       |   |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |   |
| Daily Rate per Excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours  |
| Daily Rate for 2 Excavators  | \$/day     | 2.0            | \$ 28,461    |       |   |
| CAT 789 Off-Road Truck (105m <sup>3</sup> Capacity)  |            |                |              |       |   |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |   |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours  |
| Daily Rate for 8 trucks  | \$/day     | 8.0            | \$ 63,638    |       |   |
| CAT 775E Off-Road Truck (41.5m <sup>3</sup> Capacity)  |            |                |              |       |   |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |   |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours  |
| Daily Rate for 2 trucks  | \$/day     | 2.0            | \$ 13,200    |       |   |
| CAT 994D Front End Loader (20m <sup>3</sup> Capacity)  |            |                |              |       |   |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |   |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours  |
| <b>Haul Roads</b>  |            |                |              |       |   |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |   |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |   |
| Maintenance Cost per day   | \$/day     |                | \$4,000.00   |       |   |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty   | Price/Rate | Total         | Comments |
|------------------------|------|-------|------------|---------------|----------|
| <b>Equipment</b>       |      |       |            |               |          |
| Excavators             | day  | 172.5 | \$ 28,461  | \$ 4,909,603  |          |
| 105m3 Off-Road Trucks  | day  | 172.5 | \$ 63,638  | \$ 10,977,492 |          |
| 41.5m3 Off-Road Trucks | day  | 172.5 | \$ 13,200  | \$ 2,277,000  |          |
| 20m3 Front End Loader  | day  | 172.5 | \$ 14,400  | \$ 2,484,000  |          |
| <b>Haul Roads</b>      |      |       |            |               |          |
| Construction           | km   | 4.0   | \$ 250,000 | \$ 1,000,000  |          |
| Maintenance            | day  | 172.5 | \$ 4,000   | \$ 690,000    |          |

|  |                     |
|--|---------------------|
| <b>Total Cost - Material Transportation</b>      | <b>\$22,338,094</b> |
| <b>Unit cost of truck haul per m<sup>3</sup></b> | <b>\$3.79</b>       |

**Backup Calculations**

**Project Specifications - Truck Haul to T10**

| Item   | Unit       | Qty            | Price/Rate   | Total | Comments   |
|--|------------|----------------|--------------|-------|--|
| Cells requiring user input are highlighted thus:   |            |                |              |       |  |
| <b>General Parameters</b>  |            |                |              |       |  |
| Total Material to be Hauled by Truck   | m3         | 87,557,333     |              |       |  |
| Time to transport material   | year       | 5.2            |              |       |  |
| Working Days per Year  | day/year   | 345            |              |       |  |
| Total Working Days   | day        | 1,794          |              |       |  |
| Calculated Target Production (total material/working days)   | m3/day     | 48,806         |              |       |  |
| Working Hours per day  | hr         | 24             |              |       |  |
| <b>Equipment Parameters</b>  |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Single Bucket Capacity   | m3         | 17.0           |              |       |  |
| Bucket Fill Factor   |            | 55%            |              |       |  |
| Factored Bucket Capacity   |            | 9.35           |              |       |  |
| Bucket Cycle Time  |            | 30.0           |              |       |  |
| Production Rate for 41m3 clamshell + crane   |            | 1122.0         |              |       | Comparison: Harza Report, 1200m3/hr                                      |
| Daily Loading Rate per Excavator   |            | 26,928.00      |              |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   |            | <b>2.0</b>     |              |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  |            | <b>2,244.0</b> |              |       |  |
| <b>CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)</b>   |            |                |              |       |  |
| Truck Capacity (Max.)  | m3         | 105            |              |       |  |
| Truck Capacity (Struck)  | m3         | 73             |              |       |  |
| Total Truck Trips Required to Meet Target  | no.        | 1,199,416      |              |       |  |
| Calculated truck trips per day   | no.        | 669.0          |              |       |  |
| Max. load/unload time per truck *  | hr         | 0.036          |              |       | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |            |                |              |       |  |
| <b>Truck Transportation Cycle</b>  |            |                |              |       |  |
| Average one-way distance (excavation site/stockpile to disposal site)  | km         | 20.4           |              |       | Source: site plan  |
| Average Truck Travel Speed   |            | 30             |              |       |  |
| Estimated Load Time  | hr         | 0.033          |              |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr         | 1.360          |              |       | Calculated round-trip distance of 40.8 km                                |
| Estimated Unload Time  | hr         | 0.033          |              |       | 2 minutes per truck  |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>1.43</b>    |              |       |  |
| Calculated Trips Per Truck per Day   | no.        | 16.8           |              |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b> | <b>40.0</b>    |              |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b> | <b>8.0</b>     |              |       | Arbitrary no. used to maintain continuous flow at excavation site        |
| <b>Equipment Costs</b>   |            |                |              |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 592.95    |       |  |
| Daily Rate per excavator   | \$/day     |                | \$ 14,231    |       | 24 pay hours   |
| Daily Rate for 2 excavators  | \$/day     | 2.0            | \$ 28,461    |       |  |
| <b>CAT 789C Off-Road Truck (105m<sup>3</sup> Capacity)</b>   |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 331.45    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 7,955     |       | 24 pay hours   |
| Daily Rate for 40 trucks   | \$/day     | 40.0           | \$ 318,188   |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 275.00    |       |  |
| Daily Rate per truck   | \$/day     |                | \$ 6,600     |       | 24 pay hours   |
| Daily Rate for 8 trucks  | \$/day     | 8.0            | \$ 52,800    |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |            |                |              |       |  |
| Hourly Rate  | \$/hr      |                | \$ 600.00    |       |  |
| Daily Rate per loader  | \$/day     |                | \$ 14,400    |       | 24 pay hours   |
| <b>Haul Roads</b>  |            |                |              |       |  |
| Construction Cost per km   | \$/km      |                | \$250,000.00 |       |  |
| Maintenance Cost per km per day  | \$/km/day  |                | \$1,000.00   |       |  |
| Maintenance Cost per day   | \$/day     |                | \$20,400.00  |       |  |

**Truck Loading and Transportation Costs**

| Item                   | Unit | Qty     | Price/Rate | Total          | Comments |
|------------------------|------|---------|------------|----------------|----------|
| <b>Equipment</b>       |      |         |            |                |          |
| Excavators             | day  | 1,794.0 | \$ 28,461  | \$ 51,059,869  |          |
| 105m3 Off-Road Trucks  | day  | 1,794.0 | \$ 318,188 | \$ 570,829,559 |          |
| 41.5m3 Off-Road Trucks | day  | 1,794.0 | \$ 52,800  | \$ 94,723,200  |          |
| 20m3 Front End Loader  | day  | 1,794.0 | \$ 14,400  | \$ 25,833,600  |          |
| <b>Haul Roads</b>      |      |         |            |                |          |
| Construction           | km   | 20.4    | \$ 250,000 | \$ 5,100,000   |          |
| Maintenance            | day  | 1,794.0 | \$ 20,400  | \$ 36,597,600  |          |

**Total Cost - Material Transportation** **\$784,143,828**  
**Unit cost of truck haul per m<sup>3</sup>** **\$8.96**

**Panama - Material Disposal Alternatives Study**

**Backup Calculations**

**Project Specifications - Train Haul to T10**

| Item   | Unit       | Qty     | Price/Rate | Total | Comments                              |
|--|------------|---------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |         |            |       |                                       |
| Formation (Section) Length                     | m          | 23000   |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2       |            |       |                                       |
| Formation cut volume                           | m3         | 9350000 |            |       |                                       |
| Formation fill volume                          | m3         | 6300000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30      |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0.6     |            |       |                                       |
| Ballast Width                                  | m          | 6       |            |       |                                       |
| Spacing of ties                                | m          | 0.6     |            |       |                                       |
| Wood tie dimensions                            |            |         |            |       |                                       |
| width  | m          | 0.2     |            |       |                                       |
| depth  | m          | 0.15    |            |       |                                       |
| length   | m          | 2.6     |            |       |                                       |
| volume   | m3         | 0.078   |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$      | 40,000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |         |            |       |                                       |
| Total Track Length                             | m          | 56,000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 93,333  |            |       |                                       |
| Ballast volume                                 | m3         | 234,280 |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 421,704 |            |       |                                       |

**Construction Costs**

| Item                                   | Unit | Qty        | Price/Rate   | Total                | Comments   |
|--|------|------------|--------------|----------------------|--|
| <b>Track Laying on Formation</b>       |      |            |              |                      |  |
| Survey                                 | Ha   | 460        | \$ 3,000.00  | \$ 1,380,000         | 200m Corridor  |
| Boreholes                              | ea   | 46         | \$ 2,400.00  | \$ 110,400           | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 69         | \$ 14,820.00 | \$ 1,022,580         | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 15,650,000 | \$ 1.10      | \$ 17,194,324        | Cut + Fill Volumes   |
| Ballast                                | t    | 421,704    | \$ 34.00     | \$ 14,337,936        | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 93,333     | \$ 58.00     | \$ 5,413,333         |  |
| Tie plates                             | ea   | 186,666    | \$ 8.60      | \$ 1,605,328         |  |
| 132lb Rail                             | m    | 112,000    | \$ 62.34     | \$ 6,981,627         |  |
| Track spikes                           | ea   | 373,333    | \$ 6.26      | \$ 2,337,067         |  |
| Rail anchors                           | ea   | 186,667    | \$ 5.90      | \$ 1,101,333         | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15         | \$ 30,000.00 | \$ 450,000           |  |
| <b>Total Cost - Track on Formation</b> |      |            |              | <b>\$ 51,933,928</b> |  |
| <b>Unit Cost per km</b>                |      |            |              | <b>\$ 927,400</b>    |  |

| Item               | Unit | Qty | Price/Rate      | Total        | Comments   |
|--------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>  |      |     |                 |              |  |
| Bridges            | ea   | 1   | \$ 2,000,000.00 | \$ 2,000,000 |  |
| Culverts           |      |     |                 |              |  |
| Waterway crossings |      | 23  |                 |              |  |
| Pipe (Class 5)     | ea   | 92  | \$ 23,580.58    | \$ 2,169,413 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall           | ea   | 46  | \$ 4,703.60     | \$ 216,366   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings     | ea   | 15  | \$ 1,819.00     | \$ 27,285    | Assume 8m-wide roadway                                     |

|  |  |  |  |                      |  |
|--|--|--|--|----------------------|--|
| <b>Total Cost - Formation + Track Laying</b> |  |  |  | <b>\$ 51,933,928</b> |  |
| <b>Total Cost - Railway Structures</b>       |  |  |  | <b>\$ 4,413,064</b>  |  |
| <b>Total Cost - Railway Construction</b>     |  |  |  | <b>\$ 56,346,992</b> |  |

**MATERIAL TRANSPORTATION**

**General Specifications**

| Item   | Unit     | Qty        | Price/Rate | Total | Comments |
|--|----------|------------|------------|-------|----------|
| <b>General Parameters</b>                                  |          |            |            |       |          |
| Total Material to be Hauled                                | m3       | 87,557,333 |            |       |          |
| Time to transport material                                 | year     | 5.7        |            |       |          |
| Working Days   | day/year | 345        |            |       |          |
| Total Working Days   | day      | 1,967      |            |       |          |
| Calculated Target Production (total material/working days) | m3/day   | 44,525     |            |       |          |
| Working Hours per day                                      | hr       | 24.0       |            |       |          |

## Panama - Material Disposal Alternatives Study

### Equipment Parameters

|  |              |                |  |  |
|--|--------------|----------------|--|--|
| <b>CAT 5230B Mass Excavator/Shovel (17m<sup>3</sup> bucket)</b>  |              |                |  |  |
| Single Bucket Capacity   | m3           | 17.0           |  |  |
| Bucket Fill Factor   | no.          | 55%            |  |  |
| Factored Bucket Capacity   | m3           | 9.35           |  |  |
| Bucket Cycle Time  | sec          | 30.0           |  |  |
| Production Rate for Excavator  | m3/hr        | 1122.0         |  | Comparison: Harza Report, 1200m <sup>3</sup> /hr                         |
| Daily Loading Rate per Excavator   | m3/day       | 26,928.00      |  |  |
| <b>No. Excavators Required to maintain Target Rate</b>   | <b>no.</b>   | <b>2.0</b>     |  |  |
| <b>Hourly Loading Rate for 2 Excavators</b>  | <b>m3/hr</b> | <b>2,244.0</b> |  |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |  |  |
| Single Bucket Capacity   | m3           | 20.0           |  |  |
| Bucket Fill Factor   | no.          | 70%            |  |  |
| Factored Bucket Capacity   | m3           | 14             |  |  |
| Dig/Load Cycle Time  | sec          | 45.0           |  |  |
| Production Rate for Loader   | m3/hr        | 1120.0         |  | Comparison: Harza Report, 1200m <sup>3</sup> /hr                         |
| Daily Loading Rate per Loader  | m3/day       | 26,880.00      |  |  |
| <b>No. Loaders Required to maintain Target Rate</b>  | <b>no.</b>   | <b>2.0</b>     |  |  |
| <b>Hourly Loading Rate for 2 Loaders</b>   | <b>m3/hr</b> | <b>2,240.0</b> |  |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |              |                |  |  |
| Design Truck Capacity  | m3           | 41.5           |  |  |
| Truck Fill Factor  | no.          | 80%            |  |  |
| Factored Truck Capacity  | m3           | 33             |  |  |
| Total Truck Trips Required to Meet Target  | no.          | 2,637,269      |  |  |
| Calculated truck trips per day   | no.          | 1,342.0        |  |  |
| Max. load/unload time per truck *  | hr           | 0.018          |  | Note: logistics check, indicates maximum in order to maintain production |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |  |  |

|  |          |       |  |   |
|--|----------|-------|--|---|
| <b>Trains</b>  |          |       |  |   |
| Rail Car Capacity  | m3       | 40    |  |   |
| Rail Cars Per Train  | no.      | 50    |  |   |
| Locos per Train  | no.      | 2     |  | Ruling Grade @ 1.5%                                 |
| Total Train Capacity   | m3       | 2,000 |  |   |
| Train Trips Required Per Day to Meet Target  | no.      | 22    |  | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *  | hr/train | 1.076 |  | Note: logistics check                               |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |          |       |  |   |

|  |            |             |  |  |
|--|------------|-------------|--|--|
| <b>Truck Transportation Cycle</b>                                  |            |             |  |  |
| Average one-way distance (excavation to stockpile)                 | km         | 1           |  | Source: site plan                      |
| Average Truck Travel Speed   |            | 25          |  |  |
| Estimated Load Time  | hr         | 0.015       |  | 0.9 minutes                            |
| Estimated Travel Time (Round Trip)                                 | hr         | 0.080       |  | Calculated round-trip distance of 2 km |
| Estimated Unload Time  | hr         | 0.017       |  | 1 minutes per truck                    |
| <b>Total Cycle Time</b>  | <b>hr</b>  | <b>0.11</b> |  |  |
| Calculated Trips Per Truck per Day                                 | no.        | 215.3       |  |  |
| <b>No. 41.5m<sup>3</sup> Trucks Required (short haul &lt; 1km)</b> | <b>no.</b> | <b>7.0</b>  |  |  |

|  |            |              |  |   |
|--|------------|--------------|--|---|
| <b>Rail Transportation Cycle</b>                         |            |              |  |   |
| Avg. track distance (material transfer to disposal site) | km         | 20.4         |  |   |
| Average Train Speed                                      | km/hr      | 15           |  | factors included for train movements and delays                     |
| Time to Load Train                                       | hr         | 0.89         |  |   |
| Average Travel Time (Round Trip)                         | hr         | 2.72         |  |   |
| Time to Unload Train                                     | hr         | 0.83         |  | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | <b>hr</b>  | <b>4.45</b>  |  |   |
| No. trains loading/dumping simultaneously                | no.        | 0.80         |  | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.        | 5.4          |  |   |
| <b>No. of Train Consists Required</b>                    | <b>no.</b> | <b>5.0</b>   |  |   |
| <b>No. Rail Cars Required</b>                            | <b>no.</b> | <b>250.0</b> |  |   |
| <b>No. Locos Required</b>                                | <b>no.</b> | <b>10.0</b>  |  |   |

### Equipment Costs

|   |             |               |  |                  |
|---|-------------|---------------|--|------------------|
| <b>CAT 5230B Mass Excavator/Shovel (17m<sup>3</sup> bucket)</b> |             |               |  |                  |
| Hourly Rate   | \$/hr       | \$ 592.95     |  |                  |
| Daily Rate per Excavator  | \$/day      | \$ 14,231     |  | 24 pay hours     |
| Daily Rate for 2 Excavators                                     | \$/day      | 2.0 \$ 28,461 |  |                  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>     |             |               |  |                  |
| Hourly Rate   | \$/hr       | \$ 275.00     |  | confirm rate     |
| Daily Rate per truck  | \$/day      | \$ 6,600      |  | 24 pay hours     |
| Daily Rate for 7 trucks   | \$/day      | 7.0 \$ 46,200 |  |                  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>     |             |               |  |                  |
| Hourly Rate   | \$/hr       | \$ 600.00     |  | confirm rate     |
| Daily Rate per loader   | \$/day      | \$ 14,400     |  | 24 pay hours     |
| Daily Rate for 2 loaders  | \$/day      | 2.0 \$ 28,800 |  |                  |
| <b>Rollingstock</b>   |             |               |  |                  |
| Locomotive - Purchase Cost                                      | ea          | \$ 2,200,000  |  | Research results |
| Locomotive - Salvage Value (@ 20%)                              | ea          | \$ 440,000    |  | Research results |
| Side-dump rail car - Purchase Cost                              | ea          | \$ 80,000     |  | Research results |
| Side-dump rail car - Salvage Value (@ 20%)                      | ea          | \$ 16,000     |  | Research results |
| Locomotive operational cost                                     | \$/day/unit | \$ 1,500      |  | Research results |
| Locomotive maintenance cost                                     | \$/day/unit | \$ 1,000      |  | Research results |
| Rail car maintenance cost                                       | \$/day/unit | \$ 100        |  | Research results |

## Panama - Material Disposal Alternatives Study

### Railway Operation and Maintenance Costs

|  |           |     |    |        |          |
|--|-----------|-----|----|--------|----------|
| <b>Rollingstock</b>                      |           |     |    |        |          |
| Daily Operations Cost for 10 Locos       | \$/day    | 10  | \$ | 15,000 |          |
| Daily Maintenance Cost for 10 Locos      | \$/day    | 10  | \$ | 10,000 |          |
| Daily Maintenance Cost for 250 Rail Cars | \$/day    | 250 | \$ | 25,000 |          |
| <b>Track</b>                             |           |     |    |        |          |
| No. Mainline Tracks                      | no.       | 2   |    |        |          |
| Daily maintenance cost                   | \$/km/day | 46  | \$ | 100.00 | \$ 4,600 |

### Haul Roads

|  |           |     |  |              |  |
|--|-----------|-----|--|--------------|--|
| Construction Cost per km                     | \$/km     |     |  | \$250,000.00 |  |
| Maintenance Cost per km per day              | \$/km/day |     |  | \$1,000.00   |  |
| Daily maintenance cost for 1 km of haul road | \$/day    | 1.0 |  | \$1,000.00   |  |

### Conveyors

|                                |           |   |  |             |  |
|--------------------------------|-----------|---|--|-------------|--|
| Maintenance and operation      | \$/km/day |   |  | \$4,000.00  |  |
| Daily cost for 5km of conveyor | \$/day    | 5 |  | \$20,000.00 |  |

### Transportation Costs

| Item  | Unit     | Qty           | Price/Rate    | Total          | Comments  |
|---|----------|---------------|---------------|----------------|---|
| <b>Material Transfer and Transportation</b> |          |               |               |                |   |
| 41.5m3 Truck(s)                             | no.      | 1,967         | \$ 46,200     | \$ 90,852,300  |   |
| 20m3 Front End Loader                       | no.      | 1,967         | \$ 28,800     | \$ 56,635,200  |   |
| Conveyor/Railcar Loading System             | LS       | 1             | \$ 43,000,000 | \$ 43,000,000  | Source: EDC report April 2003                             |
| Railway Equipment/Operation                 | tonne.km | 3,423,491,720 | \$ 0.050      | \$ 171,174,586 | ** Cost comparison provided by 'Rollingstock Costs' below |
| Railway Construction                        | LS       | 1             | \$ 56,346,992 | \$ 56,346,992  |   |
| Track Maintenance                           | day      | 1,967         | \$ 4,600      | \$ 9,045,900   |   |
| Railcar dumper + stacker conveyor           | no.      | 2             | \$ 3,000,000  | \$ 6,000,000   |   |
| <b>Haul Roads and Conveyor</b>              |          |               |               |                |   |
| Haul Road Construction                      | km       | 1.0           | \$ 250,000    | \$ 250,000     |   |
| Haul Road Maintenance                       | day      | 1,967         | \$ 1,000      | \$ 1,966,500   |   |
| Conveyor maintenance and operation          | day      | 1,967         | \$ 20,000     | \$ 39,330,000  |   |

**Total Cost - Material Transportation** **\$474,601,478**

**Unit cost of transport per m<sup>3</sup>** **\$5.42**

### \*\*Rollingstock Costs

| Item                               | Unit | Qty  | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|------|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |      |              |                |                           |
| Locomotives                        | no.  | 12   | \$ 2,200,000 | \$ 26,400,000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 260  | \$ 80,000    | \$ 20,800,000  | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |      |              |                |                           |
| Operational cost of locomotives    | day  | 1967 | \$ 15,000    | \$ 29,497,500  |                           |
| Maintenance cost of locomotives    | day  | 1967 | \$ 10,000    | \$ 19,665,000  |                           |
| Maintenance cost of rail cars      | day  | 1967 | \$ 25,000    | \$ 49,162,500  |                           |
| <b>Salvage Value</b>               |      |      |              |                |                           |
| Locomotives                        | no.  | 12   | \$ 440,000   | \$ (5,280,000) |                           |
| Rail cars                          | no.  | 260  | \$ 16,000    | \$ (4,160,000) |                           |

**\*\* Total Cost - Rollingstock** **\$136,085,000**

| PRELIMINARY COST ESTIMATE                                      |                  |  |           | DATE PREPARED<br>14-Jan-04 |
|--|------------------|--|-----------|----------------------------|
| CLIENT<br>AUTORIDAD DEL CANAL DE PANAMA                        |                  | PROJECT NO.<br>4594-08                     |           |                            |
|  |                  | ESTIMATED BY<br>MOFFATT & NICHOL ENGINEERS |           |                            |
| PROJECT TITLE<br>Material Disposal Alternatives Study          |                  | STATUS OF DESIGN<br>Conceptual             |           |                            |
| <b>Typical Transportation Costs to Various Disposal Sites</b>  |                  |  |           |                            |
| <b>Material Source: Third Locks/Pacific Entrance Deepening</b> |                  |  |           |                            |
| Item   | Maximum Quantity | Units                                      | Unit Cost | Total                      |
| <b>Material Transportation to M1</b>                           |                  |  |           |                            |
| Scow Haul to Disposal Site - Wet                               | 14.315.000       | m <sup>3</sup>                             | \$2,67    | \$38.237.618               |
| Train/Scow Haul to Disposal Site - Dry                         | 43.700.000       | m <sup>3</sup>                             | \$7,33    | \$320.477.958              |
| Truck/Scow Haul to Disposal Site - Dry                         | 43.700.000       | m <sup>3</sup>                             | \$6,46    | \$282.157.025              |
| <b>Material Transportation to M2</b>                           |                  |  |           |                            |
| Scow Haul to Disposal Site - Wet                               | 4.300.000        | m <sup>3</sup>                             | \$2,01    | \$8.648.378                |
| Train/Scow Haul to Disposal Site - Dry                         | 4.300.000        | m <sup>3</sup>                             | \$3,14    | \$13.516.337               |
| Truck/Scow Haul to Disposal Site - Dry                         | 4.300.000        | m <sup>3</sup>                             | \$7,98    | \$34.312.622               |
| <b>Material Transportation to M3</b>                           |                  |  |           |                            |
| Scow Haul to Disposal Site - Wet                               | 11.200.000       | m <sup>3</sup>                             | \$2,01    | \$22.485.782               |
| <b>Material Transportation to M4</b>                           |                  |  |           |                            |
| Scow Haul to Disposal Site - Wet                               | 14.315.000       | m <sup>3</sup>                             | \$1,96    | \$28.107.228               |
| Train Haul to Disposal Site - Dry                              | 32.400.000       | m <sup>3</sup>                             | \$7,06    | \$228.639.819              |
| Truck Haul to Disposal Site - Dry                              | 32.400.000       | m <sup>3</sup>                             | \$6,62    | \$214.375.729              |
| Truck/Scow Haul to Disposal Site - Dry                         | 32.400.000       | m <sup>3</sup>                             | \$8,67    | \$280.894.442              |
| <b>Material Transportation to M5</b>                           |                  |  |           |                            |
| Scow Haul to Disposal Site - Wet                               | 14.315.000       | m <sup>3</sup>                             | \$2,15    | \$30.722.710               |
| Train Haul to Disposal Site - Dry                              | 90.155.000       | m <sup>3</sup>                             | \$4,20    | \$378.613.604              |
| Truck Haul to Disposal Site - Dry                              | 90.155.000       | m <sup>3</sup>                             | \$6,87    | \$618.954.061              |
| Truck/Scow Haul to Disposal Site - Dry                         | 90.155.000       | m <sup>3</sup>                             | \$5,35    | \$482.058.655              |
| <b>Material Transportation to M6</b>                           |                  |  |           |                            |
| Scow Haul to Disposal Site - Wet                               | 14.315.000       | m <sup>3</sup>                             | \$2,15    | \$30.722.710               |
| Train/Scow Haul to Disposal Site - Dry                         | 90.155.000       | m <sup>3</sup>                             | \$6,36    | \$573.514.122              |
| Truck/Scow Haul to Disposal Site - Dry                         | 90.155.000       | m <sup>3</sup>                             | \$5,08    | \$457.779.723              |

Note: Costs for respective dredging, excavation and disposal site work not included. Refer figures xx & xx for basis of costs diagrams

## Backup Calculations

### Project Specifications - Scow Haul to M1

| Item   | Unit     | Qty        | Price/Rate | Total | Comments  |
|--|----------|------------|------------|-------|---|
| Cells requiring user input are highlighted thus:         |          |            |            |       |   |
| <b>General Parameters</b>                                |          |            |            |       |   |
| Total Material to be Hauled by Scow (Entrance Deepening) | m3       | 14,315,000 |            |       |   |
| Time to transport material by scow                       | year     | 3,25       |            |       |   |
| Working Days per Year                                    | day/year | 345        |            |       |   |
| Total Working Days - Dredge Material                     | day      | 1,121      |            |       |   |
| Calculated Target Production - dredging                  | m3/day   | 12,768     |            |       |   |
| ACP Production Rate - Wet                                | m3/day   | 4,522      |            |       | based on published average production rate of 30,000m3/week |
| Working Hours per day                                    | hr       | 24         |            |       |   |
| <b>Equipment Parameters</b>                              |          |            |            |       |   |
| <b>3000m3 Scow</b>                                       |          |            |            |       |   |
| Scow Capacity  | m3       | 1,800      |            |       | Assume 60% fill factor                                      |
| Total scow trips required to move dredged material       | no.      | 7,953      |            |       |   |
| Scow/Tug trips required per day - dredging               | no.      | 7,09       |            |       |   |
| <b>41m3 Clamshell Bucket Dredge</b>                      |          |            |            |       |   |
| Single Bucket Capacity                                   | m3       | 41,3       |            |       | used to calculate transport cycles                          |
| Bucket Fill Factor                                       | no.      | 45%        |            |       |   |
| Factored Bucket Capacity                                 | m3       | 18,585     |            |       |   |
| Bucket Cycle Time  | sec      | 120        |            |       |   |
| Production Rate for 41m3 clamshell + crane               | m3/hr    | 557,55     |            |       | Compares with CEDEP (Corps of Engineers cost model)         |
| Daily Loading Rate (hourly rate x working hours)         | m3/day   | 13,381,20  |            |       |   |
| No. Clamshell(s) Required to maintain Target Rate        | no.      | 1,0        |            |       |   |
| Hourly Loading Rate for 1 clamshell(s)                   | m3/hr    | 557,6      |            |       |   |
| <b>Scow Transportation Cycle 1</b>                       |          |            |            |       |   |
| Average one-way distance (dredge to disposal site)       | km       | 12,5       |            |       | Dredge to disposal<br>Ref: site plan                        |
| Average Scow/Tug Travel Speed                            | km/hr    | 9          |            |       |   |
| Time to Load Scow  | hr       | 3,23       |            |       |   |
| Average Travel Time (round Trip)                         | hr       | 2,78       |            |       |   |
| Time to Berth and Dump Scow                              | hr       | 0,50       |            |       |   |
| Total trip cycle time                                    | hr       | 6,51       |            |       |   |
| Max scow trips per day (assuming 24 operating hours)     | no.      | 3,69       |            |       |   |
| No. Scow(s) required                                     | no.      | 3,0        |            |       |   |
| No. Tow Tug(s) required                                  | no.      | 3,0        |            |       | Tug estimate based on cycle time                            |
| <b>Equipment Costs</b>                                   |          |            |            |       |   |
| <b>Scow/Tugs</b>   |          |            |            |       |   |
| 3000m3 scow (includes labor and operating costs)         | \$/day   |            | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30,4375  |
| 3000HP towing tug (includes labor and operating costs)   | \$/day   |            | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30,4375  |
| Dredged material   |          |            |            |       |   |
| Total cost for 3 scow(s)                                 | \$/day   | 3,00       | \$ 6,998   |       |   |
| Total cost for 3 tow tug(s)                              | \$/day   | 3,00       | \$ 27,105  |       |   |

### Transportation Costs

| Item  | Unit | Qty     | Price/Rate | Total               | Comments |
|---|------|---------|------------|---------------------|----------|
| <b>Equipment</b>                                  |      |         |            |                     |          |
| 3000m3 Scow - Dredged material                    | day  | 1,121,3 | \$ 6,998   | \$ 7,846,448        |          |
| 3000HP Tug - Dredged material                     | day  | 1,121,3 | \$ 27,105  | \$ 30,391,170       |          |
| <b>Total Cost - Material Transportation (Wet)</b> |      |         |            | <b>\$38,237,618</b> |          |
| <b>Unit cost of scow haul per m<sup>3</sup></b>   |      |         |            | <b>\$2,67</b>       |          |

## Backup Calculations

### Project Specifications - Train Haul to M1

| Item   | Unit       | Qty     | Price/Rate | Total | Comments                              |
|--|------------|---------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |         |            |       |                                       |
| Formation (Section) Length                     | m          | 9000    |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2       |            |       |                                       |
| Formation cut volume                           | m3         | 2000000 |            |       |                                       |
| Formation fill volume                          | m3         | 3000000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30      |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0,6     |            |       |                                       |
| Ballast Width                                  | m          | 6       |            |       |                                       |
| Spacing of ties                                | m          | 0,6     |            |       |                                       |
| Wood tie dimensions                            |            |         |            |       |                                       |
| width  | m          | 0,2     |            |       |                                       |
| depth  | m          | 0,15    |            |       |                                       |
| length   | m          | 2,6     |            |       |                                       |
| volume   | m3         | 0,078   |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$      | 40,000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |         |            |       |                                       |
| Total Track Length                             | m          | 28,000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 46,667  |            |       |                                       |
| Ballast volume                                 | m3         | 135,440 |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 243,792 |            |       |                                       |

### Construction Costs

| Item                                   | Unit | Qty       | Price/Rate   | Total                | Comments   |
|--|------|-----------|--------------|----------------------|--|
| <b>Track Laying on Formation</b>       |      |           |              |                      |  |
| Survey                                 | Ha   | 180       | \$ 3,000,00  | \$ 540,000           | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea   | 18        | \$ 2,400,00  | \$ 43,200            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 27        | \$ 14,820,00 | \$ 400,140           | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 5,000,000 | \$ 1,10      | \$ 5,493,394         | Cut + Fill Volumes   |
| Ballast                                | t    | 243,792   | \$ 34,00     | \$ 8,288,928         | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 46,667    | \$ 58,00     | \$ 2,706,667         |  |
| Tie plates                             | ea   | 93,334    | \$ 8,60      | \$ 802,672           |  |
| 132lb Rail                             | m    | 56,000    | \$ 62,34     | \$ 3,490,814         |  |
| Track spikes                           | ea   | 186,667   | \$ 6,26      | \$ 1,168,533         |  |
| Rail anchors                           | ea   | 93,333    | \$ 5,90      | \$ 550,667           | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15        | \$ 30,000,00 | \$ 450,000           |  |
| <b>Total Cost - Track on Formation</b> |      |           |              | <b>\$ 23,935,015</b> |  |
| <b>Unit Cost per km</b>                |      |           |              | <b>854,900</b>       |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2,000,000,00 | \$ 2,000,000 |  |
| Culvert - crossings |      | 45  |                 |              |  |
| Pipe (Class 5)      | ea   | 180 | \$ 23,580,58    | \$ 4,244,504 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 90  | \$ 4,703,60     | \$ 423,324   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1,819,00     | \$ 12,733    | Assume 8m-wide roadway                                     |

|  |                      |
|--|----------------------|
| <b>Total Cost - Formation + Track Laying</b> | <b>\$ 23,935,015</b> |
| <b>Total Cost - Railway Structures</b>       | <b>\$ 6,680,561</b>  |
| <b>Total Cost - Railway Construction</b>     | <b>\$ 30,615,576</b> |

## MATERIAL TRANSPORTATION

| Item  | Unit         | Qty            | Price/Rate | Total | Comments   |
|---|--------------|----------------|------------|-------|--|
| <b>General Parameters</b>                                   |              |                |            |       |  |
| Total Material to be Hauled                                 | m3           | 43,700,000     |            |       |  |
| Time to transport material                                  | year         | 3,75           |            |       |  |
| Working Days  | day/year     | 345            |            |       |  |
| Total Working Days  | day          | 1,294          |            |       |  |
| Calculated Target Production (total material/working days)  | m3/day       | 33,778         |            |       |  |
| ACP Production Rate - Dry                                   | m3/day       | 22,609         |            |       | based on published average production rate of 150,000m3/week |
| Working Hours per day                                       | hr           | 24,0           |            |       |  |
| <b>Equipment Parameters</b>                                 |              |                |            |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |              |                |            |       |  |
| Single Bucket Capacity                                      | m3           | 17,0           |            |       |  |
| Bucket Fill Factor  | no.          | 55%            |            |       |  |
| Factored Bucket Capacity                                    | m3           | 9,35           |            |       |  |
| Bucket Cycle Time   | sec          | 30,0           |            |       |  |
| Production Rate for Excavator                               | m3/hr        | 1122,0         |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Excavator                            | m3/day       | 26,928,00      |            |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>      | <b>no.</b>   | <b>2,0</b>     |            |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>                 | <b>m3/hr</b> | <b>2,244,0</b> |            |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |              |                |            |       |  |
| Single Bucket Capacity                                      | m3           | 20,0           |            |       |  |
| Bucket Fill Factor  | no.          | 70%            |            |       |  |
| Factored Bucket Capacity                                    | m3           | 14             |            |       |  |
| Dig/Load Cycle Time   | sec          | 45,0           |            |       |  |
| Production Rate for Loader                                  | m3/hr        | 1120,0         |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Loader                               | m3/day       | 26,880,00      |            |       |  |
| <b>No. Loaders Required to maintain Target Rate</b>         | <b>no.</b>   | <b>2,0</b>     |            |       |  |
| <b>Hourly Loading Rate for 2 Loaders</b>                    | <b>m3/hr</b> | <b>2,240,0</b> |            |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>             |              |                |            |       |  |
| Truck Capacity (Max.)                                       | m3           | 105,0          |            |       |  |

|   |     |         |
|---|-----|---------|
| Truck Capacity (Struck)                   | m3  | 73      |
| Total Truck Trips Required to Meet Target | no. | 598.630 |
| Calculated truck trips per day            | no. | 463,0   |
| Max. load/unload time per truck *         | hr  | 0,052   |

Note: logistics check, indicates maximum in order to maintain production

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

### Trains

|   |          |       |
|---|----------|-------|
| Rail Car Capacity                           | m3       | 40    |
| Rail Cars Per Train                         | no.      | 50    |
| Locos per Train                             | no.      | 2     |
| Total Train Capacity                        | m3       | 2.000 |
| Train Trips Required Per Day to Meet Target | no.      | 17    |
| Max. load/unload time per train *           | hr/train | 1,420 |

Ruling Grade @ 1.5%

To meet target, requires 2 tracks at unloading site  
Note: logistics check

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

### 3000m3 Scow

|                                 |     |        |
|---------------------------------|-----|--------|
| Scow Capacity                   | m3  | 1.800  |
| Total scow trips required       | no. | 24.278 |
| Scow/Tug trips required per day | no. | 18,77  |

Assume 60% fill factor

### Truck Transportation Cycle

|  |           |             |
|--|-----------|-------------|
| Average one-way distance (excavation to stockpile) | km        | 1,5         |
| Average Truck Travel Speed                         |           | 25          |
| Estimated Load Time                                | hr        | 0,033       |
| Estimated Travel Time (Round Trip)                 | hr        | 0,120       |
| Estimated Unload Time                              | hr        | 0,017       |
| <b>Total Cycle Time</b>                            | <b>hr</b> | <b>0,17</b> |

Source: site plan

2 minutes  
Calculated round-trip distance of 3 km  
1 minutes per truck

|   |            |            |
|---|------------|------------|
| Calculated Trips Per Truck per Day            | no.        | 141,8      |
| <b>No. 105m3 Trucks Required (short haul)</b> | <b>no.</b> | <b>5,0</b> |

including one spare

### Rail Transportation Cycle

|  |           |             |
|--|-----------|-------------|
| Avg. track distance (material transfer to disposal site) | km        | 9,0         |
| Average Train Speed                                      | km/hr     | 15          |
| Time to Load Train                                       | hr        | 0,89        |
| Average Travel Time (Round Trip)                         | hr        | 1,20        |
| Time to Unload Train                                     | hr        | 0,83        |
| <b>Total trip cycle time</b>                             | <b>hr</b> | <b>2,93</b> |

factors included for train movements and delays

Dual-car dumpers, 2min per car per dumper

|   |            |              |
|---|------------|--------------|
| No. trains loading/dumping simultaneously | no.        | 0,60         |
| Calculated Trips Per Train Per Day        | no.        | 8,2          |
| <b>No. of Train Consists Required</b>     | <b>no.</b> | <b>3,0</b>   |
| <b>No. Rail Cars Required</b>             | <b>no.</b> | <b>150,0</b> |
| <b>No. Locos Required</b>                 | <b>no.</b> | <b>6,0</b>   |

Indicates no. of trains loading/unloading to meet production target

### Scow Transportation Cycle

|  |           |             |
|--|-----------|-------------|
| Average one-way distance (transfer station to disposal site) | km        | 14,0        |
| Average Scow/Tug Travel Speed                                | km/hr     | 9           |
| Time to Load Scow  | hr        | 1,24        |
| Average Travel Time (round Trip)                             | hr        | 3,11        |
| Time to Berth and Dump Scow                                  | hr        | 0,50        |
| <b>Total trip cycle time</b>                                 | <b>hr</b> | <b>4,86</b> |

Transfer to disposal  
Ref: site plan

matches loading rate at train loading station

|  |            |            |
|--|------------|------------|
| Max scow trips per day (assuming 24 operating hours) | no.        | 4,94       |
| <b>No. Scow(s) required</b>                          | <b>no.</b> | <b>5,0</b> |
| <b>No. Tow Tug(s) required</b>                       | <b>no.</b> | <b>3,0</b> |

includes one spare  
Tug estimate based on cycle time

### Equipment Costs

|  |        |        |        |
|--|--------|--------|--------|
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b> |        |        |        |
| Hourly Rate  | \$/hr  | \$     | 592,95 |
| Daily Rate per Excavator                             | \$/day | \$     | 14.231 |
| Daily Rate for 2 Excavators                          | \$/day | 2,0 \$ | 28.461 |

24 pay hours

|   |        |        |        |
|---|--------|--------|--------|
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b> |        |        |        |
| Hourly Rate   | \$/hr  | \$     | 275,00 |
| Daily Rate per truck  | \$/day | \$     | 6.600  |
| Daily Rate for 5 trucks                                     | \$/day | 5,0 \$ | 33.000 |

confirm rate  
24 pay hours

|   |        |        |        |
|---|--------|--------|--------|
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |        |        |        |
| Hourly Rate   | \$/hr  | \$     | 600,00 |
| Daily Rate per loader                                       | \$/day | \$     | 14.400 |
| Daily Rate for 2 loaders                                    | \$/day | 2,0 \$ | 28.800 |

confirm rate  
24 pay hours

### Rollingstock

|  |             |    |           |
|--|-------------|----|-----------|
| Locomotive - Purchase Cost                 | ea          | \$ | 2.200.000 |
| Locomotive - Salvage Value (@ 20%)         | ea          | \$ | 440.000   |
| Side-dump rail car - Purchase Cost         | ea          | \$ | 80.000    |
| Side-dump rail car - Salvage Value (@ 20%) | ea          | \$ | 16.000    |
| Locomotive operational cost                | \$/day/unit | \$ | 1.500     |
| Locomotive maintenance cost                | \$/day/unit | \$ | 1.000     |
| Rail car maintenance cost                  | \$/day/unit | \$ | 100       |

Research results  
Research results  
Research results  
Research results  
Research results  
Research results  
Research results

### Railway Operation and Maintenance Costs

|  |           |        |                 |
|--|-----------|--------|-----------------|
| <b>Rollingstock</b>                      |           |        |                 |
| Daily Operations Cost for 6 Locos        | \$/day    | 6 \$   | 9.000           |
| Daily Maintenance Cost for 6 Locos       | \$/day    | 6 \$   | 6.000           |
| Daily Maintenance Cost for 150 Rail Cars | \$/day    | 150 \$ | 15.000          |
| <b>Track</b>                             |           |        |                 |
| No. Mainline Tracks                      | no.       | 2      |                 |
| Daily maintenance cost                   | \$/km/day | 18 \$  | 100,00 \$ 1.800 |

### Scow/Tugs

|  |        |    |       |
|--|--------|----|-------|
| 3000m3 scow (includes labor and operating costs)       | \$/day | \$ | 2.333 |
| 3000HP towing tug (includes labor and operating costs) | \$/day | \$ | 9.035 |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

|                             |        |      |    |        |
|-----------------------------|--------|------|----|--------|
| Third locks material        |        |      |    |        |
| Total cost for 5 scow(s)    | \$/day | 5,00 | \$ | 11.663 |
| Total cost for 3 tow tug(s) | \$/day | 3,00 | \$ | 27.105 |

### Haul Roads

|  |           |     |  |              |
|--|-----------|-----|--|--------------|
| Construction Cost per km                       | \$/km     |     |  | \$250.000,00 |
| Maintenance Cost per km per day                | \$/km/day |     |  | \$1.000,00   |
| Daily maintenance cost for 1.5 km of haul road | \$/day    | 1,5 |  | \$1.500,00   |

### Conveyors

|                                |        |   |  |             |
|--------------------------------|--------|---|--|-------------|
| Maintenance and operation      | \$/km  |   |  | \$4.000,00  |
| Daily cost for 5km of conveyor | \$/day | 5 |  | \$20.000,00 |

### Transportation Costs

| Item                               | Unit     | Qty         | Price/Rate    | Total         | Comments  |
|------------------------------------|----------|-------------|---------------|---------------|---|
| <b>Equipment and Operation</b>     |          |             |               |               |   |
| 41.5m3 Truck(s)                    | no.      | 1.294       | \$ 33.000     | \$ 42.693.750 |   |
| 20m3 Front End Loader              | no.      | 1.294       | \$ 28.800     | \$ 37.260.000 |   |
| Conveyor/Railcar Loading System    | LS       | 1           | \$ 43.000.000 | \$ 43.000.000 | Source: EDC report April 2003                             |
| Railway Equipment/Operation        | tonne.km | 668.610.000 | \$ 0,120      | \$ 80.233.200 | ** Cost comparison provided by 'Rollingstock Costs' below |
| Railway Construction               | LS       | 1           | \$ 30.615.576 | \$ 30.615.576 |   |
| Track Maintenance                  | day      | 1.294       | \$ 1.800      | \$ 2.328.750  |   |
| 3000m3 Scow                        | day      | 1.294       | \$ 11.663     | \$ 15.089.322 |   |
| 3000HP Tug                         | day      | 1.294       | \$ 27.105     | \$ 35.066.735 |   |
| <b>Transfer Station</b>            |          |             |               |               |   |
| Railcar dumper + stacker conveyor  | no.      | 2           | \$ 3.000.000  | \$ 6.000.000  | Source: EDC report April 2003                             |
| <b>Haul Roads and Conveyor</b>     |          |             |               |               |   |
| Haul Road Construction             | km       | 1,5         | \$ 250.000    | \$ 375.000    |   |
| Haul Road Maintenance              | day      | 1.294       | \$ 1.500      | \$ 1.940.625  |   |
| Conveyor maintenance and operation | day      | 1.294       | \$ 20.000     | \$ 25.875.000 |   |

**Total Cost - Material Transportation** **\$320.477.958**

**Unit cost of transport per m<sup>3</sup>** **\$7,33**

### \*\*Rollingstock Costs

| Item                               | Unit | Qty  | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|------|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |      |              |                |                           |
| Locomotives                        | no.  | 8    | \$ 2.200.000 | \$ 17.600.000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 160  | \$ 80.000    | \$ 12.800.000  | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |      |              |                |                           |
| Operational cost of locomotives    | day  | 1294 | \$ 9.000     | \$ 11.643.750  |                           |
| Maintenance cost of locomotives    | day  | 1294 | \$ 6.000     | \$ 7.762.500   |                           |
| Maintenance cost of rail cars      | day  | 1294 | \$ 15.000    | \$ 19.406.250  |                           |
| <b>Salvage Value</b>               |      |      |              |                |                           |
| Locomotives                        | no.  | 8    | \$ 440.000   | \$ (3.520.000) |                           |
| Rail cars                          | no.  | 160  | \$ 16.000    | \$ (2.560.000) |                           |

**\*\* Total Cost - Rollingstock** **\$63.132.500**

## Backup Calculations

### Project Specifications - Material Haul to M1

| Item   | Unit     | Qty        | Price/Rate | Total | Comments  |
|--|----------|------------|------------|-------|---|
| Cells requiring user input are highlighted thus:   |          |            |            |       |   |
| <b>General Parameters</b>  |          |            |            |       |   |
| Total Material to be Hauled (Third Locks Excavation)   | m3       | 43,700.000 |            |       |   |
| Time to transport material by truck  | year     | 3.80       |            |       |   |
| Working Days per Year  | day/year | 345        |            |       |   |
| Total Working Days - Third Locks Material  | day      | 1,311      |            |       |   |
| ACP Production Rate - Dry  | m3/day   | 22,609     |            |       | based on published average production rate of 150,000m3/week            |
| Calculated Target Production - dry excavation  | m3/day   | 33,334     |            |       |   |
| Working Hours per day  | hr       | 24         |            |       |   |
| <b>Equipment Parameters</b>  |          |            |            |       |   |
| <b>3000m3 Scow</b>   |          |            |            |       |   |
| Scow Capacity  | m3       | 1,800      |            |       | Assume 60% fill factor  |
| Total scow trips required to move third locks material   | no.      | 24,278     |            |       |   |
| Scow/Tug trips required per day - third locks  | no.      | 18,52      |            |       |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |          |            |            |       |   |
| Single Bucket Capacity   | m3       | 17.0       |            |       | Excavation site material removal - cost not included                    |
| Bucket Fill Factor   | no.      | 55%        |            |       |   |
| Factored Bucket Capacity   | m3       | 9.35       |            |       |   |
| Bucket Cycle Time  | sec      | 30.0       |            |       |   |
| Production Rate for Excavator  | m3/hr    | 1122.0     |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Excavator   | m3/day   | 26,928.00  |            |       |   |
| <b>No. Excavators Required to maintain Target Rate</b>   | no.      | 2.0        |            |       |   |
| <b>Hourly Loading Rate for 2 Excavator(s)</b>  | m3/hr    | 2,244.0    |            |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |          |            |            |       |   |
| Single Bucket Capacity   | m3       | 20.0       |            |       | Intermediate transfer to ensure continuous removal from excavation site |
| Bucket Fill Factor   | no.      | 70%        |            |       |   |
| Factored Bucket Capacity   | m3       | 14         |            |       |   |
| Dig/Load Cycle Time  | sec      | 45.0       |            |       |   |
| Production Rate for Loader   | m3/hr    | 1120.0     |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Loader  | m3/day   | 26,880.00  |            |       |   |
| <b>No. Loaders Required to maintain Target Rate</b>  | no.      | 2.0        |            |       |   |
| <b>Hourly Loading Rate for 2 Loaders</b>   | m3/hr    | 2,240.0    |            |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |          |            |            |       |   |
| Truck Capacity (Max.)  | m3       | 105        |            |       |   |
| Truck Capacity (Struck)  | m3       | 73         |            |       |   |
| Total Truck Trips Required to Meet Target  | no.      | 598.630    |            |       |   |
| Calculated truck trips per day   | no.      | 457.0      |            |       |   |
| Max. load/unload time per truck *  | hr       | 0.053      |            |       | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |          |            |            |       |   |
| <b>Truck Transportation Cycle</b>  |          |            |            |       |   |
| Average one-way distance (excavation site to transfer station)   | km       | 9.0        |            |       | Source: site plan   |
| Average Truck Travel Speed   |          | 30         |            |       |   |
| Estimated Load Time  | hr       | 0.033      |            |       | 2 minutes   |
| Estimated Travel Time (Round Trip)   | hr       | 0.600      |            |       | Calculated round-trip distance of 18 km                                 |
| Estimated Unload Time  | hr       | 0.050      |            |       | 3 minutes   |
| <b>Total Cycle Time</b>  | hr       | 0.68       |            |       |   |
| Calculated Trips Per Truck per Day   | no.      | 35.2       |            |       |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | no.      | 13.0       |            |       |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | no.      | 4.0        |            |       | Arbitrary no. used to maintain continuous flow at transfer station      |
| <b>Scow Transportation Cycle</b>   |          |            |            |       |   |
| Average one-way distance (transfer station to disposal site)   | km       | 14.5       |            |       | Transfer to disposal  |
| Average Scow/Tug Travel Speed  | km/hr    | 9          |            |       | Ref: site plan  |
| Time to Load Scow  | hr       | 1.00       |            |       |   |
| Average Travel Time (round Trip)   | hr       | 3.22       |            |       |   |
| Time to Berth and Dump Scow  | hr       | 0.50       |            |       |   |
| <b>Total trip cycle time</b>   | hr       | 4.72       |            |       |   |
| Max scow trips per day (assuming 24 operating hours)   | no.      | 5.08       |            |       |   |
| <b>No. Scow(s) required</b>  | no.      | 5.0        |            |       |   |
| <b>No. Tow Tug(s) required</b>   | no.      | 3.0        |            |       | Tug estimate based on cycle time  |
| <b>Equipment Costs</b>   |          |            |            |       |   |
| <b>Scow/Tugs</b>   |          |            |            |       |   |
| 3000m3 scow (includes labor and operating costs)   | \$/day   |            | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| 3000HP towing tug (includes labor and operating costs)   | \$/day   |            | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| Third locks material   |          |            |            |       |   |
| Total cost for 5 scow(s)   | \$/day   | 5,00       | \$ 11,663  |       |   |
| Total cost for 3 tow tug(s)  | \$/day   | 3,00       | \$ 27,105  |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |          |            |            |       |   |
| Hourly Rate  | \$/hr    |            | \$ 331.45  |       |   |
| Daily Rate per truck   | \$/day   |            | \$ 7,955   |       | 24 pay hours per day  |
| Daily Rate for 13 trucks   | \$/day   | 13,00      | \$ 103,411 |       |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |          |            |            |       |   |
| Hourly Rate  | \$/hr    |            | \$ 275.00  |       |   |
| Daily Rate per truck   | \$/day   |            | \$ 6,600   |       | 24 pay hours  |
| Daily Rate for 4 trucks  | \$/day   | 4,0        | \$ 26,400  |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |          |            |            |       |   |
| Hourly Rate  | \$/hr    |            | \$ 600.00  |       |   |
| Daily Rate per loader  | \$/day   |            | \$ 14,400  |       | 24 pay hours  |

Daily Rate for 2 trucks \$/day 2,0 \$ 28.800

**Haul Roads**

Construction Cost per km \$/km \$250.000,00  
 Maintenance Cost per km per day \$/km/day \$1.000,00  
 Maintenance Cost per day \$/day 9,0 \$9.000,00

**Conveyors**

Maintenance and operation \$/km \$4.000,00  
 Daily cost for 1 km of conveyor \$/day 1 \$4.000,00

**Transportation Costs**

| Item                               | Unit | Qty     | Price/Rate   | Total          | Comments |
|------------------------------------|------|---------|--------------|----------------|----------|
| <b>Equipment</b>                   |      |         |              |                |          |
| 105m3 Off-Road Trucks              | day  | 1.311,0 | \$ 103.411   | \$ 135.572.020 |          |
| 41.5m3 Off-Road Trucks             | day  | 1.311,0 | \$ 26.400    | \$ 34.610.400  |          |
| 20m3 Front End Loader              | day  | 1.311,0 | \$ 28.800    | \$ 37.756.800  |          |
| 3000m3 Scow                        | day  | 1.311,0 | \$ 11.663    | \$ 15.290.513  |          |
| 3000HP Tug                         | day  | 1.311,0 | \$ 27.105    | \$ 35.534.292  |          |
| <b>Transfer Station</b>            |      |         |              |                |          |
| Receival Hopper + Stacker Conveyor | LS   | 1,0     | \$ 1.500.000 | \$ 1.500.000   |          |
| Berth Structure                    | m2   | 2.000,0 | \$ 1.300     | \$ 2.600.000   |          |
| <b>Haul Roads and Conveyor</b>     |      |         |              |                |          |
| Haul Road Construction             | km   | 9,0     | \$ 250.000   | \$ 2.250.000   |          |
| Haul Road Maintenance              | day  | 1.311,0 | \$ 9.000     | \$ 11.799.000  |          |
| Conveyor maintenance and operation | day  | 1.311,0 | \$ 4.000     | \$ 5.244.000   |          |

**Total Cost - Material Transportation (Dry) \$282.157.025**  
**Unit cost of truck and scow haul per m<sup>3</sup> \$6,46**

## Backup Calculations

### Project Specifications - Scow Haul to M2

| Item   | Unit     | Qty       | Price/Rate | Total | Comments  |
|--|----------|-----------|------------|-------|---|
| Cells requiring user input are highlighted thus:       |          |           |            |       |   |
| <b>General Parameters</b>                              |          |           |            |       |   |
| Total Material to be Hauled (Entrance Deepening)       | m3       | 4,300,000 |            |       |   |
| Time to transport material by scow                     | year     | 1,00      |            |       |   |
| Working Days per Year                                  | day/year | 345       |            |       |   |
| Total Working Days - Dredge Material                   | day      | 345       |            |       |   |
| Calculated Target Production - dredging                | m3/day   | 12,464    |            |       |   |
| ACP Production Rate - Wet                              | m3/day   | 4,522     |            |       | based on published average production rate of 30,000m3/week |
| Working Hours per day                                  | hr       | 24        |            |       |   |
| <b>Equipment Parameters</b>                            |          |           |            |       |   |
| <b>3000m3 Scow</b>                                     |          |           |            |       |   |
| Scow Capacity  | m3       | 1,800     |            |       | Assume 60% fill factor                                      |
| Total scow trips required to move dredged material     | no.      | 2,389     |            |       |   |
| Scow/Tug trips required per day - dredging             | no.      | 6,92      |            |       |   |
| <b>41m3 Clamshell Bucket Dredge</b>                    |          |           |            |       |   |
| Single Bucket Capacity                                 | m3       | 41,3      |            |       | used to calculate transport cycles                          |
| Bucket Fill Factor                                     | no.      | 45%       |            |       |   |
| Factored Bucket Capacity                               | m3       | 18,585    |            |       |   |
| Bucket Cycle Time                                      | sec      | 120       |            |       |   |
| Production Rate for 41m3 clamshell + crane             | m3/hr    | 557,55    |            |       | Compares with CEDEP (Corps of Engineers cost model)         |
| Daily Loading Rate (hourly rate x working hours)       | m3/day   | 13,381,20 |            |       |   |
| No. Clamshell(s) Required to maintain Target Rate      | no.      | 1,0       |            |       |   |
| Hourly Loading Rate for 1 clamshell(s)                 | m3/hr    | 557,6     |            |       | Indicates train loading rate                                |
| <b>Scow Transportation Cycle</b>                       |          |           |            |       |   |
| Average one-way distance (dredge to disposal site)     | km       | 12,0      |            |       | Dredge to disposal  |
| Average Scow/Tug Travel Speed                          | km/hr    | 9         |            |       | Ref: site plan  |
| Time to Load Scow                                      | hr       | 3,23      |            |       |   |
| Average Travel Time (round Trip)                       | hr       | 2,67      |            |       |   |
| Factor for maneuvering and dumping scow                | hr       | 0,50      |            |       |   |
| Total trip cycle time                                  | hr       | 6,40      |            |       |   |
| Max scow trips per day (assuming 24 operating hours)   | no.      | 3,75      |            |       |   |
| No. Scow(s) required                                   | no.      | 3,0       |            |       |   |
| No. Tow Tug(s) required                                | no.      | 2,0       |            |       | Tug estimate based on cycle time                            |
| <b>Equipment Costs</b>                                 |          |           |            |       |   |
| <b>Scow/Tugs</b>                                       |          |           |            |       |   |
| 3000m3 scow (includes labor and operating costs)       | \$/day   |           | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30.4375  |
| 3000HP towing tug (includes labor and operating costs) | \$/day   |           | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30.4375  |
| Dredged material                                       |          |           |            |       |   |
| Total cost for 3 scow(s)                               | \$/day   | 3,00      | \$ 6,998   |       |   |
| Total cost for 2 tow tug(s)                            | \$/day   | 2,00      | \$ 18,070  |       |   |

### Transportation Costs

| Item  | Unit | Qty | Price/Rate | Total              | Comments |
|---|------|-----|------------|--------------------|----------|
| <b>Dredged Material</b>                           |      |     |            |                    |          |
| <b>Equipment</b>                                  |      |     |            |                    |          |
| 3000m3 Scow - Dredged material                    | day  | 345 | \$ 6,998   | \$ 2,414,292       |          |
| 3000HP Tug - Dredged material                     | day  | 345 | \$ 18,070  | \$ 6,234,086       |          |
| <b>Total Cost - Material Transportation (Wet)</b> |      |     |            | <b>\$8,648,378</b> |          |
| <b>Unit cost of scow haul per m<sup>3</sup></b>   |      |     |            | <b>\$2,01</b>      |          |

## Backup Calculations

### Project Specifications - Train Haul to M2

| Item   | Unit       | Qty     | Price/Rate | Total | Comments                              |
|--|------------|---------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |         |            |       |                                       |
| Formation (Section) Length                     | m          | 9000    |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2       |            |       |                                       |
| Formation cut volume                           | m3         | 2000000 |            |       |                                       |
| Formation fill volume                          | m3         | 3000000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30      |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0,6     |            |       |                                       |
| Ballast Width                                  | m          | 6       |            |       |                                       |
| Spacing of ties                                | m          | 0,6     |            |       |                                       |
| Wood tie dimensions                            |            |         |            |       |                                       |
| width  | m          | 0,2     |            |       |                                       |
| depth  | m          | 0,15    |            |       |                                       |
| length   | m          | 2,6     |            |       |                                       |
| volume   | m3         | 0,078   |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$      | 40,000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |         |            |       |                                       |
| Total Track Length                             | m          | 28,000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 46,667  |            |       |                                       |
| Ballast volume                                 | m3         | 135,440 |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 243,792 |            |       |                                       |

### Construction Costs

| Item                                   | Unit | Qty       | Price/Rate   | Total                | Comments   |
|--|------|-----------|--------------|----------------------|--|
| <b>Track Laying on Formation</b>       |      |           |              |                      |  |
| Survey                                 | Ha   | 180       | \$ 3,000,00  | \$ 540,000           | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea   | 18        | \$ 2,400,00  | \$ 43,200            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 27        | \$ 14,820,00 | \$ 400,140           | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 5,000,000 | \$ 1,10      | \$ 5,493,394         | Cut + Fill Volumes   |
| Ballast                                | t    | 243,792   | \$ 34,00     | \$ 8,288,928         | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 46,667    | \$ 58,00     | \$ 2,706,667         |  |
| Tie plates                             | ea   | 93,334    | \$ 8,60      | \$ 802,672           |  |
| 132lb Rail                             | m    | 56,000    | \$ 62,34     | \$ 3,490,814         |  |
| Track spikes                           | ea   | 186,667   | \$ 6,26      | \$ 1,168,533         |  |
| Rail anchors                           | ea   | 93,333    | \$ 5,90      | \$ 550,667           | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15        | \$ 30,000,00 | \$ 450,000           |  |
| <b>Total Cost - Track on Formation</b> |      |           |              | <b>\$ 23,935,015</b> |  |
| <b>Unit Cost per km</b>                |      |           |              | <b>854,900</b>       |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2,000,000,00 | \$ 2,000,000 |  |
| Culvert - crossings |      | 45  |                 |              |  |
| Pipe (Class 5)      | ea   | 180 | \$ 23,580,58    | \$ 4,244,504 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 90  | \$ 4,703,60     | \$ 423,324   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1,819,00     | \$ 12,733    | Assume 8m-wide roadway                                     |

|  |                      |
|--|----------------------|
| <b>Total Cost - Formation + Track Laying</b> | <b>\$ 23,935,015</b> |
| <b>Total Cost - Railway Structures</b>       | <b>\$ 6,680,561</b>  |
| <b>Total Cost - Railway Construction</b>     | <b>\$ 30,615,576</b> |

## MATERIAL TRANSPORTATION

| Item  | Unit     | Qty       | Price/Rate | Total | Comments   |
|---|----------|-----------|------------|-------|--|
| <b>General Parameters</b>                                   |          |           |            |       |  |
| Total Material to be Hauled                                 | m3       | 4,300,000 |            |       |  |
| Time to transport material                                  | year     | 0,8       |            |       |  |
| Working Days  | day/year | 345       |            |       |  |
| Total Working Days  | day      | 276       |            |       |  |
| Calculated Target Production (total material/working days)  | m3/day   | 15,580    |            |       |  |
| ACP Production Rate - Wet                                   | m3/day   | 4,522     |            |       | based on published average production rate of 30,000m3/week  |
| ACP Production Rate - Dry                                   | m3/day   | 22,609    |            |       | based on published average production rate of 150,000m3/week |
| Working Hours per day                                       | hr       | 24,0      |            |       |  |
| <b>Equipment Parameters</b>                                 |          |           |            |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |          |           |            |       |  |
| Single Bucket Capacity                                      | m3       | 17,0      |            |       |  |
| Bucket Fill Factor  | no.      | 55%       |            |       |  |
| Factored Bucket Capacity                                    | m3       | 9,35      |            |       |  |
| Bucket Cycle Time   | sec      | 30,0      |            |       |  |
| Production Rate for Excavator                               | m3/hr    | 1122,0    |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Excavator                            | m3/day   | 26,928,00 |            |       |  |
| No. Excavators Required to maintain Target Rate             | no.      | 1,0       |            |       |  |
| Hourly Loading Rate for 1 Excavators                        | m3/hr    | 1,122,0   |            |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |          |           |            |       |  |
| Single Bucket Capacity                                      | m3       | 20,0      |            |       |  |
| Bucket Fill Factor  | no.      | 70%       |            |       |  |
| Factored Bucket Capacity                                    | m3       | 14        |            |       |  |
| Dig/Load Cycle Time   | sec      | 45,0      |            |       |  |
| Production Rate for Loader                                  | m3/hr    | 1120,0    |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Loader                               | m3/day   | 26,880,00 |            |       |  |
| No. Loaders Required to maintain Target Rate                | no.      | 1,0       |            |       |  |
| Hourly Loading Rate for 1 Loaders                           | m3/hr    | 1,120,0   |            |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>             |          |           |            |       |  |

|   |     |        |  |
|---|-----|--------|--|
| Truck Capacity (Max.)                     | m3  | 105,0  |  |
| Truck Capacity (Struck)                   | m3  | 73     |  |
| Total Truck Trips Required to Meet Target | no. | 58,904 |  |
| Calculated truck trips per day            | no. | 214,0  |  |
| Max. load/unload time per truck *         | hr  | 0,112  | Note: logistics check, indicates maximum in order to maintain production |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

**Trains**

|   |          |       |   |
|---|----------|-------|---|
| Rail Car Capacity                           | m3       | 40    |   |
| Rail Cars Per Train                         | no.      | 50    |   |
| Locos per Train                             | no.      | 2     | Ruling Grade @ 1.5%                                 |
| Total Train Capacity                        | m3       | 2,000 |   |
| Train Trips Required Per Day to Meet Target | no.      | 8     | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *           | hr/train | 3,077 | Note: logistics check                               |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

**3000m3 Scow**

|                                 |     |       |                        |
|---------------------------------|-----|-------|------------------------|
| Scow Capacity                   | m3  | 1,800 | Assume 60% fill factor |
| Total scow trips required       | no. | 2,389 |                        |
| Scow/Tug trips required per day | no. | 8,66  |                        |

**Truck Transportation Cycle**

|  |            |             |  |
|--|------------|-------------|--|
| Average one-way distance (excavation to stockpile) | km         | 1,5         | Source: site plan                      |
| Average Truck Travel Speed                         |            | 25          |  |
| Estimated Load Time                                | hr         | 0,065       | 3.9 minutes                            |
| Estimated Travel Time (Round Trip)                 | hr         | 0,120       | Calculated round-trip distance of 3 km |
| Estimated Unload Time                              | hr         | 0,017       | 1 minutes per truck                    |
| <b>Total Cycle Time</b>                            | <b>hr</b>  | <b>0,20</b> |  |
| Calculated Trips Per Truck per Day                 | no.        | 119,0       |  |
| <b>No. 105m3 Trucks Required (short haul)</b>      | <b>no.</b> | <b>3,0</b>  | including one spare                    |

**Rail Transportation Cycle**

|  |            |              |   |
|--|------------|--------------|---|
| Avg. track distance (material transfer to disposal site) | km         | 9,0          |   |
| Average Train Speed                                      | km/hr      | 15           | factors included for train movements and delays                     |
| Time to Load Train                                       | hr         | 1,79         |   |
| Average Travel Time (Round Trip)                         | hr         | 1,20         |   |
| Time to Unload Train                                     | hr         | 0,83         | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | <b>hr</b>  | <b>3,82</b>  |   |
| No. trains loading/dumping simultaneously                | no.        | 0,30         | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.        | 6,3          |   |
| <b>No. of Train Consists Required</b>                    | <b>no.</b> | <b>2,0</b>   |   |
| <b>No. Rail Cars Required</b>                            | <b>no.</b> | <b>100,0</b> |   |
| <b>No. Locos Required</b>                                | <b>no.</b> | <b>4,0</b>   |   |

**Scow Transportation Cycle**

|  |            |             |   |
|--|------------|-------------|---|
| Average one-way distance (transfer station to disposal site) | km         | 13,8        | Transfer to disposal                          |
| Average Scow/Tug Travel Speed                                | km/hr      | 9           | Ref: site plan                                |
| Time to Load Scow  | hr         | 1,61        |   |
| Average Travel Time (round Trip)                             | hr         | 3,07        | matches loading rate at train loading station |
| Time to Berth and Dump Scow                                  | hr         | 0,50        |   |
| <b>Total trip cycle time</b>                                 | <b>hr</b>  | <b>5,17</b> |   |
| Max scow trips per day (assuming 24 operating hours)         | no.        | 4,64        |   |
| <b>No. Scow(s) required</b>                                  | <b>no.</b> | <b>3,0</b>  | includes one spare                            |
| <b>No. Tow Tug(s) required</b>                               | <b>no.</b> | <b>3,0</b>  | Tug estimate based on cycle time              |

**Equipment Costs**

|   |             |               |                  |
|---|-------------|---------------|------------------|
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |             |               |                  |
| Hourly Rate   | \$/hr       | \$ 592,95     |                  |
| Daily Rate per Excavator                                    | \$/day      | \$ 14,231     | 24 pay hours     |
| Daily Rate for 1 Excavators                                 | \$/day      | 1,0 \$ 14,231 |                  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b> |             |               |                  |
| Hourly Rate   | \$/hr       | \$ 275,00     | confirm rate     |
| Daily Rate per truck  | \$/day      | \$ 6,600      | 24 pay hours     |
| Daily Rate for 3 trucks                                     | \$/day      | 3,0 \$ 19,800 |                  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |             |               |                  |
| Hourly Rate   | \$/hr       | \$ 600,00     | confirm rate     |
| Daily Rate per loader                                       | \$/day      | \$ 14,400     | 24 pay hours     |
| Daily Rate for 2 loaders                                    | \$/day      | 2,0 \$ 28,800 |                  |
| <b>Rollingstock</b>   |             |               |                  |
| Locomotive - Purchase Cost                                  | ea          | \$ 2,200,000  | Research results |
| Locomotive - Salvage Value (@ 20%)                          | ea          | \$ 440,000    | Research results |
| Side-dump rail car - Purchase Cost                          | ea          | \$ 80,000     | Research results |
| Side-dump rail car - Salvage Value (@ 20%)                  | ea          | \$ 16,000     | Research results |
| Locomotive operational cost                                 | \$/day/unit | \$ 1,500      | Research results |
| Locomotive maintenance cost                                 | \$/day/unit | \$ 1,000      | Research results |
| Rail car maintenance cost                                   | \$/day/unit | \$ 100        | Research results |

**Railway Operation and Maintenance Costs**

|  |           |                 |       |
|--|-----------|-----------------|-------|
| <b>Rollingstock</b>                      |           |                 |       |
| Daily Operations Cost for 4 Locos        | \$/day    | 4 \$ 6,000      |       |
| Daily Maintenance Cost for 4 Locos       | \$/day    | 4 \$ 4,000      |       |
| Daily Maintenance Cost for 100 Rail Cars | \$/day    | 100 \$ 10,000   |       |
| <b>Track</b>                             |           |                 |       |
| No. Mainline Tracks                      | no.       | 2               |       |
| Daily maintenance cost                   | \$/km/day | 18 \$ 100,00 \$ | 1.800 |

**Scow/Tugs**

|  |        |          |  |
|--|--------|----------|--|
| 3000m3 scow (includes labor and operating costs) | \$/day | \$ 2,333 | Source: Corps of Engineers, divide monthly cost by 30.4375 |
|--|--------|----------|--|

|  |        |         |        |
|--|--------|---------|--------|
| 3000HP towing tug (includes labor and operating costs) | \$/day | \$      | 9.035  |
| Third locks material                                   |        |         |        |
| Total cost for 3 scow(s)                               | \$/day | 3,00 \$ | 6.998  |
| Total cost for 3 tow tug(s)                            | \$/day | 3,00 \$ | 27.105 |

Source: Corps of Engineers, divide monthly cost by 30.4375

#### Haul Roads

|  |           |                |
|--|-----------|----------------|
| Construction Cost per km                       | \$/km     | \$250.000,00   |
| Maintenance Cost per km per day                | \$/km/day | \$1.000,00     |
| Daily maintenance cost for 1.5 km of haul road | \$/day    | 1,5 \$1.500,00 |

#### Conveyors

|                                |        |              |
|--------------------------------|--------|--------------|
| Maintenance and operation      | \$/km  | \$4.000,00   |
| Daily cost for 1km of conveyor | \$/day | 1 \$4.000,00 |

#### Transportation Costs

| Item                               | Unit     | Qty | Price/Rate    | Total        | Comments                    |
|------------------------------------|----------|-----|---------------|--------------|-----------------------------|
| <b>Equipment and Operation</b>     |          |     |               |              |                             |
| 41.5m3 Truck(s)                    | no.      | 0   | \$ 19.800     | \$ -         | costed in M4 rail operation |
| 20m3 Front End Loader              | no.      | 0   | \$ 28.800     | \$ -         | costed in M4 rail operation |
| Rail Transportation                | tonne.km | -   | \$ 0,100      | \$ -         | costed in M4 rail operation |
| Railway Equipment/Operation        | day      | 0   | \$ 1.800      | \$ -         | costed in M4 rail operation |
| Railway Construction               | LS       | 0   | \$ 30.615.576 | \$ -         | costed in M4 rail operation |
| 3000m3 Scow                        | day      | 276 | \$ 6.998      | \$ 1.931.433 |                             |
| 3000HP Tug                         | day      | 276 | \$ 27.105     | \$ 7.480.903 |                             |
| <b>Transfer Station</b>            |          |     |               |              |                             |
| Railcar dumper + stacker conveyor  | no.      | 1   | \$ 3.000.000  | \$ 3.000.000 |                             |
| <b>Haul Roads and Conveyor</b>     |          |     |               |              |                             |
| Conveyor maintenance and operation | day      | 276 | \$ 4.000      | \$ 1.104.000 |                             |

**Total Cost - Material Transportation** \$13.516.337  
**Unit cost of transport per m<sup>3</sup>** \$3,14

#### \*\*Rollingstock Costs

| Item                               | Unit | Qty | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|-----|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |     |              |                |                           |
| Locomotives                        | no.  | 6   | \$ 2.200.000 | \$ 13.200.000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 110 | \$ 80.000    | \$ 8.800.000   | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |     |              |                |                           |
| Operational cost of locomotives    | day  | 276 | \$ 6.000     | \$ 1.656.000   |                           |
| Maintenance cost of locomotives    | day  | 276 | \$ 4.000     | \$ 1.104.000   |                           |
| Maintenance cost of rail cars      | day  | 276 | \$ 10.000    | \$ 2.760.000   |                           |
| <b>Salvage Value</b>               |      |     |              |                |                           |
| Locomotives                        | no.  | 6   | \$ 440.000   | \$ (2.640.000) |                           |
| Rail cars                          | no.  | 110 | \$ 16.000    | \$ (1.760.000) |                           |

**\*\* Total Cost - Rollingstock** \$23.120.000

## Backup Calculations

### Project Specifications - Truck and Scow Haul to M2

| Item   | Unit     | Qty       | Price/Rate | Total | Comments  |
|--|----------|-----------|------------|-------|---|
| Cells requiring user input are highlighted thus:   |          |           |            |       |   |
| <b>General Parameters</b>  |          |           |            |       |   |
| Total Material to be Hauled by Truck (Third Locks Excavation)  | m3       | 4,300.000 |            |       |   |
| Time to transport material by truck  | year     | 0,50      |            |       |   |
| Working Days per Year  | day/year | 345       |            |       |   |
| Total Working Days - Third Locks Material  | day      | 173       |            |       |   |
| Calculated Target Production - dry excavation  | m3/day   | 24.928    |            |       |   |
| ACP Production Rate - Dry  | m3/day   | 22.609    |            |       | based on published average production rate of 150,000m3/week            |
| Working Hours per day  | hr       | 24        |            |       |   |
| <b>Equipment Parameters</b>  |          |           |            |       |   |
| <b>3000m3 Scow</b>   |          |           |            |       |   |
| Scow Capacity  | m3       | 1,800     |            |       | Assume 60% fill factor  |
| Total scow trips required to move third locks material   | no.      | 2,389     |            |       |   |
| Scow/Tug trips required per day - third locks  | no.      | 13,85     |            |       |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |          |           |            |       |   |
| Single Bucket Capacity   | m3       | 17,0      |            |       | Excavation site material removal - cost not included                    |
| Bucket Fill Factor   | no.      | 55%       |            |       |   |
| Factored Bucket Capacity   | m3       | 9,35      |            |       |   |
| Bucket Cycle Time  | sec      | 30,0      |            |       |   |
| Production Rate for Excavator  | m3/hr    | 1122,0    |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Excavator   | m3/day   | 26.928,00 |            |       |   |
| <b>No. Excavators Required to maintain Target Rate</b>   | no.      | 1,0       |            |       |   |
| <b>Hourly Loading Rate for 1 Excavator(s)</b>  | m3/hr    | 1.122,0   |            |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |          |           |            |       |   |
| Single Bucket Capacity   | m3       | 20,0      |            |       | Intermediate transfer to ensure continuous removal from excavation site |
| Bucket Fill Factor   | no.      | 70%       |            |       |   |
| Factored Bucket Capacity   | m3       | 14        |            |       |   |
| Dig/Load Cycle Time  | sec      | 45,0      |            |       |   |
| Production Rate for Loader   | m3/hr    | 1120,0    |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Loader  | m3/day   | 26.880,00 |            |       |   |
| <b>No. Loaders Required to maintain Target Rate</b>  | no.      | 1,0       |            |       |   |
| <b>Hourly Loading Rate for 1 Loaders</b>   | m3/hr    | 1.120,0   |            |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |          |           |            |       |   |
| Truck Capacity (Max.)  | m3       | 105       |            |       |   |
| Truck Capacity (Struck)  | m3       | 73        |            |       |   |
| Total Truck Trips Required to Meet Target  | no.      | 58,904    |            |       |   |
| Calculated truck trips per day   | no.      | 342,0     |            |       |   |
| Max. load/unload time per truck *  | hr       | 0,070     |            |       | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |          |           |            |       |   |
| <b>Truck Transportation Cycle</b>  |          |           |            |       |   |
| Average one-way distance (excavation site to transfer station)   | km       | 9,0       |            |       | Source: site plan   |
| Average Truck Travel Speed   |          | 30        |            |       |   |
| Estimated Load Time  | hr       | 0,065     |            |       | 3.9 minutes   |
| Estimated Travel Time (Round Trip)   | hr       | 0,600     |            |       | Calculated round-trip distance of 18 km                                 |
| Estimated Unload Time  | hr       | 0,050     |            |       | 3 minutes   |
| <b>Total Cycle Time</b>  | hr       | 0,72      |            |       |   |
| Calculated Trips Per Truck per Day   | no.      | 33,6      |            |       |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | no.      | 11,0      |            |       |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | no.      | 3,0       |            |       | Arbitrary no. used to maintain continuous flow at transfer station      |
| <b>Scow Transportation Cycle</b>   |          |           |            |       |   |
| Average one-way distance (transfer station to disposal site)   | km       | 13,8      |            |       | Transfer to disposal  |
| Average Scow/Tug Travel Speed  | km/hr    | 9         |            |       | Ref: site plan  |
| Time to Load Scow  | hr       | 1,00      |            |       |   |
| Average Travel Time (round Trip)   | hr       | 3,07      |            |       |   |
| Time to Berth and Dump Scow  | hr       | 0,50      |            |       |   |
| <b>Total trip cycle time</b>   | hr       | 4,57      |            |       |   |
| Max scow trips per day (assuming 24 operating hours)   | no.      | 5,25      |            |       |   |
| <b>No. Scow(s) required</b>  | no.      | 4,0       |            |       |   |
| <b>No. Tow Tug(s) required</b>   | no.      | 2,0       |            |       | Tug estimate based on cycle time  |
| <b>Equipment Costs</b>   |          |           |            |       |   |
| <b>Scow/Tugs</b>   |          |           |            |       |   |
| 3000m3 scow (includes labor and operating costs)   | \$/day   |           | \$ 2.333   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| 3000HP towing tug (includes labor and operating costs)   | \$/day   |           | \$ 9.035   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| Third locks material   |          |           |            |       |   |
| Total cost for 4 scow(s)   | \$/day   | 4,00      | \$ 9.331   |       |   |
| Total cost for 2 tow tug(s)  | \$/day   | 2,00      | \$ 18.070  |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |          |           |            |       |   |
| Hourly Rate  | \$/hr    |           | \$ 331.45  |       |   |
| Daily Rate per truck   | \$/day   |           | \$ 7.955   |       | 24 pay hours per day  |
| Daily Rate for 11 trucks   | \$/day   | 11,00     | \$ 87.502  |       |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |          |           |            |       |   |
| Hourly Rate  | \$/hr    |           | \$ 275.00  |       |   |
| Daily Rate per truck   | \$/day   |           | \$ 6.600   |       | 24 pay hours  |
| Daily Rate for 3 trucks  | \$/day   | 3,0       | \$ 19.800  |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |          |           |            |       |   |
| Hourly Rate  | \$/hr    |           | \$ 600,00  |       |   |
| Daily Rate per loader  | \$/day   |           | \$ 14.400  |       | 24 pay hours  |

|                                 |           |     |              |
|---------------------------------|-----------|-----|--------------|
| Daily Rate for 1 trucks         | \$/day    | 1,0 | \$ 14.400    |
| <b>Haul Roads</b>               |           |     |              |
| Construction Cost per km        | \$/km     |     | \$250.000,00 |
| Maintenance Cost per km per day | \$/km/day |     | \$1.000,00   |
| Maintenance Cost per day        | \$/day    | 9,0 | \$9.000,00   |
| <b>Conveyors</b>                |           |     |              |
| Maintenance and operation       | \$/km     |     | \$4.000,00   |
| Daily cost for 1 km of conveyor | \$/day    | 1   | \$4.000,00   |

**Transportation Costs**

| Item                               | Unit | Qty     | Price/Rate   | Total         | Comments |
|------------------------------------|------|---------|--------------|---------------|----------|
| <b>Equipment</b>                   |      |         |              |               |          |
| 105m3 Off-Road Trucks              | day  | 172,5   | \$ 87.502    | \$ 15.094.051 |          |
| 41.5m3 Off-Road Trucks             | day  | 172,5   | \$ 19.800    | \$ 3.415.500  |          |
| 20m3 Front End Loader              | day  | 172,5   | \$ 14.400    | \$ 2.484.000  |          |
| 3000m3 Scow                        | day  | 172,5   | \$ 9.331     | \$ 1.609.528  |          |
| 3000HP Tug                         | day  | 172,5   | \$ 18.070    | \$ 3.117.043  |          |
| <b>Transfer Station</b>            |      |         |              |               |          |
| Receival Hopper + Stacker Conveyor | LS   | 1,0     | \$ 1.500.000 | \$ 1.500.000  |          |
| Berth Structure                    | m2   | 2.000,0 | \$ 1.300     | \$ 2.600.000  |          |
| <b>Haul Roads and Conveyor</b>     |      |         |              |               |          |
| Haul Road Construction             | km   | 9,0     | \$ 250.000   | \$ 2.250.000  |          |
| Haul Road Maintenance              | day  | 172,5   | \$ 9.000     | \$ 1.552.500  |          |
| Conveyor maintenance and operation | day  | 172,5   | \$ 4.000     | \$ 690.000    |          |

|   |                     |
|---|---------------------|
| <b>Total Cost - Material Transportation</b>               | <b>\$34.312.622</b> |
| <b>Unit cost of truck and scow haul per m<sup>3</sup></b> | <b>\$7,98</b>       |

## Backup Calculations

### Project Specifications - Material Haul to M3

| Item   | Unit     | Qty        | Price/Rate | Total | Comments   |
|--|----------|------------|------------|-------|--|
| Cells requiring user input are highlighted thus:         |          |            |            |       |  |
| <b>General Parameters</b>                                |          |            |            |       |  |
| Total Material to be Hauled by Scow (Entrance Deepening) | m3       | 11,200.000 |            |       |  |
| Time to transport material by scow                       | year     | 2,60       |            |       |  |
| Working Days per Year                                    | day/year | 345        |            |       |  |
| Total Working Days - Scow                                | day      | 897        |            |       |  |
| Calculated Target Production - scow                      | m3/day   | 12,487     |            |       |  |
| ACP Production Rate - Wet                                | m3/day   | 4,522      |            |       | based on published production rate (weighted) of 94,800m3/week |
| Working Hours per day                                    | hr       | 24         |            |       |  |
| <b>Equipment Parameters</b>                              |          |            |            |       |  |
| <b>3000m3 Scow</b>                                       |          |            |            |       |  |
| Scow Capacity  | m3       | 1,800      |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material           | no.      | 6,223      |            |       |  |
| Scow/Tug trips required per day                          | no.      | 6,94       |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>                      |          |            |            |       |  |
| Single Bucket Capacity                                   | m3       | 41,3       |            |       | used to calculate transport cycles                             |
| Bucket Fill Factor                                       | no.      | 45%        |            |       |  |
| Factored Bucket Capacity                                 | m3       | 18,585     |            |       |  |
| Bucket Cycle Time  | sec      | 120        |            |       |  |
| Production Rate for 41m3 clamshell + crane               | m3/hr    | 557,55     |            |       | Compares with CEDEP (Corps of Engineers cost model)            |
| Daily Loading Rate (hourly rate x working hours)         | m3/day   | 13,381,20  |            |       |  |
| No. Clamshell(s) Required to maintain Target Rate        | no.      | 1,0        |            |       |  |
| Hourly Loading Rate for 1 clamshell(s)                   | m3/hr    | 557,6      |            |       | Indicates train loading rate                                   |
| <b>Scow Transportation Cycle</b>                         |          |            |            |       |  |
| Average one-way distance (dredge to unloading station)   | km       | 11,5       |            |       | Assume scows loaded by 41m3 clamshell dredge                   |
| Average Scow/Tug Travel Speed                            | km/hr    | 9          |            |       | Ref: site plan   |
| Time to Load Scow  | hr       | 3,23       |            |       |  |
| Average Travel Time (round Trip)                         | hr       | 2,56       |            |       |  |
| Factor for maneuvering and dumping scow                  | hr       | 0,50       |            |       |  |
| Total trip cycle time                                    | hr       | 6,28       |            |       |  |
| Max scow trips per day (assuming 24 operating hours)     | no.      | 3,82       |            |       |  |
| No. Scow(s) required                                     | no.      | 3,0        |            |       |  |
| No. Tow Tug(s) required                                  | no.      | 2,0        |            |       | Tug estimate based on cycle time                               |
| <b>Equipment Costs</b>                                   |          |            |            |       |  |
| <b>Scow/Tugs</b>   |          |            |            |       |  |
| 3000m3 scow (includes labor and operating costs)         | \$/day   |            | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30,4375     |
| 3000HP towing tug (includes labor and operating costs)   | \$/day   |            | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30,4375     |
| Total cost for 3 scow(s)                                 | \$/day   | 3,00       | \$ 6,998   |       |  |
| Total cost for 2 tow tug(s)                              | \$/day   | 2,00       | \$ 18,070  |       |  |

### Transportation Costs

| Item             | Unit | Qty   | Price/Rate | Total         | Comments |
|------------------|------|-------|------------|---------------|----------|
| <b>Equipment</b> |      |       |            |               |          |
| 3000m3 Scow      | day  | 897,0 | \$ 6,998   | \$ 6,277,158  |          |
| 3000HP Tug       | day  | 897,0 | \$ 18,070  | \$ 16,208,624 |          |

|   |                     |
|---|---------------------|
| <b>Total Cost - Material Transportation (Wet)</b> | <b>\$22,485,782</b> |
| <b>Unit cost of scow haul per m<sup>3</sup></b>   | <b>\$2,01</b>       |

## Backup Calculations

### Project Specifications - Scow Haul to M4

| Item   | Unit     | Qty        | Price/Rate | Total | Comments  |
|--|----------|------------|------------|-------|---|
| Cells requiring user input are highlighted thus:         |          |            |            |       |   |
| <b>General Parameters</b>                                |          |            |            |       |   |
| Total Material to be Hauled by Scow (Entrance Deepening) | m3       | 14,315.000 |            |       |   |
| Time to transport material by scow                       | year     | 3,25       |            |       |   |
| Working Days per Year                                    | day/year | 345        |            |       |   |
| Total Working Days - Dredge Material                     | day      | 1,121      |            |       |   |
| Calculated Target Production - dredging                  | m3/day   | 12,768     |            |       |   |
| ACP Production Rate - Wet                                | m3/day   | 4,522      |            |       | based on published average production rate of 30,000m3/week |
| Working Hours per day                                    | hr       | 24         |            |       |   |
| <b>Equipment Parameters</b>                              |          |            |            |       |   |
| <b>3000m3 Scow</b>                                       |          |            |            |       |   |
| Scow Capacity  | m3       | 1,800      |            |       | Assume 60% fill factor                                      |
| Total scow trips required to move dredged material       | no.      | 7,953      |            |       |   |
| Scow/Tug trips required per day - dredging               | no.      | 7,09       |            |       |   |
| <b>41m3 Clamshell Bucket Dredge</b>                      |          |            |            |       |   |
| Single Bucket Capacity                                   | m3       | 41,3       |            |       | used to calculate transport cycles                          |
| Bucket Fill Factor                                       | no.      | 45%        |            |       |   |
| Factored Bucket Capacity                                 | m3       | 18,585     |            |       |   |
| Bucket Cycle Time  | sec      | 120        |            |       |   |
| Production Rate for 41m3 clamshell + crane               | m3/hr    | 557,55     |            |       | Compares with CEDEP (Corps of Engineers cost model)         |
| Daily Loading Rate (hourly rate x working hours)         | m3/day   | 13,381,20  |            |       |   |
| No. Clamshell(s) Required to maintain Target Rate        | no.      | 1,0        |            |       |   |
| Hourly Loading Rate for 1 clamshell(s)                   | m3/hr    | 557,6      |            |       |   |
| <b>Scow Transportation Cycle</b>                         |          |            |            |       |   |
| Average one-way distance (dredge to disposal site)       | km       | 2,5        |            |       | Dredge to disposal  |
| Average Scow/Tug Travel Speed                            | km/hr    | 9          |            |       | Ref: site plan  |
| Time to Load Scow  | hr       | 3,23       |            |       |   |
| Average Travel Time (round Trip)                         | hr       | 0,56       |            |       |   |
| Factor for maneuvering and dumping scow                  | hr       | 0,50       |            |       |   |
| Total trip cycle time                                    | hr       | 4,28       |            |       |   |
| Max scow trips per day (assuming 24 operating hours)     | no.      | 5,60       |            |       |   |
| No. Scow(s) required                                     | no.      | 3,0        |            |       |   |
| No. Tow Tug(s) required                                  | no.      | 2,0        |            |       | Tug estimate based on cycle time                            |
| <b>Equipment Costs</b>                                   |          |            |            |       |   |
| <b>Scow/Tugs</b>   |          |            |            |       |   |
| 3000m3 scow (includes labor and operating costs)         | \$/day   |            | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30.4375  |
| 3000HP towing tug (includes labor and operating costs)   | \$/day   |            | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30.4375  |
| Dredged material   |          |            |            |       |   |
| Total cost for 3 scow(s)                                 | \$/day   | 3,00       | \$ 6,998   |       |   |
| Total cost for 2 tow tug(s)                              | \$/day   | 2,00       | \$ 18,070  |       |   |

### Transportation Costs

| Item  | Unit | Qty   | Price/Rate | Total               | Comments |
|---|------|-------|------------|---------------------|----------|
| <b>Dredged Material</b>                           |      |       |            |                     |          |
| <b>Equipment</b>                                  |      |       |            |                     |          |
| 3000m3 Scow                                       | day  | 1,121 | \$ 6,998   | \$ 7,846,448        |          |
| 3000HP Tug  | day  | 1,121 | \$ 18,070  | \$ 20,260,780       |          |
| <b>Total Cost - Material Transportation (Wet)</b> |      |       |            | <b>\$28,107,228</b> |          |
| <b>Unit cost of scow haul per m<sup>3</sup></b>   |      |       |            | <b>\$1,96</b>       |          |

## Backup Calculations

### Project Specifications - Train Haul to M4

| Item   | Unit       | Qty     | Price/Rate | Total | Comments                              |
|--|------------|---------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |         |            |       |                                       |
| Formation (Section) Length                     | m          | 13000   |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2       |            |       |                                       |
| Formation cut volume                           | m3         | 2500000 |            |       |                                       |
| Formation fill volume                          | m3         | 3500000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30      |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0,6     |            |       |                                       |
| Ballast Width                                  | m          | 6       |            |       |                                       |
| Spacing of ties                                | m          | 0,6     |            |       |                                       |
| Wood tie dimensions                            |            |         |            |       |                                       |
| width  | m          | 0,2     |            |       |                                       |
| depth  | m          | 0,15    |            |       |                                       |
| length   | m          | 2,6     |            |       |                                       |
| volume   | m3         | 0,078   |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$      | 40.000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |         |            |       |                                       |
| Total Track Length                             | m          | 36.000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 60.000  |            |       |                                       |
| Ballast volume                                 | m3         | 163.680 |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 294.624 |            |       |                                       |

### Construction Costs

| Item                                   | Unit | Qty       | Price/Rate   | Total                | Comments   |
|--|------|-----------|--------------|----------------------|--|
| <b>Track Laying on Formation</b>       |      |           |              |                      |  |
| Survey                                 | Ha   | 260       | \$ 3.000,00  | \$ 780.000           | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea   | 26        | \$ 2.400,00  | \$ 62.400            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 39        | \$ 14.820,00 | \$ 577.980           | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 6.000.000 | \$ 1,10      | \$ 6.592.073         | Cut + Fill Volumes   |
| Ballast                                | t    | 294.624   | \$ 34,00     | \$ 10.017.216        | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 60.000    | \$ 58,00     | \$ 3.480.000         |  |
| Tie plates                             | ea   | 120.000   | \$ 8,60      | \$ 1.032.000         |  |
| 132lb Rail                             | m    | 72.000    | \$ 62,34     | \$ 4.488.189         |  |
| Track spikes                           | ea   | 240.000   | \$ 6,26      | \$ 1.502.400         |  |
| Rail anchors                           | ea   | 120.000   | \$ 5,90      | \$ 708.000           | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15        | \$ 30.000,00 | \$ 450.000           |  |
| <b>Total Cost - Track on Formation</b> |      |           |              | <b>\$ 29.690.258</b> |  |
| <b>Unit Cost per km</b>                |      |           |              | <b>824.800</b>       |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2.000.000,00 | \$ 2.000.000 |  |
| Culvert - crossings |      | 45  |                 |              |  |
| Pipe (Class 5)      | ea   | 180 | \$ 23.580,58    | \$ 4.244.504 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 90  | \$ 4.703,60     | \$ 423.324   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1.819,00     | \$ 12.733    | Assume 8m-wide roadway                                     |

|  |  |  |  |                      |  |
|--|--|--|--|----------------------|--|
| <b>Total Cost - Formation + Track Laying</b> |  |  |  | <b>\$ 29.690.258</b> |  |
| <b>Total Cost - Railway Structures</b>       |  |  |  | <b>\$ 6.680.561</b>  |  |
| <b>Total Cost - Railway Construction</b>     |  |  |  | <b>\$ 36.370.819</b> |  |

## MATERIAL TRANSPORTATION

| Item  | Unit     | Qty        | Price/Rate | Total | Comments   |
|---|----------|------------|------------|-------|--|
| <b>General Parameters</b>                                   |          |            |            |       |  |
| Total Material to be Hauled                                 | m3       | 32.400.000 |            |       |  |
| Time to transport material                                  | year     | 2,25       |            |       |  |
| Working Days  | day/year | 345        |            |       |  |
| Total Working Days  | day      | 776        |            |       |  |
| Calculated Target Production (total material/working days)  | m3/day   | 41.740     |            |       |  |
| ACP Production Rate - Wet                                   | m3/day   | 4.522      |            |       | based on published average production rate of 30,000m3/week  |
| ACP Production Rate - Dry                                   | m3/day   | 22.609     |            |       | based on published average production rate of 150,000m3/week |
| Working Hours per day                                       | hr       | 24,0       |            |       |  |
| <b>Equipment Parameters</b>                                 |          |            |            |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |          |            |            |       |  |
| Single Bucket Capacity                                      | m3       | 17,0       |            |       |  |
| Bucket Fill Factor  | no.      | 55%        |            |       |  |
| Factored Bucket Capacity                                    | m3       | 9,35       |            |       |  |
| Bucket Cycle Time   | sec      | 30,0       |            |       |  |
| Production Rate for Excavator                               | m3/hr    | 1122,0     |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Excavator                            | m3/day   | 26.928,00  |            |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>      | no.      | 2,0        |            |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>                 | m3/hr    | 2.244,0    |            |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |          |            |            |       |  |
| Single Bucket Capacity                                      | m3       | 20,0       |            |       |  |
| Bucket Fill Factor  | no.      | 70%        |            |       |  |
| Factored Bucket Capacity                                    | m3       | 14         |            |       |  |
| Dig/Load Cycle Time   | sec      | 45,0       |            |       |  |
| Production Rate for Loader                                  | m3/hr    | 1120,0     |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Loader                               | m3/day   | 26.880,00  |            |       |  |
| <b>No. Loaders Required to maintain Target Rate</b>         | no.      | 2,0        |            |       |  |
| <b>Hourly Loading Rate for 2 Loaders</b>                    | m3/hr    | 2.240,0    |            |       |  |
| <b>CAT 775E Off-Road Truck (41.5m3 Capacity)</b>            |          |            |            |       |  |

|   |     |         |  |
|---|-----|---------|--|
| Design Truck Capacity                     | m3  | 41,5    |  |
| Truck Fill Factor                         | no. | 80%     |  |
| Factored Truck Capacity                   | m3  | 33      |  |
| Total Truck Trips Required to Meet Target | no. | 975.904 |  |
| Calculated truck trips per day            | no. | 1.258,0 |  |
| Max. load/unload time per truck *         | hr  | 0,019   | Note: logistics check, indicates maximum in order to maintain production |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

#### Trains

|   |          |       |   |
|---|----------|-------|---|
| Rail Car Capacity                           | m3       | 40    |   |
| Rail Cars Per Train                         | no.      | 50    |   |
| Locos per Train                             | no.      | 2     | Ruling Grade @ 1.5%                                 |
| Total Train Capacity                        | m3       | 2.000 |   |
| Train Trips Required Per Day to Meet Target | no.      | 21    | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *           | hr/train | 1,148 | Note: logistics check                               |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

#### Truck Transportation Cycle

|   |            |             |  |
|---|------------|-------------|--|
| Average one-way distance (excavation to stockpile)      | km         | 1,0         | Source: site plan                      |
| Average Truck Travel Speed                              |            | 25          |  |
| Estimated Load Time                                     | hr         | 0,015       | 0.9 minutes                            |
| Estimated Travel Time (Round Trip)                      | hr         | 0,080       | Calculated round-trip distance of 2 km |
| Estimated Unload Time                                   | hr         | 0,017       | 1 minutes per truck                    |
| <b>Total Cycle Time</b>                                 | <b>hr</b>  | <b>0,11</b> |  |
| Calculated Trips Per Truck per Day                      | no.        | 215,3       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b> | <b>no.</b> | <b>6,0</b>  |  |

#### Rail Transportation Cycle

|  |            |              |   |
|--|------------|--------------|---|
| Avg. track distance (material transfer to disposal site) | km         | 13,0         |   |
| Average Train Speed                                      | km/hr      | 15           | factors included for train movements and delays                     |
| Time to Load Train                                       | hr         | 0,89         |   |
| Average Travel Time (Round Trip)                         | hr         | 1,73         |   |
| Time to Unload Train                                     | hr         | 0,83         | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | <b>hr</b>  | <b>3,46</b>  |   |
| No. trains loading/dumping simultaneously                | no.        | 0,70         | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.        | 6,9          |   |
| <b>No. of Train Consists Required</b>                    | <b>no.</b> | <b>4,0</b>   |   |
| <b>No. Rail Cars Required</b>                            | <b>no.</b> | <b>200,0</b> |   |
| <b>No. Locos Required</b>                                | <b>no.</b> | <b>8,0</b>   |   |

#### Equipment Costs

|   |        |        |        |
|---|--------|--------|--------|
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |        |        |        |
| Hourly Rate   | \$/hr  | \$     | 592,95 |
| Daily Rate per Excavator                                    | \$/day | \$     | 14.231 |
| Daily Rate for 2 Excavators                                 | \$/day | 2,0 \$ | 28.461 |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b> |        |        |        |
| Hourly Rate   | \$/hr  | \$     | 275,00 |
| Daily Rate per truck  | \$/day | \$     | 6.600  |
| Daily Rate for 6 trucks                                     | \$/day | 6,0 \$ | 39.600 |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |        |        |        |
| Hourly Rate   | \$/hr  | \$     | 600,00 |
| Daily Rate per loader                                       | \$/day | \$     | 14.400 |
| Daily Rate for 2 loaders                                    | \$/day | 2,0 \$ | 28.800 |

#### Rollingstock

|  |             |    |           |                  |
|--|-------------|----|-----------|------------------|
| Locomotive - Purchase Cost                 | ea          | \$ | 2.200.000 | Research results |
| Locomotive - Salvage Value (@ 20%)         | ea          | \$ | 440.000   | Research results |
| Side-dump rail car - Purchase Cost         | ea          | \$ | 80.000    | Research results |
| Side-dump rail car - Salvage Value (@ 20%) | ea          | \$ | 16.000    | Research results |
| Locomotive operational cost                | \$/day/unit | \$ | 1.500     | Research results |
| Locomotive maintenance cost                | \$/day/unit | \$ | 1.000     | Research results |
| Rail car maintenance cost                  | \$/day/unit | \$ | 100       | Research results |

#### Railway Operation and Maintenance Costs

|  |           |        |                 |
|--|-----------|--------|-----------------|
| <b>Rollingstock</b>                      |           |        |                 |
| Daily Operations Cost for 8 Locos        | \$/day    | 8 \$   | 12.000          |
| Daily Maintenance Cost for 8 Locos       | \$/day    | 8 \$   | 8.000           |
| Daily Maintenance Cost for 200 Rail Cars | \$/day    | 200 \$ | 20.000          |
| <b>Track</b>                             |           |        |                 |
| No. Mainline Tracks                      | no.       | 2      |                 |
| Daily maintenance cost                   | \$/km/day | 26 \$  | 100,00 \$ 2.600 |

#### Haul Roads

|  |           |                |
|--|-----------|----------------|
| Construction Cost per km                     | \$/km     | \$250.000,00   |
| Maintenance Cost per km per day              | \$/km/day | \$1.000,00     |
| Daily maintenance cost for 1 km of haul road | \$/day    | 1,0 \$1.000,00 |

#### Conveyors

|                                |        |               |
|--------------------------------|--------|---------------|
| Maintenance and operation      | \$/km  | \$4.000,00    |
| Daily cost for 5km of conveyor | \$/day | 5 \$20.000,00 |

#### Train Loading and Transportation Costs

| Item                             | Unit     | Qty         | Price/Rate    | Total         | Comments  |
|----------------------------------|----------|-------------|---------------|---------------|---|
| <b>Rail Transportation Costs</b> |          |             |               |               |   |
| 41.5m3 Truck(s)                  | no.      | 776         | \$ 39.600     | \$ 30.739.500 |   |
| 20m3 Front End Loader            | no.      | 776         | \$ 28.800     | \$ 22.356.000 |   |
| Conveyor/Railcar Loading System  | LS       | 1           | \$ 43.000.000 | \$ 43.000.000 | Source: EDC report April 2003                             |
| Railway Equipment/Operation      | tonne.km | 716.040.000 | \$ 0,100      | \$ 71.604.000 | ** Cost comparison provided by 'Rollingstock Costs' below |

|                                    |     |     |    |            |    |            |
|------------------------------------|-----|-----|----|------------|----|------------|
| Railway Construction               | LS  | 1   | \$ | 36.370.819 | \$ | 36.370.819 |
| Track Maintenance                  | day | 776 | \$ | 2.600      | \$ | 2.018.250  |
| <b>Transfer Station</b>            |     |     |    |            |    |            |
| Railcar dumper + stacker conveyor  | no. | 2   | \$ | 3.000.000  | \$ | 6.000.000  |
| <b>Haul Roads and Conveyor</b>     |     |     |    |            |    |            |
| Haul Road Construction             | km  | 1,0 | \$ | 250.000    | \$ | 250.000    |
| Haul Road Maintenance              | day | 776 | \$ | 1.000      | \$ | 776.250    |
| Conveyor maintenance and operation | day | 776 | \$ | 20.000     | \$ | 15.525.000 |

**Total Cost - Material Transportation** **\$228.639.819**  
**Unit cost of transport per m<sup>3</sup>** **\$7,06**

**\*\*Rollingstock Costs**

| Item                               | Unit | Qty | Price/Rate   | Comments                                |
|------------------------------------|------|-----|--------------|---|
| <b>Rollingstock Purchase Costs</b> |      |     |              |   |
| Locomotives                        | no.  | 10  | \$ 2.200.000 | \$ 22.000.000 Includes backup loco(s)   |
| Rail cars                          | no.  | 210 | \$ 80.000    | \$ 16.800.000 Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |     |              |   |
| Operational cost of locomotives    | day  | 776 | \$ 12.000    | \$ 9.315.000                            |
| Maintenance cost of locomotives    | day  | 776 | \$ 8.000     | \$ 6.210.000                            |
| Maintenance cost of rail cars      | day  | 776 | \$ 20.000    | \$ 15.525.000                           |
| <b>Salvage Value</b>               |      |     |              |   |
| Locomotives                        | no.  | 10  | \$ 440.000   | \$ (4.400.000)                          |
| Rail cars                          | no.  | 210 | \$ 16.000    | \$ (3.360.000)                          |

**\*\* Total Cost - Rollingstock** **\$62.090.000**

## Backup Calculations

### Project Specifications - Truck Haul to M4

| Item   | Unit         | Qty            | Price/Rate   | Total | Comments  |
|--|--------------|----------------|--------------|-------|---|
| Cells requiring user input are highlighted thus:   |              |                |              |       |   |
| <b>General Parameters</b>  |              |                |              |       |   |
| Total Material to be Hauled by Truck (Third Locks Excavation)  | m3           | 32,400,000     |              |       |   |
| Time to transport material by truck  | year         | 2,70           |              |       |   |
| Working Days per Year  | day/year     | 345            |              |       |   |
| Total Working Days - Third Locks Material  | day          | 932            |              |       |   |
| Calculated Target Production - dry excavation  | m3/day       | 34,783         |              |       |   |
| ACP Production Rate - Dry  | m3/day       | 22,609         |              |       | based on published average production rate of 150,000m3/week            |
| Working Hours per day  | hr           | 24             |              |       |   |
| <b>Equipment Parameters</b>  |              |                |              |       |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |              |                |              |       |   |
| Single Bucket Capacity   | m3           | 17,0           |              |       | Excavation site material removal - cost not included                    |
| Bucket Fill Factor   | no.          | 55%            |              |       |   |
| Factored Bucket Capacity   | m3           | 9,35           |              |       |   |
| Bucket Cycle Time  | sec          | 30,0           |              |       |   |
| Production Rate for Excavator  | m3/hr        | 1122,0         |              |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Excavator   | m3/day       | 26,928,00      |              |       |   |
| <b>No. Excavators Required to maintain Target Rate</b>   | <b>no.</b>   | <b>2,0</b>     |              |       |   |
| <b>Hourly Loading Rate for 2 Excavator(s)</b>  | <b>m3/hr</b> | <b>2,244,0</b> |              |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |              |       |   |
| Single Bucket Capacity   | m3           | 20,0           |              |       | Intermediate transfer to ensure continuous removal from excavation site |
| Bucket Fill Factor   | no.          | 70%            |              |       |   |
| Factored Bucket Capacity   | m3           | 14             |              |       |   |
| Dig/Load Cycle Time  | sec          | 45,0           |              |       |   |
| Production Rate for Loader   | m3/hr        | 1120,0         |              |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Loader  | m3/day       | 26,880,00      |              |       |   |
| <b>No. Loaders Required to maintain Target Rate</b>  | <b>no.</b>   | <b>2,0</b>     |              |       |   |
| <b>Hourly Loading Rate for 2 Loaders</b>   | <b>m3/hr</b> | <b>2,240,0</b> |              |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |              |       |   |
| Truck Capacity (Max.)  | m3           | 105            |              |       |   |
| Truck Capacity (Struck)  | m3           | 73             |              |       |   |
| Total Truck Trips Required to Meet Target  | no.          | 443,836        |              |       |   |
| Calculated truck trips per day   | no.          | 477,0          |              |       |   |
| Max. load/unload time per truck *  | hr           | 0,050          |              |       | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |              |       |   |
| <b>Truck Transportation Cycle</b>  |              |                |              |       |   |
| Average one-way distance (excavation site to disposal site)  | km           | 13,0           |              |       | Source: site plan   |
| Average Truck Travel Speed   |              | 30             |              |       |   |
| Estimated Load Time  | hr           | 0,033          |              |       | 2 minutes   |
| Estimated Travel Time (Round Trip)   | hr           | 0,867          |              |       | Calculated round-trip distance of 26 km                                 |
| Estimated Unload Time  | hr           | 0,050          |              |       | 3 minutes   |
| <b>Total Cycle Time</b>  | <b>hr</b>    | <b>0,95</b>    |              |       |   |
| Calculated Trips Per Truck per Day   | no.          | 25,3           |              |       |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b>   | <b>19,0</b>    |              |       |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b>   | <b>5,0</b>     |              |       | Arbitrary no. used to maintain continuous flow at transfer station      |
| <b>Equipment Costs</b>   |              |                |              |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |              |       |   |
| Hourly Rate  | \$/hr        |                | \$ 331,45    |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 7,955     |       | 24 pay hours per day  |
| Daily Rate for 19 trucks   | \$/day       | 19,00          | \$ 151,139   |       |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |              |                |              |       |   |
| Hourly Rate  | \$/hr        |                | \$ 275,00    |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 6,600     |       | 24 pay hours  |
| Daily Rate for 5 trucks  | \$/day       | 5,0            | \$ 33,000    |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |              |       |   |
| Hourly Rate  | \$/hr        |                | \$ 600,00    |       |   |
| Daily Rate per loader  | \$/day       |                | \$ 14,400    |       | 24 pay hours  |
| Daily Rate for 2 trucks  | \$/day       | 2,0            | \$ 28,800    |       |   |
| <b>Haul Roads</b>  |              |                |              |       |   |
| Construction Cost per km   | \$/km        |                | \$250,000,00 |       |   |
| Maintenance Cost per km per day  | \$/km/day    |                | \$1,000,00   |       |   |
| Maintenance Cost per day   | \$/day       | 13,0           | \$13,000,00  |       |   |
| <b>Conveyors</b>   |              |                |              |       |   |
| Maintenance and operation  | \$/km        |                | \$4,000,00   |       |   |
| Daily cost for 1 km of conveyor  | \$/day       | 1              | \$4,000,00   |       |   |

### Transportation Costs

| Item                           | Unit | Qty   | Price/Rate | Total          | Comments |
|--------------------------------|------|-------|------------|----------------|----------|
| <b>Dry Material</b>            |      |       |            |                |          |
| <b>Equipment</b>               |      |       |            |                |          |
| 105m3 Off-Road Trucks          | day  | 931,5 | \$ 151,139 | \$ 140,786.329 |          |
| 41.5m3 Off-Road Trucks         | day  | 931,5 | \$ 33,000  | \$ 30,739.500  |          |
| 20m3 Front End Loader          | day  | 931,5 | \$ 28,800  | \$ 26,827.200  |          |
| <b>Haul Roads and Conveyor</b> |      |       |            |                |          |
| Haul Road Construction         | km   | 13,0  | \$ 14,400  | \$ 187.200     |          |
| Haul Road Maintenance          | day  | 931,5 | \$ 13,000  | \$ 12,109.500  |          |

Conveyor maintenance and operation

day

931,5 \$

4.000 \$

3.726.000

**Total Cost - Material Transportation**

**\$214.375.729**

**Unit cost of truck haul per m<sup>3</sup>**

**\$6,62**

## Backup Calculations

### Project Specifications - Truck and Scow Haul to M4

| Item   | Unit         | Qty            | Price/Rate | Total | Comments  |
|--|--------------|----------------|------------|-------|---|
| Cells requiring user input are highlighted thus:   |              |                |            |       |   |
| <b>General Parameters</b>  |              |                |            |       |   |
| Total Material to be Hauled by Truck (Third Locks Excavation)  | m3           | 32,400.000     |            |       |   |
| Time to transport material by truck  | year         | 10.50          |            |       |   |
| Working Days per Year  | day/year     | 345            |            |       |   |
| Total Working Days - Third Locks Material  | day          | 3,623          |            |       |   |
| Calculated Target Production - dry excavation  | m3/day       | 8,945          |            |       |   |
| ACP Production Rate - Dry  | m3/day       | 22,609         |            |       | based on published average production rate of 150,000m3/week            |
| Working Hours per day  | hr           | 24             |            |       |   |
| <b>Equipment Parameters</b>  |              |                |            |       |   |
| <b>3000m3 Scow</b>   |              |                |            |       |   |
| Scow Capacity  | m3           | 1,800          |            |       | Assume 60% fill factor  |
| Total scow trips required to move third locks material   | no.          | 18,000         |            |       |   |
| Scow/Tug trips required per day - third locks  | no.          | 4,97           |            |       |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |              |                |            |       |   |
| Single Bucket Capacity   | m3           | 17.0           |            |       |   |
| Bucket Fill Factor   | no.          | 55%            |            |       | Excavation site material removal - cost not included                    |
| Factored Bucket Capacity   | m3           | 9.35           |            |       |   |
| Bucket Cycle Time  | sec          | 30.0           |            |       |   |
| Production Rate for Excavator  | m3/hr        | 1,122.0        |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Excavator   | m3/day       | 26,928.00      |            |       |   |
| <b>No. Excavators Required to maintain Target Rate</b>   | <b>no.</b>   | <b>1.0</b>     |            |       |   |
| <b>Hourly Loading Rate for 1 Excavator(s)</b>  | <b>m3/hr</b> | <b>1,122.0</b> |            |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Single Bucket Capacity   | m3           | 20.0           |            |       | Intermediate transfer to ensure continuous removal from excavation site |
| Bucket Fill Factor   | no.          | 70%            |            |       |   |
| Factored Bucket Capacity   | m3           | 14             |            |       |   |
| Dig/Load Cycle Time  | sec          | 45.0           |            |       |   |
| Production Rate for Loader   | m3/hr        | 1,120.0        |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Loader  | m3/day       | 26,880.00      |            |       |   |
| <b>No. Loaders Required to maintain Target Rate</b>  | <b>no.</b>   | <b>1.0</b>     |            |       |   |
| <b>Hourly Loading Rate for 1 Loaders</b>   | <b>m3/hr</b> | <b>1,120.0</b> |            |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |            |       |   |
| Truck Capacity (Max.)  | m3           | 105            |            |       |   |
| Truck Capacity (Struck)  | m3           | 73             |            |       |   |
| Total Truck Trips Required to Meet Target  | no.          | 443.836        |            |       |   |
| Calculated truck trips per day   | no.          | 123.0          |            |       |   |
| Max. load/unload time per truck *  | hr           | 0.195          |            |       | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |            |       |   |
| <b>Truck Transportation Cycle</b>  |              |                |            |       |   |
| Average one-way distance (excavation site to transfer station)   | km           | 4.5            |            |       | Source: site plan   |
| Average Truck Travel Speed   |              | 30             |            |       |   |
| Estimated Load Time  | hr           | 0.065          |            |       | 3.9 minutes   |
| Estimated Travel Time (Round Trip)   | hr           | 0.300          |            |       | Calculated round-trip distance of 9 km                                  |
| Estimated Unload Time  | hr           | 0.050          |            |       | 3 minutes   |
| <b>Total Cycle Time</b>  | <b>hr</b>    | <b>0.42</b>    |            |       |   |
| Calculated Trips Per Truck per Day   | no.          | 57.8           |            |       |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b>   | <b>3.0</b>     |            |       |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b>   | <b>1.0</b>     |            |       | Arbitrary no. used to maintain continuous flow at transfer station      |
| <b>Scow Transportation Cycle</b>   |              |                |            |       |   |
| Average one-way distance (transfer station to disposal site)   | km           | 6.8            |            |       | Transfer to disposal  |
| Average Scow/Tug Travel Speed  | km/hr        | 9              |            |       | Ref: site plan  |
| Time to Load Scow  | hr           | 1.00           |            |       |   |
| Average Travel Time (round Trip)   | hr           | 1.51           |            |       |   |
| Time to Berth and Dump Scow  | hr           | 0.50           |            |       |   |
| <b>Total trip cycle time</b>   | <b>hr</b>    | <b>3.01</b>    |            |       |   |
| Max scow trips per day (assuming 24 operating hours)   | no.          | 7.97           |            |       |   |
| <b>No. Scow(s) required</b>  | <b>no.</b>   | <b>2.0</b>     |            |       |   |
| <b>No. Tow Tug(s) required</b>   | <b>no.</b>   | <b>2.0</b>     |            |       | Tug estimate based on cycle time  |
| <b>Equipment Costs</b>   |              |                |            |       |   |
| <b>Scow/Tugs</b>   |              |                |            |       |   |
| 3000m3 scow (includes labor and operating costs)   | \$/day       |                | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30,4375              |
| 3000HP towing tug (includes labor and operating costs)   | \$/day       |                | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30,4375              |
| Third locks material   |              |                |            |       |   |
| Total cost for 2 scow(s)   | \$/day       | 2,00           | \$ 4,665   |       |   |
| Total cost for 2 tow tug(s)  | \$/day       | 2,00           | \$ 18,070  |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 331.45  |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 7,955   |       | 24 pay hours per day  |
| Daily Rate for 3 trucks  | \$/day       | 3,00           | \$ 23,864  |       |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 275.00  |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 6,600   |       | 24 pay hours  |
| Daily Rate for 1 trucks  | \$/day       | 1,0            | \$ 6,600   |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 600.00  |       |   |
| Daily Rate per loader  | \$/day       |                | \$ 14,400  |       | 24 pay hours  |

|                         |        |     |    |        |
|-------------------------|--------|-----|----|--------|
| Daily Rate for 1 loader | \$/day | 1,0 | \$ | 14.400 |
|-------------------------|--------|-----|----|--------|

**Haul Roads**

|  |           |     |  |              |
|--|-----------|-----|--|--------------|
| Construction Cost per km                       | \$/km     |     |  | \$250.000,00 |
| Maintenance Cost per km per day                | \$/km/day |     |  | \$1.000,00   |
| Daily maintenance cost for 4.5 km of haul road | \$/day    | 4,5 |  | \$4.500,00   |

**Conveyors**

|                                 |        |   |  |            |
|---------------------------------|--------|---|--|------------|
| Maintenance and operation       | \$/km  |   |  | \$4.000,00 |
| Daily cost for 1 km of conveyor | \$/day | 1 |  | \$4.000,00 |

**Transportation Costs**

| Item                               | Unit | Qty     | Price/Rate   | Total         | Comments |
|------------------------------------|------|---------|--------------|---------------|----------|
| <b>Equipment</b>                   |      |         |              |               |          |
| 105m3 Off-Road Trucks              | day  | 3.622,5 | \$ 23.864    | \$ 86.447.746 |          |
| 41.5m3 Off-Road Trucks             | day  | 3.622,5 | \$ 6.600     | \$ 23.908.500 |          |
| 20m3 Front End Loader              | day  | 3.622,5 | \$ 14.400    | \$ 52.164.000 |          |
| 3000m3 Scow                        | day  | 3.622,5 | \$ 4.665     | \$ 16.900.041 |          |
| 3000HP Tug                         | day  | 3.622,5 | \$ 18.070    | \$ 65.457.906 |          |
| <b>Transfer Station</b>            |      |         |              |               |          |
| Receival Hopper + Stacker Conveyor | LS   | 1,0     | \$ 1.500.000 | \$ 1.500.000  |          |
| Berth Structure                    | m2   | 2.000,0 | \$ 1.300     | \$ 2.600.000  |          |
| <b>Haul Roads and Conveyor</b>     |      |         |              |               |          |
| Haul Road Construction             | km   | 4,5     | \$ 250.000   | \$ 1.125.000  |          |
| Haul Road Maintenance              | day  | 3.622,5 | \$ 4.500     | \$ 16.301.250 |          |
| Conveyor maintenance and operation | day  | 3.622,5 | \$ 4.000     | \$ 14.490.000 |          |

|   |  |  |  |                      |  |
|---|--|--|--|----------------------|--|
| <b>Total Cost - Material Transportation</b>               |  |  |  | <b>\$280.894.442</b> |  |
| <b>Unit cost of truck and scow haul per m<sup>3</sup></b> |  |  |  | <b>\$8,67</b>        |  |

## Backup Calculations

### Project Specifications - Scow Haul to M5

| Item   | Unit     | Qty        | Price/Rate | Total  | Comments   |
|--|----------|------------|------------|--------|--|
| Cells requiring user input are highlighted thus:         |          |            |            |        |  |
| <b>General Parameters</b>                                |          |            |            |        |  |
| Total Material to be Hauled by Scow (Entrance Deepening) | m3       | 14,315.000 |            |        |  |
| Time to transport material by scow                       | year     | 3.25       |            |        |  |
| Working Days per Year                                    | day/year | 345        |            |        |  |
| Total Working Days - Scow                                | day      | 1.121      |            |        |  |
| Calculated Target Production - scow                      | m3/day   | 12,768     |            |        |  |
| ACP Daily Production Rate - Wet                          | m3/day   | 4,522      |            |        | based on published production rate (weighted) of 94,800m3/week |
| ACP Hourly Production Rate - Wet                         | m3/hr    | 188        |            |        | based on published production rate (weighted) of 94,800m3/week |
| Working Hours per day                                    | hr       | 24         |            |        |  |
| <b>Equipment Parameters</b>                              |          |            |            |        |  |
| <b>3000m3 Scow</b>                                       |          |            |            |        |  |
| Scow Capacity  |          | 3,000      |            |        |  |
| Fill Factor  |          | 60%        |            |        |  |
| Scow Capacity  | m3       | 1,800      |            |        | Assume 60% fill factor   |
| Total scow trips required to move all material           | no.      | 7.953      |            |        |  |
| Scow/Tug trips required per day                          | no.      | 7.09       |            |        |  |
| <b>41m3 Clamshell Bucket Dredge</b>                      |          |            |            |        |  |
| Single Bucket Capacity                                   | m3       | 41.3       |            |        |  |
| Bucket Fill Factor                                       | no.      | 45%        |            |        |  |
| Factored Bucket Capacity                                 | m3       | 18,585     |            |        |  |
| Bucket Cycle Time  | sec      | 120        |            |        |  |
| Production Rate for clamshell + crane                    | m3/hr    | 557.55     |            |        | Compares with CEDEP (Corps of Engineers cost model)            |
| Daily Loading Rate (hourly rate x working hours)         | m3/day   | 13,381.20  |            |        |  |
| No. Clamshell(s) Required to maintain Target Rate        | no.      | 1.0        |            |        |  |
| Hourly Loading Rate for 1 clamshell(s)                   | m3/hr    | 557.6      |            |        | Indicates train loading rate                                   |
| <b>Scow Transportation Cycle</b>                         |          |            |            |        |  |
| Average one-way distance (dredge to unloading station)   | km       | 15.0       |            |        | Assume scows loaded by 41m3 clamshell dredge                   |
| Average Scow/Tug Travel Speed                            | km/hr    | 9          |            |        | Ref: site plan   |
| Time to Load Scow  | hr       | 3.23       |            |        |  |
| Average Travel Time (round Trip)                         | hr       | 3.33       |            |        |  |
| Factor for maneuvering and dumping scow                  | hr       | 0.50       |            |        |  |
| Total trip cycle time                                    | hr       | 7.06       |            |        |  |
| Max scow trips per day (assuming 24 operating hours)     | no.      | 3.40       |            |        |  |
| No. Scow(s) required                                     | no.      | 4.0        |            |        |  |
| No. Tow Tug(s) required                                  | no.      | 2.0        |            |        | Tug estimate based on cycle time                               |
| <b>Equipment Costs</b>                                   |          |            |            |        |  |
| <b>Scow/Tugs</b>   |          |            |            |        |  |
| 3000m3 scow (includes labor and operating costs)         | \$/day   |            | \$ 2,333   |        | Source: Corps of Engineers, divide monthly cost by 30.4375     |
| 3000HP towing tug (includes labor and operating costs)   | \$/day   |            | \$ 9,035   |        | Source: Corps of Engineers, divide monthly cost by 30.4375     |
| Total cost for 4 scow(s)                                 | \$/day   | 4.00       | \$         | 9,331  |  |
| Total cost for 2 tow tug(s)                              | \$/day   | 2.00       | \$         | 18,070 |  |

### Transportation Costs

| Item             | Unit | Qty     | Price/Rate | Total         | Comments |
|------------------|------|---------|------------|---------------|----------|
| <b>Equipment</b> |      |         |            |               |          |
| 3000m3 Scow      | day  | 1,121.3 | \$ 9,331   | \$ 10,461,930 |          |
| 3000HP Tug       | day  | 1,121.3 | \$ 18,070  | \$ 20,260,780 |          |

**Total Cost - Material Transportation (Wet)**

**\$30,722,710**

**Unit cost of scow haul per m<sup>3</sup>**

**\$2,15**

## Backup Calculations

### Project Specifications - Train Haul to M5

| Item   | Unit       | Qty       | Price/Rate | Total | Comments                              |
|--|------------|-----------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |           |            |       |                                       |
| Formation (Section) Length                     | m          | 13000     |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2         |            |       |                                       |
| Formation cut volume                           | m3         | 2500000   |            |       |                                       |
| Formation fill volume                          | m3         | 3500000   |            |       |                                       |
| Width at Base of Formation                     | m          | 30        |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0,6       |            |       |                                       |
| Ballast Width                                  | m          | 6         |            |       |                                       |
| Spacing of ties                                | m          | 0,6       |            |       |                                       |
| Wood tie dimensions                            |            |           |            |       |                                       |
| width  | m          | 0,2       |            |       |                                       |
| depth  | m          | 0,15      |            |       |                                       |
| length   | m          | 2,6       |            |       |                                       |
| volume   | m3         | 0,078     |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$ 40.000 |            |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |           |            |       |                                       |
| Total Track Length                             | m          | 36.000    |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 60.000    |            |       |                                       |
| Ballast volume                                 | m3         | 163.680   |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 294.624   |            |       |                                       |

### Construction Costs

| Item                                   | Unit | Qty       | Price/Rate   | Total                | Comments   |
|--|------|-----------|--------------|----------------------|--|
| <b>Track Laying on Formation</b>       |      |           |              |                      |  |
| Survey                                 | Ha   | 260       | \$ 3.000,00  | \$ 780.000           | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea   | 26        | \$ 2.400,00  | \$ 62.400            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 39        | \$ 14.820,00 | \$ 577.980           | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 6.000.000 | \$ 1,10      | \$ 6.592.073         | Cut + Fill Volumes   |
| Ballast                                | t    | 294.624   | \$ 34,00     | \$ 10.017.216        | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 60.000    | \$ 58,00     | \$ 3.480.000         |  |
| Tie plates                             | ea   | 120.000   | \$ 8,60      | \$ 1.032.000         |  |
| 132lb Rail                             | m    | 72.000    | \$ 62,34     | \$ 4.488.189         |  |
| Track spikes                           | ea   | 240.000   | \$ 6,26      | \$ 1.502.400         |  |
| Rail anchors                           | ea   | 120.000   | \$ 5,90      | \$ 708.000           | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15        | \$ 30.000,00 | \$ 450.000           |  |
| <b>Total Cost - Track on Formation</b> |      |           |              | <b>\$ 29.690.258</b> |  |
| <b>Unit Cost per km</b>                |      |           |              | <b>824.800</b>       |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2.000.000,00 | \$ 2.000.000 |  |
| Culvert - crossings |      | 45  |                 |              |  |
| Pipe (Class 5)      | ea   | 180 | \$ 23.580,58    | \$ 4.244.504 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 90  | \$ 4.703,60     | \$ 423.324   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1.819,00     | \$ 12.733    | Assume 8m-wide roadway                                     |

|  |  |  |  |                      |  |
|--|--|--|--|----------------------|--|
| <b>Total Cost - Formation + Track Laying</b> |  |  |  | <b>\$ 29.690.258</b> |  |
| <b>Total Cost - Railway Structures</b>       |  |  |  | <b>\$ 6.680.561</b>  |  |
| <b>Total Cost - Railway Construction</b>     |  |  |  | <b>\$ 36.370.819</b> |  |

## MATERIAL TRANSPORTATION

| Item  | Unit     | Qty        | Price/Rate | Total | Comments   |
|---|----------|------------|------------|-------|--|
| <b>General Parameters</b>                                   |          |            |            |       |  |
| Total Material to be Hauled                                 | m3       | 90.155.000 |            |       |  |
| Time to transport material                                  | year     | 5,5        |            |       |  |
| Working Days  | day/year | 345        |            |       |  |
| Total Working Days  | day      | 1.898      |            |       |  |
| Calculated Target Production (total material/working days)  | m3/day   | 47.513     |            |       |  |
| ACP Production Rate - Wet                                   | m3/day   | 4.522      |            |       | based on published average production rate of 30,000m3/week  |
| ACP Production Rate - Dry                                   | m3/day   | 22.609     |            |       | based on published average production rate of 150,000m3/week |
| Working Hours per day                                       | hr       | 24,0       |            |       |  |
| <b>Equipment Parameters</b>                                 |          |            |            |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |          |            |            |       |  |
| Single Bucket Capacity                                      | m3       | 17,0       |            |       |  |
| Bucket Fill Factor  | no.      | 55%        |            |       |  |
| Factored Bucket Capacity                                    | m3       | 9,35       |            |       |  |
| Bucket Cycle Time   | sec      | 30,0       |            |       |  |
| Production Rate for Excavator                               | m3/hr    | 1122,0     |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Excavator                            | m3/day   | 26.928,00  |            |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>      | no.      | 2,0        |            |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>                 | m3/hr    | 2.244,0    |            |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |          |            |            |       |  |
| Single Bucket Capacity                                      | m3       | 20,0       |            |       |  |
| Bucket Fill Factor  | no.      | 70%        |            |       |  |
| Factored Bucket Capacity                                    | m3       | 14         |            |       |  |
| Dig/Load Cycle Time   | sec      | 45,0       |            |       |  |
| Production Rate for Loader                                  | m3/hr    | 1120,0     |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Loader                               | m3/day   | 26.880,00  |            |       |  |
| <b>No. Loaders Required to maintain Target Rate</b>         | no.      | 2,0        |            |       |  |
| <b>Hourly Loading Rate for 2 Loaders</b>                    | m3/hr    | 2.240,0    |            |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>             |          |            |            |       |  |

|   |     |           |  |
|---|-----|-----------|--|
| Truck Capacity (Max.)                     | m3  | 105,0     |  |
| Truck Capacity (Struck)                   | m3  | 73        |  |
| Total Truck Trips Required to Meet Target | no. | 1,235,000 |  |
| Calculated truck trips per day            | no. | 651,0     |  |
| Max. load/unload time per truck *         | hr  | 0,037     | Note: logistics check, indicates maximum in order to maintain production |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

#### Trains

|   |          |       |   |
|---|----------|-------|---|
| Rail Car Capacity                           | m3       | 40    |   |
| Rail Cars Per Train                         | no.      | 50    |   |
| Locos per Train                             | no.      | 2     | Ruling Grade @ 1.5%                                 |
| Total Train Capacity                        | m3       | 2,000 |   |
| Train Trips Required Per Day to Meet Target | no.      | 24    | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *           | hr/train | 1,008 | Note: logistics check                               |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

#### Truck Transportation Cycle

|   |            |             |  |
|---|------------|-------------|--|
| Average one-way distance (excavation to stockpile)      | km         | 1,0         | Source: site plan                      |
| Average Truck Travel Speed                              |            | 25          |  |
| Estimated Load Time                                     | hr         | 0,033       | 2 minutes                              |
| Estimated Travel Time (Round Trip)                      | hr         | 0,080       | Calculated round-trip distance of 2 km |
| Estimated Unload Time                                   | hr         | 0,017       | 1 minutes per truck                    |
| <b>Total Cycle Time</b>                                 | <b>hr</b>  | <b>0,13</b> |  |
| Calculated Trips Per Truck per Day                      | no.        | 185,8       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b> | <b>no.</b> | <b>4,0</b>  |  |

#### Rail Transportation Cycle

|  |            |              |   |
|--|------------|--------------|---|
| Avg. track distance (material transfer to disposal site) | km         | 13,0         |   |
| Average Train Speed                                      | km/hr      | 15           | factors included for train movements and delays                     |
| Time to Load Train                                       | hr         | 0,89         |   |
| Average Travel Time (Round Trip)                         | hr         | 1,73         |   |
| Time to Unload Train                                     | hr         | 0,83         | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | <b>hr</b>  | <b>3,46</b>  |   |
| No. trains loading/dumping simultaneously                | no.        | 0,80         | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.        | 6,9          |   |
| <b>No. of Train Consists Required</b>                    | <b>no.</b> | <b>4,0</b>   |   |
| <b>No. Rail Cars Required</b>                            | <b>no.</b> | <b>200,0</b> |   |
| <b>No. Locos Required</b>                                | <b>no.</b> | <b>8,0</b>   |   |

#### Equipment Costs

|   |        |               |              |
|---|--------|---------------|--------------|
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |        |               |              |
| Hourly Rate   | \$/hr  | \$ 592,95     |              |
| Daily Rate per Excavator                                    | \$/day | \$ 14,231     | 24 pay hours |
| Daily Rate for 2 Excavators                                 | \$/day | 2,0 \$ 28,461 |              |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b> |        |               |              |
| Hourly Rate   | \$/hr  | \$ 275,00     | confirm rate |
| Daily Rate per truck  | \$/day | \$ 6,600      | 24 pay hours |
| Daily Rate for 4 trucks                                     | \$/day | 4,0 \$ 26,400 |              |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |        |               |              |
| Hourly Rate   | \$/hr  | \$ 600,00     | confirm rate |
| Daily Rate per loader                                       | \$/day | \$ 14,400     | 24 pay hours |
| Daily Rate for 2 loaders                                    | \$/day | 2,0 \$ 28,800 |              |

#### Rollingstock

|  |             |              |                  |
|--|-------------|--------------|------------------|
| Locomotive - Purchase Cost                 | ea          | \$ 2,200,000 | Research results |
| Locomotive - Salvage Value (@ 20%)         | ea          | \$ 440,000   | Research results |
| Side-dump rail car - Purchase Cost         | ea          | \$ 80,000    | Research results |
| Side-dump rail car - Salvage Value (@ 20%) | ea          | \$ 16,000    | Research results |
| Locomotive operational cost                | \$/day/unit | \$ 1,500     | Research results |
| Locomotive maintenance cost                | \$/day/unit | \$ 1,000     | Research results |
| Rail car maintenance cost                  | \$/day/unit | \$ 100       | Research results |

#### Railway Operation and Maintenance Costs

|  |           |        |                 |
|--|-----------|--------|-----------------|
| <b>Rollingstock</b>                      |           |        |                 |
| Daily Operations Cost for 8 Locos        | \$/day    | 8 \$   | 12,000          |
| Daily Maintenance Cost for 8 Locos       | \$/day    | 8 \$   | 8,000           |
| Daily Maintenance Cost for 200 Rail Cars | \$/day    | 200 \$ | 20,000          |
| <b>Track</b>                             |           |        |                 |
| No. Mainline Tracks                      | no.       | 2      |                 |
| Daily maintenance cost                   | \$/km/day | 26 \$  | 100,00 \$ 2,600 |

#### Haul Roads

|  |           |                |
|--|-----------|----------------|
| Construction Cost per km                     | \$/km     | \$250,000,00   |
| Maintenance Cost per km per day              | \$/km/day | \$1,000,00     |
| Daily maintenance cost for 1 km of haul road | \$/day    | 1,0 \$1,000,00 |

#### Conveyors

|                                |        |               |
|--------------------------------|--------|---------------|
| Maintenance and operation      | \$/km  | \$4,000,00    |
| Daily cost for 5km of conveyor | \$/day | 5 \$20,000,00 |

#### Transportation Costs

| Item                             | Unit     | Qty           | Price/Rate    | Total          | Comments  |
|----------------------------------|----------|---------------|---------------|----------------|---|
| <b>Equipment and Operation</b>   |          |               |               |                |   |
| 41.5m3 Truck(s)                  | no.      | 1,898         | \$ 26,400     | \$ 50,094,000  |   |
| 20m3 Front End Loader            | no.      | 1,898         | \$ 28,800     | \$ 54,648,000  |   |
| Conveyor/Railcar Loading Systems | LS       | 1             | \$ 43,000,000 | \$ 43,000,000  | Source: EDC report April 2003                             |
| Railcar dumpers (disposal site)  | no.      | 2             | \$ 2,000,000  | \$ 4,000,000   | Source: EDC report April 2003                             |
| Railway Equipment/Operation      | tonne.km | 1,992,425,500 | \$ 0,070      | \$ 139,469,785 | ** Cost comparison provided by 'Rollingstock Costs' below |

|                                    |     |       |    |            |    |            |
|------------------------------------|-----|-------|----|------------|----|------------|
| Railway Construction               | LS  | 1     | \$ | 36.370.819 | \$ | 36.370.819 |
| Track Maintenance                  | day | 1.898 | \$ | 2.600      | \$ | 4.933.500  |
| <b>Transfer Station</b>            |     |       |    |            |    |            |
| Railcar dumper + stacker conveyor  | no. | 2     | \$ | 3.000.000  | \$ | 6.000.000  |
| <b>Haul Roads and Conveyor</b>     |     |       |    |            |    |            |
| Haul Road Construction             | km  | 1,0   | \$ | 250.000    | \$ | 250.000    |
| Haul Road Maintenance              | day | 1.898 | \$ | 1.000      | \$ | 1.897.500  |
| Conveyor maintenance and operation | day | 1.898 | \$ | 20.000     | \$ | 37.950.000 |

|   |                      |
|---|----------------------|
| <b>Total Cost - Material Transportation</b>     | <b>\$378.613.604</b> |
| <b>Unit cost of transport per m<sup>3</sup></b> | <b>\$4,20</b>        |

**\*\*Rollingstock Costs**

| Item                               | Unit | Qty  | Price/Rate   | Comments                                |
|------------------------------------|------|------|--------------|---|
| <b>Rollingstock Purchase Costs</b> |      |      |              |   |
| Locomotives                        | no.  | 10   | \$ 2.200.000 | \$ 22.000.000 Includes backup loco(s)   |
| Rail cars                          | no.  | 210  | \$ 80.000    | \$ 16.800.000 Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |      |              |   |
| Operational cost of locomotives    | day  | 1898 | \$ 12.000    | \$ 22.770.000                           |
| Maintenance cost of locomotives    | day  | 1898 | \$ 8.000     | \$ 15.180.000                           |
| Maintenance cost of rail cars      | day  | 1898 | \$ 20.000    | \$ 37.950.000                           |
| <b>Salvage Value</b>               |      |      |              |   |
| Locomotives                        | no.  | 10   | \$ 440.000   | \$ (4.400.000)                          |
| Rail cars                          | no.  | 210  | \$ 16.000    | \$ (3.360.000)                          |

|                                     |                      |
|-------------------------------------|----------------------|
| <b>** Total Cost - Rollingstock</b> | <b>\$106.940.000</b> |
|-------------------------------------|----------------------|

## Backup Calculations

### Project Specifications - Truck Haul to M5

| Item   | Unit         | Qty            | Price/Rate  | Total | Comments   |
|--|--------------|----------------|-------------|-------|--|
| Cells requiring user input are highlighted thus:   |              |                |             |       |  |
| <b>General Parameters</b>  |              |                |             |       |  |
| Total Material to be Hauled by Truck (Third Locks Excavation)  | m3           | 90.155.000     |             |       |  |
| Time to transport material by truck  | year         | 7,80           |             |       |  |
| Working Days per Year  | day/year     | 345            |             |       |  |
| Total Working Days - Third Locks Material  | day          | 2.691          |             |       |  |
| Calculated Target Production - dry excavation  | m3/day       | 33.503         |             |       |  |
| ACP Production Rate - Dry  | m3/day       | 22.609         |             |       | based on published average production rate of 150,000m3      |
| Working Hours per day  | hr           | 24             |             |       |  |
| <b>Equipment Parameters</b>  |              |                |             |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |              |                |             |       |  |
| Single Bucket Capacity   | m3           | 17,0           |             |       | Excavation site material removal - cost not included         |
| Bucket Fill Factor   | no.          | 55%            |             |       |  |
| Factored Bucket Capacity   | m3           | 9,35           |             |       |  |
| Bucket Cycle Time  | sec          | 30,0           |             |       |  |
| Production Rate for Excavator  | m3/hr        | 1122,0         |             |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Excavator   | m3/day       | 26.928,00      |             |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>   | <b>no.</b>   | <b>2,0</b>     |             |       |  |
| <b>Hourly Loading Rate for 2 Excavator(s)</b>  | <b>m3/hr</b> | <b>2.244,0</b> |             |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |             |       |  |
| Single Bucket Capacity   | m3           | 20,0           |             |       | Intermediate transfer to ensure continuous removal from e.   |
| Bucket Fill Factor   | no.          | 70%            |             |       |  |
| Factored Bucket Capacity   | m3           | 14             |             |       |  |
| Dig/Load Cycle Time  | sec          | 45,0           |             |       |  |
| Production Rate for Loader   | m3/hr        | 1120,0         |             |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Loader  | m3/day       | 26.880,00      |             |       |  |
| <b>No. Loaders Required to maintain Target Rate</b>  | <b>no.</b>   | <b>2,0</b>     |             |       |  |
| <b>Hourly Loading Rate for 2 Loaders</b>   | <b>m3/hr</b> | <b>2.240,0</b> |             |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |             |       |  |
| Truck Capacity (Max.)  | m3           | 105            |             |       |  |
| Truck Capacity (Struck)  | m3           | 73             |             |       |  |
| Total Truck Trips Required to Meet Target  | no.          | 1.235.000      |             |       |  |
| Calculated truck trips per day   | no.          | 459,0          |             |       |  |
| Max. load/unload time per truck *  | hr           | 0,052          |             |       | Note: logistics check  |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |             |       |  |
| <b>Truck Transportation Cycle</b>  |              |                |             |       |  |
| Average one-way distance (excavation site to disposal site)  | km           | 13,0           |             |       | Source: site plan  |
| Average Truck Travel Speed   |              | 30             |             |       |  |
| Estimated Load Time  | hr           | 0,033          |             |       | 2 minutes  |
| Estimated Travel Time (Round Trip)   | hr           | 0,867          |             |       | Calculated round-trip distance of 26 km                      |
| Estimated Unload Time  | hr           | 0,050          |             |       | 3 minutes  |
| <b>Total Cycle Time</b>  | <b>hr</b>    | <b>0,95</b>    |             |       |  |
| Calculated Trips Per Truck per Day   | no.          | 25,3           |             |       |  |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b>   | <b>19,0</b>    |             |       |  |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b>   | <b>5,0</b>     |             |       | Arbitrary no. used to maintain continuous flow at transfer s |
| <b>Equipment Costs</b>   |              |                |             |       |  |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |             |       |  |
| Hourly Rate  | \$/hr        |                | \$ 331,45   |       |  |
| Daily Rate per truck   | \$/day       |                | \$ 7.955    |       | 24 pay hours per day   |
| Daily Rate for 19 trucks   | \$/day       | 19,00          | \$ 151.139  |       |  |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |              |                |             |       |  |
| Hourly Rate  | \$/hr        |                | \$ 275,00   |       |  |
| Daily Rate per truck   | \$/day       |                | \$ 6.600    |       | 24 pay hours   |
| Daily Rate for 5 trucks  | \$/day       | 5,0            | \$ 33.000   |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |             |       |  |
| Hourly Rate  | \$/hr        |                | \$ 600,00   |       |  |
| Daily Rate per loader  | \$/day       |                | \$ 14.400   |       | 24 pay hours   |
| Daily Rate for 2 trucks  | \$/day       | 2,0            | \$ 28.800   |       |  |
| <b>Haul Roads</b>  |              |                |             |       |  |
| Construction Cost per km   | \$/km        |                | #####       |       |  |
| Maintenance Cost per km per day  | \$/km/day    |                | \$1.000,00  |       |  |
| Maintenance Cost per day   | \$/day       | 13,0           | \$13.000,00 |       |  |
| <b>Conveyors</b>   |              |                |             |       |  |
| Maintenance and operation  | \$/km        |                | \$4.000,00  |       |  |

Daily cost for 1 km of conveyor

\$/day

1

\$4,000,00

**Transportation Costs**

| Item                               | Unit | Qty     | Price/Rate | Total | Comments |
|------------------------------------|------|---------|------------|-------|----------|
| <b>Dry Material</b>                |      |         |            |       |          |
| <b>Equipment</b>                   |      |         |            |       |          |
| 105m3 Off-Road Trucks              | day  | 2,691,0 | \$ 151.139 | ##### |          |
| 41.5m3 Off-Road Trucks             | day  | 2,691,0 | \$ 33.000  | ##### |          |
| 20m3 Front End Loader              | day  | 2,691,0 | \$ 28.800  | ##### |          |
| <b>Haul Roads and Conveyor</b>     |      |         |            |       |          |
| Haul Road Construction             | km   | 13,0    | \$ 14.400  | ##### |          |
| Haul Road Maintenance              | day  | 2,691,0 | \$ 13.000  | ##### |          |
| Conveyor maintenance and operation | day  | 2,691,0 | \$ 4.000   | ##### |          |

**Total Cost - Material Transportation**

#####

**Unit cost of truck haul per m<sup>3</sup>**

**\$6,87**

## Backup Calculations

### Project Specifications - Truck and Scow Haul to M5

| Item   | Unit         | Qty            | Price/Rate | Total | Comments  |
|--|--------------|----------------|------------|-------|---|
| Cells requiring user input are highlighted thus:   |              |                |            |       |   |
| <b>General Parameters</b>  |              |                |            |       |   |
| Total Material to be Hauled by Truck (Third Locks Excavation)  | m3           | 90,155,000     |            |       |   |
| Time to transport material by truck  | year         | 10,50          |            |       |   |
| Working Days per Year  | day/year     | 345            |            |       |   |
| Total Working Days - Third Locks Material  | day          | 3,623          |            |       |   |
| Calculated Target Production - dry excavation  | m3/day       | 24,888         |            |       |   |
| ACP Production Rate - Dry  | m3/day       | 22,609         |            |       | based on published average production rate of 150,000m3/week            |
| Working Hours per day  | hr           | 24             |            |       |   |
| <b>Equipment Parameters</b>  |              |                |            |       |   |
| <b>3000m3 Scow</b>   |              |                |            |       |   |
| Scow Capacity  | m3           | 1,800          |            |       | Assume 60% fill factor  |
| Total scow trips required to move third locks material   | no.          | 50,087         |            |       |   |
| Scow/Tug trips required per day - third locks  | no.          | 13,83          |            |       |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |              |                |            |       |   |
| Single Bucket Capacity   | m3           | 17,0           |            |       | Excavation site material removal - cost not included                    |
| Bucket Fill Factor   | no.          | 55%            |            |       |   |
| Factored Bucket Capacity   | m3           | 9,35           |            |       |   |
| Bucket Cycle Time  | sec          | 30,0           |            |       |   |
| Production Rate for Excavator  | m3/hr        | 1122,0         |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Excavator   | m3/day       | 26,928,00      |            |       |   |
| <b>No. Excavators Required to maintain Target Rate</b>   | <b>no.</b>   | <b>1,0</b>     |            |       |   |
| <b>Hourly Loading Rate for 1 Excavator(s)</b>  | <b>m3/hr</b> | <b>1,122,0</b> |            |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Single Bucket Capacity   | m3           | 20,0           |            |       | Intermediate transfer to ensure continuous removal from excavation site |
| Bucket Fill Factor   | no.          | 70%            |            |       |   |
| Factored Bucket Capacity   | m3           | 14             |            |       |   |
| Dig/Load Cycle Time  | sec          | 45,0           |            |       |   |
| Production Rate for Loader   | m3/hr        | 1120,0         |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Loader  | m3/day       | 26,880,00      |            |       |   |
| <b>No. Loaders Required to maintain Target Rate</b>  | <b>no.</b>   | <b>1,0</b>     |            |       |   |
| <b>Hourly Loading Rate for 1 Loaders</b>   | <b>m3/hr</b> | <b>1,120,0</b> |            |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |            |       |   |
| Truck Capacity (Max.)  | m3           | 105            |            |       |   |
| Truck Capacity (Struck)  | m3           | 73             |            |       |   |
| Total Truck Trips Required to Meet Target  | no.          | 1,235,000      |            |       |   |
| Calculated truck trips per day   | no.          | 341,0          |            |       |   |
| Max. load/unload time per truck *  | hr           | 0,070          |            |       | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |            |       |   |
| <b>Truck Transportation Cycle</b>  |              |                |            |       |   |
| Average one-way distance (excavation site to transfer station)   | km           | 4,5            |            |       | Source: site plan   |
| Average Truck Travel Speed   |              | 30             |            |       |   |
| Estimated Load Time  | hr           | 0,065          |            |       | 3.9 minutes   |
| Estimated Travel Time (Round Trip)   | hr           | 0,300          |            |       | Calculated round-trip distance of 9 km                                  |
| Estimated Unload Time  | hr           | 0,050          |            |       | 3 minutes   |
| <b>Total Cycle Time</b>  | <b>hr</b>    | <b>0,42</b>    |            |       |   |
| Calculated Trips Per Truck per Day   | no.          | 57,8           |            |       |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b>   | <b>6,0</b>     |            |       |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b>   | <b>2,0</b>     |            |       | Arbitrary no. used to maintain continuous flow at transfer station      |
| <b>Scow Transportation Cycle</b>   |              |                |            |       |   |
| Average one-way distance (transfer station to disposal site)   | km           | 21,0           |            |       | Transfer to disposal  |
| Average Scow/Tug Travel Speed  | km/hr        | 9              |            |       | Ref: site plan  |
| Time to Load Scow  | hr           | 1,00           |            |       |   |
| Average Travel Time (round Trip)   | hr           | 4,67           |            |       |   |
| Time to Berth and Dump Scow  | hr           | 0,50           |            |       |   |
| <b>Total trip cycle time</b>   | <b>hr</b>    | <b>6,17</b>    |            |       |   |
| Max scow trips per day (assuming 24 operating hours)   | no.          | 3,89           |            |       |   |
| <b>No. Scow(s) required</b>  | <b>no.</b>   | <b>5,0</b>     |            |       |   |
| <b>No. Tow Tug(s) required</b>   | <b>no.</b>   | <b>4,0</b>     |            |       | Tug estimate based on cycle time  |
| <b>Equipment Costs</b>   |              |                |            |       |   |
| <b>Scow/Tugs</b>   |              |                |            |       |   |
| 3000m3 scow (includes labor and operating costs)   | \$/day       |                | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| 3000HP towing tug (includes labor and operating costs)   | \$/day       |                | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| Third locks material   |              |                |            |       |   |
| Total cost for 5 scow(s)   | \$/day       | 5,00           | \$ 11,663  |       |   |
| Total cost for 4 tow tug(s)  | \$/day       | 4,00           | \$ 36,140  |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 331,45  |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 7,955   |       | 24 pay hours per day  |
| Daily Rate for 6 trucks  | \$/day       | 6,00           | \$ 47,728  |       |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 275,00  |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 6,600   |       | 24 pay hours  |
| Daily Rate for 2 trucks  | \$/day       | 2,0            | \$ 13,200  |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 600,00  |       |   |
| Daily Rate per loader  | \$/day       |                | \$ 14,400  |       | 24 pay hours  |

|                         |        |     |    |        |
|-------------------------|--------|-----|----|--------|
| Daily Rate for 1 loader | \$/day | 1,0 | \$ | 14.400 |
|-------------------------|--------|-----|----|--------|

**Haul Roads**

|  |           |     |  |              |
|--|-----------|-----|--|--------------|
| Construction Cost per km                       | \$/km     |     |  | \$250.000,00 |
| Maintenance Cost per km per day                | \$/km/day |     |  | \$1.000,00   |
| Daily maintenance cost for 4.5 km of haul road | \$/day    | 4,5 |  | \$4.500,00   |

**Conveyors**

|                                 |        |   |  |            |
|---------------------------------|--------|---|--|------------|
| Maintenance and operation       | \$/km  |   |  | \$4.000,00 |
| Daily cost for 1 km of conveyor | \$/day | 1 |  | \$4.000,00 |

**Transportation Costs**

| Item                               | Unit | Qty     | Price/Rate   | Total          | Comments |
|------------------------------------|------|---------|--------------|----------------|----------|
| <b>Equipment</b>                   |      |         |              |                |          |
| 105m3 Off-Road Trucks              | day  | 3.622,5 | \$ 47.728    | \$ 172.895.491 |          |
| 41.5m3 Off-Road Trucks             | day  | 3.622,5 | \$ 13.200    | \$ 47.817.000  |          |
| 20m3 Front End Loader              | day  | 3.622,5 | \$ 14.400    | \$ 52.164.000  |          |
| 3000m3 Scow                        | day  | 3.622,5 | \$ 11.663    | \$ 42.250.103  |          |
| 3000HP Tug                         | day  | 3.622,5 | \$ 36.140    | \$ 130.915.811 |          |
| <b>Transfer Station</b>            |      |         |              |                |          |
| Receival Hopper + Stacker Conveyor | LS   | 1,0     | \$ 1.500.000 | \$ 1.500.000   |          |
| Berth Structure                    | m2   | 2.000,0 | \$ 1.300     | \$ 2.600.000   |          |
| <b>Haul Roads and Conveyor</b>     |      |         |              |                |          |
| Haul Road Construction             | km   | 4,5     | \$ 250.000   | \$ 1.125.000   |          |
| Haul Road Maintenance              | day  | 3.622,5 | \$ 4.500     | \$ 16.301.250  |          |
| Conveyor maintenance and operation | day  | 3.622,5 | \$ 4.000     | \$ 14.490.000  |          |

|   |                      |
|---|----------------------|
| <b>Total Cost - Material Transportation</b>               | <b>\$482.058.655</b> |
| <b>Unit cost of truck and scow haul per m<sup>3</sup></b> | <b>\$5,35</b>        |

## Backup Calculations

### Project Specifications - Scow Haul to M6

| Item   | Unit     | Qty        | Price/Rate | Total | Comments   |
|--|----------|------------|------------|-------|--|
| Cells requiring user input are highlighted thus:         |          |            |            |       |  |
| <b>General Parameters</b>                                |          |            |            |       |  |
| Total Material to be Hauled by Scow (Entrance Deepening) | m3       | 14,315,000 |            |       |  |
| Time to transport material by scow                       | year     | 3,25       |            |       |  |
| Working Days per Year                                    | day/year | 345        |            |       |  |
| Total Working Days - Scow                                | day      | 1,121      |            |       |  |
| Calculated Target Production - scow                      | m3/day   | 12,768     |            |       |  |
| ACP Daily Production Rate - Wet                          | m3/day   | 4,522      |            |       | based on published production rate (weighted) of 94,800m3/week |
| ACP Hourly Production Rate - Wet                         | m3/hr    | 188        |            |       | based on published production rate (weighted) of 94,800m3/week |
| Working Hours per day                                    | hr       | 24         |            |       |  |
| <b>Equipment Parameters</b>                              |          |            |            |       |  |
| <b>3000m3 Scow</b>                                       |          |            |            |       |  |
| Scow Capacity  |          | 3,000      |            |       |  |
| Fill Factor  |          | 60%        |            |       |  |
| Scow Capacity  | m3       | 1,800      |            |       | Assume 60% fill factor   |
| Total scow trips required to move all material           | no.      | 7,953      |            |       |  |
| Scow/Tug trips required per day                          | no.      | 7,09       |            |       |  |
| <b>41m3 Clamshell Bucket Dredge</b>                      |          |            |            |       |  |
| Single Bucket Capacity                                   | m3       | 41,3       |            |       |  |
| Bucket Fill Factor                                       | no.      | 45%        |            |       |  |
| Factored Bucket Capacity                                 | m3       | 18,585     |            |       |  |
| Bucket Cycle Time  | sec      | 120        |            |       |  |
| Production Rate for clamshell + crane                    | m3/hr    | 557,55     |            |       |  |
| Daily Loading Rate (hourly rate x working hours)         | m3/day   | 13,381,20  |            |       | Compares with CEDEP (Corps of Engineers cost model)            |
| No. Clamshell(s) Required to maintain Target Rate        | no.      | 1,0        |            |       |  |
| Hourly Loading Rate for 1 clamshell(s)                   | m3/hr    | 557,6      |            |       |  |
| <b>Scow Transportation Cycle</b>                         |          |            |            |       |  |
| Average one-way distance (dredge to unloading station)   | km       | 24,0       |            |       | Assume scows loaded by 41m3 clamshell dredge                   |
| Average Scow/Tug Travel Speed                            | km/hr    | 9          |            |       | Ref: site plan   |
| Time to Load Scow  | hr       | 3,23       |            |       |  |
| Average Travel Time (round Trip)                         | hr       | 5,33       |            |       |  |
| Factor for maneuvering and dumping scow                  | hr       | 0,50       |            |       |  |
| Total trip cycle time                                    | hr       | 9,06       |            |       |  |
| Max scow trips per day (assuming 24 operating hours)     | no.      | 2,65       |            |       |  |
| No. Scow(s) required                                     | no.      | 4,0        |            |       |  |
| No. Tow Tug(s) required                                  | no.      | 2,0        |            |       | Tug estimate based on cycle time                               |
| <b>Equipment Costs</b>                                   |          |            |            |       |  |
| <b>Scow/Tugs</b>   |          |            |            |       |  |
| 3000m3 scow (includes labor and operating costs)         | \$/day   |            | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30,4375     |
| 3000HP towing tug (includes labor and operating costs)   | \$/day   |            | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30,4375     |
| Total cost for 4 scow(s)                                 | \$/day   | 4,00       | \$ 9,331   |       |  |
| Total cost for 2 tow tug(s)                              | \$/day   | 2,00       | \$ 18,070  |       |  |

### Transportation Costs

| Item             | Unit | Qty     | Price/Rate | Total         | Comments |
|------------------|------|---------|------------|---------------|----------|
| <b>Equipment</b> |      |         |            |               |          |
| 3000m3 Scow      | day  | 1,121,3 | \$ 9,331   | \$ 10,461,930 |          |
| 3000HP Tug       | day  | 1,121,3 | \$ 18,070  | \$ 20,260,780 |          |

**Total Cost - Material Transportation (Wet)** **\$30,722,710**

**Unit cost of scow haul per m<sup>3</sup>** **\$2,15**

## Backup Calculations

### Project Specifications - Train/Scow Haul to M6

| Item   | Unit       | Qty     | Price/Rate | Total | Comments                              |
|--|------------|---------|------------|-------|---------------------------------------|
| <b>Railway Construction Data</b>               |            |         |            |       |                                       |
| Formation (Section) Length                     | m          | 9000    |            |       |                                       |
| No. main-line tracks (Standard Gauge - 1435mm) | no.        | 2       |            |       |                                       |
| Formation cut volume                           | m3         | 2000000 |            |       |                                       |
| Formation fill volume                          | m3         | 3000000 |            |       |                                       |
| Width at Base of Formation                     | m          | 30      |            |       | Estimated average base width          |
| Ballast Depth (top of tie to formation)        | m          | 0,6     |            |       |                                       |
| Ballast Width                                  | m          | 6       |            |       |                                       |
| Spacing of ties                                | m          | 0,6     |            |       |                                       |
| Wood tie dimensions                            |            |         |            |       |                                       |
| width  | m          | 0,2     |            |       |                                       |
| depth  | m          | 0,15    |            |       |                                       |
| length   | m          | 2,6     |            |       |                                       |
| volume   | m3         | 0,078   |            |       |                                       |
| Annual Maintenance                             | \$/year/km | \$      | 40.000     |       | Factored from 1993/94 Westrail data   |
| <b>Quantity Calculations</b>                   |            |         |            |       |                                       |
| Total Track Length                             | m          | 28.000  |            |       | Includes 10,000m for marshalling yard |
| Total no. ties                                 | no.        | 46.667  |            |       |                                       |
| Ballast volume                                 | m3         | 135.440 |            |       |                                       |
| Ballast mass @ 1.8 t/m3                        | t          | 243.792 |            |       |                                       |

### Construction Costs

| Item                                   | Unit | Qty       | Price/Rate   | Total                | Comments   |
|--|------|-----------|--------------|----------------------|--|
| <b>Track Laying on Formation</b>       |      |           |              |                      |  |
| Survey                                 | Ha   | 180       | \$ 3.000,00  | \$ 540.000           | 200m Corridor to shoreline, guesstimate                          |
| Boreholes                              | ea   | 18        | \$ 2.400,00  | \$ 43.200            | Assuming 20m deep @ \$120 per metre (\$35 per foot) - every 500m |
| Clearing and Stripping                 | Ha   | 27        | \$ 14.820,00 | \$ 400.140           | Assume \$6000 per Acre   |
| Formation/Roadbed Earthworks           | m3   | 5.000.000 | \$ 1,10      | \$ 5.493.394         | Cut + Fill Volumes   |
| Ballast                                | t    | 243.792   | \$ 34,00     | \$ 8.288.928         | Cut + Fill Volumes   |
| Treated Wood Ties                      | ea   | 46.667    | \$ 58,00     | \$ 2.706.667         |  |
| Tie plates                             | ea   | 93.334    | \$ 8,60      | \$ 802.672           |  |
| 132lb Rail                             | m    | 56.000    | \$ 62,34     | \$ 3.490.814         |  |
| Track spikes                           | ea   | 186.667   | \$ 6,26      | \$ 1.168.533         |  |
| Rail anchors                           | ea   | 93.333    | \$ 5,90      | \$ 550.667           | Anchor pattern: 1 tie in 2                                       |
| Turnout (#10)                          | ea   | 15        | \$ 30.000,00 | \$ 450.000           |  |
| <b>Total Cost - Track on Formation</b> |      |           |              | <b>\$ 23.935.015</b> |  |
| <b>Unit Cost per km</b>                |      |           |              | <b>854.900</b>       |  |

| Item                | Unit | Qty | Price/Rate      | Total        | Comments   |
|---------------------|------|-----|-----------------|--------------|--|
| <b>Structures</b>   |      |     |                 |              |  |
| Bridges             | ea   | 1   | \$ 2.000.000,00 | \$ 2.000.000 |  |
| Culvert - crossings |      | 45  |                 |              |  |
| Pipe (Class 5)      | ea   | 180 | \$ 23.580,58    | \$ 4.244.504 | Assume 30m long at each location using 4 x 1.8m (72") pipe |
| Headwall            | ea   | 90  | \$ 4.703,60     | \$ 423.324   | Assume 1.8m (72") dia pipe                                 |
| Rail Crossings      | ea   | 7   | \$ 1.819,00     | \$ 12.733    | Assume 8m-wide roadway                                     |

|  |                      |
|--|----------------------|
| <b>Total Cost - Formation + Track Laying</b> | <b>\$ 23.935.015</b> |
| <b>Total Cost - Railway Structures</b>       | <b>\$ 6.680.561</b>  |
| <b>Total Cost - Railway Construction</b>     | <b>\$ 30.615.576</b> |

## MATERIAL TRANSPORTATION

| Item  | Unit     | Qty        | Price/Rate | Total | Comments   |
|---|----------|------------|------------|-------|--|
| <b>General Parameters</b>                                   |          |            |            |       |  |
| Total Material to be Hauled                                 | m3       | 90.155.000 |            |       |  |
| Time to transport material                                  | year     | 7,5        |            |       |  |
| Working Days  | day/year | 345        |            |       |  |
| Total Working Days  | day      | 2.588      |            |       |  |
| Calculated Target Production (total material/working days)  | m3/day   | 34.843     |            |       |  |
| ACP Production Rate - Wet                                   | m3/day   | 4.522      |            |       | based on published average production rate of 30,000m3/week  |
| ACP Production Rate - Dry                                   | m3/day   | 22.609     |            |       | based on published average production rate of 150,000m3/week |
| Working Hours per day                                       | hr       | 24,0       |            |       |  |
| <b>Equipment Parameters</b>                                 |          |            |            |       |  |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>        |          |            |            |       |  |
| Single Bucket Capacity                                      | m3       | 17,0       |            |       |  |
| Bucket Fill Factor  | no.      | 55%        |            |       |  |
| Factored Bucket Capacity                                    | m3       | 9,35       |            |       |  |
| Bucket Cycle Time   | sec      | 30,0       |            |       |  |
| Production Rate for Excavator                               | m3/hr    | 1122,0     |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Excavator                            | m3/day   | 26.928,00  |            |       |  |
| <b>No. Excavators Required to maintain Target Rate</b>      | no.      | 2,0        |            |       |  |
| <b>Hourly Loading Rate for 2 Excavators</b>                 | m3/hr    | 2.244,0    |            |       |  |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b> |          |            |            |       |  |
| Single Bucket Capacity                                      | m3       | 20,0       |            |       |  |
| Bucket Fill Factor  | no.      | 70%        |            |       |  |
| Factored Bucket Capacity                                    | m3       | 14         |            |       |  |
| Dig/Load Cycle Time   | sec      | 45,0       |            |       |  |
| Production Rate for Loader                                  | m3/hr    | 1120,0     |            |       | Comparison: Harza Report, 1200m3/hr                          |
| Daily Loading Rate per Loader                               | m3/day   | 26.880,00  |            |       |  |
| <b>No. Loaders Required to maintain Target Rate</b>         | no.      | 2,0        |            |       |  |
| <b>Hourly Loading Rate for 2 Loaders</b>                    | m3/hr    | 2.240,0    |            |       |  |

**CAT 789C Off-Road Truck (105m3 Capacity)**

|   |     |           |  |
|---|-----|-----------|--|
| Truck Capacity (Max.)                     | m3  | 105.0     |  |
| Truck Capacity (Struck)                   | m3  | 73        |  |
| Total Truck Trips Required to Meet Target | no. | 1,235,000 |  |
| Calculated truck trips per day            | no. | 478,0     |  |
| Max. load/unload time per truck *         | hr  | 0,050     | Note: logistics check, indicates maximum in order to maintain production |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

**Trains**

|   |          |       |   |
|---|----------|-------|---|
| Rail Car Capacity                           | m3       | 40    |   |
| Rail Cars Per Train                         | no.      | 50    |   |
| Locos per Train                             | no.      | 2     | Ruling Grade @ 1.5%                                 |
| Total Train Capacity                        | m3       | 2,000 |   |
| Train Trips Required Per Day to Meet Target | no.      | 18    | To meet target, requires 2 tracks at unloading site |
| Max. load/unload time per train *           | hr/train | 1,371 | Note: logistics check                               |

\* Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion

**3000m3 Scow**

|                                 |     |        |                        |
|---------------------------------|-----|--------|------------------------|
| Scow Capacity                   | m3  | 1,800  | Assume 60% fill factor |
| Total scow trips required       | no. | 50,087 |                        |
| Scow/Tug trips required per day | no. | 19,36  |                        |

**Truck Transportation Cycle**

|  |            |             |  |
|--|------------|-------------|--|
| Average one-way distance (excavation to stockpile) | km         | 1,0         | Source: site plan                      |
| Average Truck Travel Speed                         |            | 25          |  |
| Estimated Load Time                                | hr         | 0,033       | 2 minutes                              |
| Estimated Travel Time (Round Trip)                 | hr         | 0,080       | Calculated round-trip distance of 2 km |
| Estimated Unload Time                              | hr         | 0,017       | 1 minutes per truck                    |
| <b>Total Cycle Time</b>                            | <b>hr</b>  | <b>0,13</b> |  |
| Calculated Trips Per Truck per Day                 | no.        | 185,8       |  |
| <b>No. 105m3 Trucks Required (short haul)</b>      | <b>no.</b> | <b>4,0</b>  | including one spare                    |

**Rail Transportation Cycle**

|  |            |              |   |
|--|------------|--------------|---|
| Avg. track distance (material transfer to disposal site) | km         | 9,0          |   |
| Average Train Speed                                      | km/hr      | 15           | factors included for train movements and delays                     |
| Time to Load Train                                       | hr         | 0,89         |   |
| Average Travel Time (Round Trip)                         | hr         | 1,20         |   |
| Time to Unload Train                                     | hr         | 0,83         | Dual-car dumpers, 2min per car per dumper                           |
| <b>Total trip cycle time</b>                             | <b>hr</b>  | <b>2,93</b>  |   |
| No. trains loading/dumping simultaneously                | no.        | 0,60         | Indicates no. of trains loading/unloading to meet production target |
| Calculated Trips Per Train Per Day                       | no.        | 8,2          |   |
| <b>No. of Train Consists Required</b>                    | <b>no.</b> | <b>3,0</b>   |   |
| <b>No. Rail Cars Required</b>                            | <b>no.</b> | <b>150,0</b> |   |
| <b>No. Locos Required</b>                                | <b>no.</b> | <b>6,0</b>   |   |

**Scow Transportation Cycle**

|  |            |             |   |
|--|------------|-------------|---|
| Average one-way distance (transfer station to disposal site) | km         | 24,5        | Transfer to disposal                          |
| Average Scow/Tug Travel Speed                                | km/hr      | 9           | Ref: site plan                                |
| Time to Load Scow  | hr         | 1,24        |   |
| Average Travel Time (round Trip)                             | hr         | 5,44        | matches loading rate at train loading station |
| Time to Berth and Dump Scow                                  | hr         | 0,50        |   |
| <b>Total trip cycle time</b>                                 | <b>hr</b>  | <b>7,19</b> |   |
| Max scow trips per day (assuming 24 operating hours)         | no.        | 3,34        |   |
| <b>No. Scow(s) required</b>                                  | <b>no.</b> | <b>7,0</b>  | includes one spare                            |
| <b>No. Tow Tug(s) required</b>                               | <b>no.</b> | <b>4,0</b>  | Tug estimate based on cycle time              |

**Equipment Costs**

**CAT 5230B Mass Excavator/Shovel (17m3 bucket)**

|                             |        |               |              |
|-----------------------------|--------|---------------|--------------|
| Hourly Rate                 | \$/hr  | \$ 592,95     |              |
| Daily Rate per Excavator    | \$/day | \$ 14,231     | 24 pay hours |
| Daily Rate for 2 Excavators | \$/day | 2,0 \$ 28,461 |              |

**CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)**

|                         |        |               |              |
|-------------------------|--------|---------------|--------------|
| Hourly Rate             | \$/hr  | \$ 275,00     | confirm rate |
| Daily Rate per truck    | \$/day | \$ 6,600      | 24 pay hours |
| Daily Rate for 4 trucks | \$/day | 4,0 \$ 26,400 |              |

**CAT 994D Front End Loader (20m<sup>3</sup> Capacity)**

|                          |        |               |              |
|--------------------------|--------|---------------|--------------|
| Hourly Rate              | \$/hr  | \$ 600,00     | confirm rate |
| Daily Rate per loader    | \$/day | \$ 14,400     | 24 pay hours |
| Daily Rate for 2 loaders | \$/day | 2,0 \$ 28,800 |              |

**Rollingstock**

|  |             |              |                  |
|--|-------------|--------------|------------------|
| Locomotive - Purchase Cost                 | ea          | \$ 2,200,000 | Research results |
| Locomotive - Salvage Value (@ 20%)         | ea          | \$ 440,000   | Research results |
| Side-dump rail car - Purchase Cost         | ea          | \$ 80,000    | Research results |
| Side-dump rail car - Salvage Value (@ 20%) | ea          | \$ 16,000    | Research results |
| Locomotive operational cost                | \$/day/unit | \$ 1,500     | Research results |
| Locomotive maintenance cost                | \$/day/unit | \$ 1,000     | Research results |
| Rail car maintenance cost                  | \$/day/unit | \$ 100       | Research results |

**Railway Operation and Maintenance Costs**

|  |           |        |           |       |
|--|-----------|--------|-----------|-------|
| <b>Rollingstock</b>                      |           |        |           |       |
| Daily Operations Cost for 6 Locos        | \$/day    | 6 \$   | 9,000     |       |
| Daily Maintenance Cost for 6 Locos       | \$/day    | 6 \$   | 6,000     |       |
| Daily Maintenance Cost for 150 Rail Cars | \$/day    | 150 \$ | 15,000    |       |
| <b>Track</b>                             |           |        |           |       |
| No. Mainline Tracks                      | no.       | 2      |           |       |
| Daily maintenance cost                   | \$/km/day | 18 \$  | 100,00 \$ | 1.800 |

**Scow/Tugs**

|  |        |      |           |
|--|--------|------|-----------|
| 3000m3 scow (includes labor and operating costs)       | \$/day | \$   | 2.333     |
| 3000HP towing tug (includes labor and operating costs) | \$/day | \$   | 9.035     |
| Third locks material                                   |        |      |           |
| Total cost for 7 scow(s)                               | \$/day | 7,00 | \$ 16.329 |
| Total cost for 4 tow tug(s)                            | \$/day | 4,00 | \$ 36.140 |

Source: Corps of Engineers, divide monthly cost by 30.4375  
Source: Corps of Engineers, divide monthly cost by 30.4375

### Haul Roads

|  |           |                |
|--|-----------|----------------|
| Construction Cost per km                     | \$/km     | \$250.000,00   |
| Maintenance Cost per km per day              | \$/km/day | \$1.000,00     |
| Daily maintenance cost for 1 km of haul road | \$/day    | 1,0 \$1.000,00 |

### Conveyors

|                                  |        |                 |
|----------------------------------|--------|-----------------|
| Maintenance and operation        | \$/km  | \$4.000,00      |
| Daily cost for 6.5km of conveyor | \$/day | 6,5 \$26.000,00 |

### Transportation Costs

| Item                               | Unit     | Qty           | Price/Rate    | Total          | Comments  |
|------------------------------------|----------|---------------|---------------|----------------|---|
| <b>Equipment and Operation</b>     |          |               |               |                |   |
| 41.5m3 Truck(s)                    | no.      | 2.588         | \$ 26.400     | \$ 68.310.000  |   |
| 20m3 Front End Loader              | no.      | 2.588         | \$ 28.800     | \$ 74.520.000  |   |
| Conveyor/Railcar Loading System    | LS       | 1             | \$ 43.000.000 | \$ 43.000.000  | Source: EDC report April 2003                             |
| Railway Equipment/Operation        | tonne.km | 1.379.371.500 | \$ 0,100      | \$ 137.937.150 | ** Cost comparison provided by 'Rollingstock Costs' below |
| Railway Construction               | LS       | 1             | \$ 30.615.576 | \$ 30.615.576  |   |
| Track Maintenance                  | day      | 2.588         | \$ 1.800      | \$ 4.657.500   |   |
| 3000m3 Scow                        | day      | 2.588         | \$ 16.329     | \$ 42.250.103  |   |
| 3000HP Tug                         | day      | 2.588         | \$ 36.140     | \$ 93.511.294  |   |
| <b>Transfer Station</b>            |          |               |               |                |   |
| Railcar dumper + stacker conveyor  | no.      | 2             | \$ 3.000.000  | \$ 6.000.000   |   |
| Berth Structure                    | m2       | 2.000,0       | \$ 1.300      | \$ 2.600.000   |   |
| <b>Haul Roads and Conveyor</b>     |          |               |               |                |   |
| Haul Road Construction             | km       | 1,0           | \$ 250.000    | \$ 250.000     |   |
| Haul Road Maintenance              | day      | 2.588         | \$ 1.000      | \$ 2.587.500   |   |
| Conveyor maintenance and operation | day      | 2.588         | \$ 26.000     | \$ 67.275.000  |   |

**Total Cost - Material Transportation** \$573.514.122

**Unit cost of transport per m<sup>3</sup>** \$6,36

### \*\*Rollingstock Costs

| Item                               | Unit | Qty  | Price/Rate   | Total          | Comments                  |
|------------------------------------|------|------|--------------|----------------|---------------------------|
| <b>Rollingstock Purchase Costs</b> |      |      |              |                |                           |
| Locomotives                        | no.  | 8    | \$ 2.200.000 | \$ 17.600.000  | Includes backup loco(s)   |
| Rail cars                          | no.  | 160  | \$ 80.000    | \$ 12.800.000  | Includes backup rail cars |
| <b>Operating/Maintenance Costs</b> |      |      |              |                |                           |
| Operational cost of locomotives    | day  | 2588 | \$ 9.000     | \$ 23.287.500  |                           |
| Maintenance cost of locomotives    | day  | 2588 | \$ 6.000     | \$ 15.525.000  |                           |
| Maintenance cost of rail cars      | day  | 2588 | \$ 15.000    | \$ 38.812.500  |                           |
| <b>Salvage Value</b>               |      |      |              |                |                           |
| Locomotives                        | no.  | 8    | \$ 440.000   | \$ (3.520.000) |                           |
| Rail cars                          | no.  | 160  | \$ 16.000    | \$ (2.560.000) |                           |

**\*\* Total Cost - Rollingstock** \$101.945.000

## Backup Calculations

### Project Specifications - Truck and Scow Haul to M6

| Item   | Unit         | Qty            | Price/Rate | Total | Comments  |
|--|--------------|----------------|------------|-------|---|
| Cells requiring user input are highlighted thus:   |              |                |            |       |   |
| <b>General Parameters</b>  |              |                |            |       |   |
| Total Material to be Hauled by Truck (Third Locks Excavation)  | m3           | 90,155,000     |            |       |   |
| Time to transport material by truck  | year         | 10,50          |            |       |   |
| Working Days per Year  | day/year     | 345            |            |       |   |
| Total Working Days - Third Locks Material  | day          | 3,623          |            |       |   |
| Calculated Target Production - dry excavation  | m3/day       | 24,888         |            |       |   |
| ACP Production Rate - Dry  | m3/day       | 22,609         |            |       | based on published average production rate of 150,000m3/week            |
| Working Hours per day  | hr           | 24             |            |       |   |
| <b>Equipment Parameters</b>  |              |                |            |       |   |
| <b>3000m3 Scow</b>   |              |                |            |       |   |
| Scow Capacity  | m3           | 1,800          |            |       | Assume 60% fill factor  |
| Total scow trips required to move third locks material   | no.          | 50,087         |            |       |   |
| Scow/Tug trips required per day - third locks  | no.          | 13,83          |            |       |   |
| <b>CAT 5230B Mass Excavator/Shovel (17m3 bucket)</b>   |              |                |            |       |   |
| Single Bucket Capacity   | m3           | 17,0           |            |       | Excavation site material removal - cost not included                    |
| Bucket Fill Factor   | no.          | 55%            |            |       |   |
| Factored Bucket Capacity   | m3           | 9,35           |            |       |   |
| Bucket Cycle Time  | sec          | 30,0           |            |       |   |
| Production Rate for Excavator  | m3/hr        | 1122,0         |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Excavator   | m3/day       | 26,928,00      |            |       |   |
| <b>No. Excavators Required to maintain Target Rate</b>   | <b>no.</b>   | <b>1,0</b>     |            |       |   |
| <b>Hourly Loading Rate for 1 Excavator(s)</b>  | <b>m3/hr</b> | <b>1,122,0</b> |            |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Single Bucket Capacity   | m3           | 20,0           |            |       | Intermediate transfer to ensure continuous removal from excavation site |
| Bucket Fill Factor   | no.          | 70%            |            |       |   |
| Factored Bucket Capacity   | m3           | 14             |            |       |   |
| Dig/Load Cycle Time  | sec          | 45,0           |            |       |   |
| Production Rate for Loader   | m3/hr        | 1120,0         |            |       | Comparison: Harza Report, 1200m3/hr                                     |
| Daily Loading Rate per Loader  | m3/day       | 26,880,00      |            |       |   |
| <b>No. Loaders Required to maintain Target Rate</b>  | <b>no.</b>   | <b>1,0</b>     |            |       |   |
| <b>Hourly Loading Rate for 1 Loaders</b>   | <b>m3/hr</b> | <b>1,120,0</b> |            |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |            |       |   |
| Truck Capacity (Max.)  | m3           | 105            |            |       |   |
| Truck Capacity (Struck)  | m3           | 73             |            |       |   |
| Total Truck Trips Required to Meet Target  | no.          | 1,235,000      |            |       |   |
| Calculated truck trips per day   | no.          | 341,0          |            |       |   |
| Max. load/unload time per truck *  | hr           | 0,070          |            |       | Note: logistics check   |
| * Note: If this value is less than either calculated load or unload time below, then load/unload maximum is exceeded - increase time to completion |              |                |            |       |   |
| <b>Truck Transportation Cycle</b>  |              |                |            |       |   |
| Average one-way distance (excavation site to transfer station)   | km           | 4,5            |            |       | Source: site plan   |
| Average Truck Travel Speed   |              | 30             |            |       |   |
| Estimated Load Time  | hr           | 0,065          |            |       | 3.9 minutes   |
| Estimated Travel Time (Round Trip)   | hr           | 0,300          |            |       | Calculated round-trip distance of 9 km                                  |
| Estimated Unload Time  | hr           | 0,050          |            |       | 3 minutes   |
| <b>Total Cycle Time</b>  | <b>hr</b>    | <b>0,42</b>    |            |       |   |
| Calculated Trips Per Truck per Day   | no.          | 57,8           |            |       |   |
| <b>No. 105m3 Trucks Required (long haul)</b>   | <b>no.</b>   | <b>6,0</b>     |            |       |   |
| <b>No. 41.5m3 Trucks Required (short haul &lt; 1km)</b>  | <b>no.</b>   | <b>2,0</b>     |            |       | Arbitrary no. used to maintain continuous flow at transfer station      |
| <b>Scow Transportation Cycle</b>   |              |                |            |       |   |
| Average one-way distance (transfer station to disposal site)   | km           | 28,0           |            |       | Transfer to disposal  |
| Average Scow/Tug Travel Speed  | km/hr        | 9              |            |       | Ref: site plan  |
| Time to Load Scow  | hr           | 1,00           |            |       |   |
| Average Travel Time (round Trip)   | hr           | 6,22           |            |       |   |
| Time to Berth and Dump Scow  | hr           | 0,50           |            |       |   |
| <b>Total trip cycle time</b>   | <b>hr</b>    | <b>7,72</b>    |            |       |   |
| Max scow trips per day (assuming 24 operating hours)   | no.          | 3,11           |            |       |   |
| <b>No. Scow(s) required</b>  | <b>no.</b>   | <b>6,0</b>     |            |       |   |
| <b>No. Tow Tug(s) required</b>   | <b>no.</b>   | <b>3,0</b>     |            |       | Tug estimate based on cycle time  |
| <b>Equipment Costs</b>   |              |                |            |       |   |
| <b>Scow/Tugs</b>   |              |                |            |       |   |
| 3000m3 scow (includes labor and operating costs)   | \$/day       |                | \$ 2,333   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| 3000HP towing tug (includes labor and operating costs)   | \$/day       |                | \$ 9,035   |       | Source: Corps of Engineers, divide monthly cost by 30.4375              |
| Third locks material   |              |                |            |       |   |
| Total cost for 6 scow(s)   | \$/day       | 6,00           | \$ 13,996  |       |   |
| Total cost for 3 tow tug(s)  | \$/day       | 3,00           | \$ 27,105  |       |   |
| <b>CAT 789C Off-Road Truck (105m3 Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 331,45  |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 7,955   |       | 24 pay hours per day  |
| Daily Rate for 6 trucks  | \$/day       | 6,00           | \$ 47,728  |       |   |
| <b>CAT 775E Off-Road Truck (41.5m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 275,00  |       |   |
| Daily Rate per truck   | \$/day       |                | \$ 6,600   |       | 24 pay hours  |
| Daily Rate for 2 trucks  | \$/day       | 2,0            | \$ 13,200  |       |   |
| <b>CAT 994D Front End Loader (20m<sup>3</sup> Capacity)</b>  |              |                |            |       |   |
| Hourly Rate  | \$/hr        |                | \$ 600,00  |       |   |
| Daily Rate per loader  | \$/day       |                | \$ 14,400  |       | 24 pay hours  |



**APPENDIX D - ENVIRONMENTAL CHARACTERIZATIONS**

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# Environmental Appendix

## Tables and Figures

**Table EA-1: Density (org/m<sup>3</sup>) and percentage (%) by taxa during night and diurnal samples.**

| Taxa                      | Causeway 2 |       |          |       | Causeway 4 |       |            |       | Causeway |       |           |       |
|---------------------------|------------|-------|----------|-------|------------|-------|------------|-------|----------|-------|-----------|-------|
|                           | Day        |       | Night    |       | Day        |       | Night      |       | Day      |       | Night     |       |
|                           | Total      | %     | Total    | %     | Total      | %     | Total      | %     | Total    | %     | Total     | %     |
| Annelids larvae           | 13.79      | 0.24  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Amphipods                 | 0.00       | 0.00  | 0.00     | 0.00  | 4957.88    | 0.99  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Copepods calanoids        | 3490.28    | 61.79 | 48263.19 | 71.11 | 287556.89  | 57.57 | 6968147.59 | 58.19 | 77869.32 | 70.47 | 376662.56 | 67.46 |
| Chaetognatha              | 158.57     | 2.81  | 4433.94  | 6.53  | 97918.08   | 19.60 | 0.00       | 0.00  | 9720.09  | 8.80  | 35619.84  | 6.38  |
| Cladoceros                | 1478.84    | 26.18 | 1758.13  | 2.59  | 69410.28   | 13.90 | 3462894.01 | 28.92 | 6570.56  | 5.95  | 23526.69  | 4.21  |
| Ctenophores               | 0.00       | 0.00  | 211.38   | 0.31  | 0.00       | 0.00  | 63539.34   | 0.53  | 0.00     | 0.00  | 0.00      | 0.00  |
| Doliolids                 | 0.00       | 0.00  | 211.38   | 0.31  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Eufasids                  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Fish eggs                 | 13.79      | 0.24  | 586.04   | 0.86  | 2478.94    | 0.50  | 25718.30   | 0.21  | 0.00     | 0.00  | 6643.39   | 1.19  |
| Fish larvae               | 0.00       | 0.00  | 211.38   | 0.31  | 3718.41    | 0.74  | 0.00       | 0.00  | 0.00     | 0.00  | 3486.60   | 0.62  |
| Young Gastropods          | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 25718.30   | 0.21  | 0.00     | 0.00  | 0.00      | 0.00  |
| Gastropod Larvae          | 0.00       | 0.00  | 0.00     | 0.00  | 1239.47    | 0.25  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Mollusk Larvae            | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 23416.75  | 4.19  |
| Young mollusks            | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 5010.02   | 0.90  |
| Misidáceos                | 56.88      | 1.01  | 211.38   | 0.31  | 2478.94    | 0.50  | 319209.54  | 2.67  | 1194.65  | 1.08  | 0.00      | 0.00  |
| Mysis                     | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 5119.96   | 0.92  |
| Oikopleura                | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Ostrácodos                | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 44650.45  | 8.00  |
| Other groups              | 124.10     | 2.20  | 3213.75  | 4.73  | 3718.41    | 0.74  | 488647.78  | 4.08  | 4724.29  | 4.28  | 0.00      | 0.00  |
| Larvae of pelecipods      | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Larvae of poliuetos       | 0.00       | 0.00  | 821.47   | 1.21  | 0.00       | 0.00  | 204233.59  | 1.71  | 0.00     | 0.00  | 15689.69  | 2.81  |
| Post larva of paniluridos | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Pendidos                  | 0.00       | 0.00  | 845.52   | 1.25  | 1239.47    | 0.25  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Pterópodos                | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 1194.65  | 1.08  | 1743.30   | 0.31  |
| Noctilucas                | 198.21     | 3.51  | 5745.26  | 8.46  | 0.00       | 0.00  | 385774.56  | 3.22  | 7765.21  | 7.03  | 0.00      | 0.00  |
| Zoea                      | 113.76     | 2.01  | 1359.42  | 2.00  | 24789.39   | 4.96  | 31769.67   | 0.27  | 1466.16  | 1.33  | 16773.36  | 3.00  |

**Table EA-2: Density (org/m<sup>3</sup>) and percentage (%) of Zooplankton by during night and day samples.**

| Taxa                      | Causeway 2 |       |          |       | Causeway 4 |       |            |       | Causeway |       |           |       |
|---------------------------|------------|-------|----------|-------|------------|-------|------------|-------|----------|-------|-----------|-------|
|                           | Day        |       | Night    |       | Day        |       | Night      |       | Day      |       | Night     |       |
|                           | Total      | %     | Total    | %     | Total      | %     | Total      | %     | Total    | %     | Total     | %     |
| Annelids larvae           | 13.79      | 0.24  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Amphipods                 | 0.00       | 0.00  | 0.00     | 0.00  | 4957.88    | 0.99  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Copepods calanoids        | 3490.28    | 61.79 | 48263.19 | 71.11 | 287556.89  | 57.57 | 6968147.59 | 58.19 | 77869.32 | 70.47 | 376662.56 | 67.46 |
| Chaetognatha              | 158.57     | 2.81  | 4433.94  | 6.53  | 97918.08   | 19.60 | 0.00       | 0.00  | 9720.09  | 8.80  | 35619.84  | 6.38  |
| Cladoceros                | 1478.84    | 26.18 | 1758.13  | 2.59  | 69410.28   | 13.90 | 3462894.01 | 28.92 | 6570.56  | 5.95  | 23526.69  | 4.21  |
| Ctenophores               | 0.00       | 0.00  | 211.38   | 0.31  | 0.00       | 0.00  | 63539.34   | 0.53  | 0.00     | 0.00  | 0.00      | 0.00  |
| Doliolids                 | 0.00       | 0.00  | 211.38   | 0.31  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Eufasids                  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Fish eggs                 | 13.79      | 0.24  | 586.04   | 0.86  | 2478.94    | 0.50  | 25718.30   | 0.21  | 0.00     | 0.00  | 6643.39   | 1.19  |
| Fish larvae               | 0.00       | 0.00  | 211.38   | 0.31  | 3718.41    | 0.74  | 0.00       | 0.00  | 0.00     | 0.00  | 3486.60   | 0.62  |
| Young Gastropods          | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 25718.30   | 0.21  | 0.00     | 0.00  | 0.00      | 0.00  |
| Gastropod Larvae          | 0.00       | 0.00  | 0.00     | 0.00  | 1239.47    | 0.25  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Mollusk Larvae            | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 23416.75  | 4.19  |
| Young mollusks            | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 5010.02   | 0.90  |
| Misidáceos                | 56.88      | 1.01  | 211.38   | 0.31  | 2478.94    | 0.50  | 319209.54  | 2.67  | 1194.65  | 1.08  | 0.00      | 0.00  |
| Mysis                     | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 5119.96   | 0.92  |
| Oikopleura                | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Ostrácodos                | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 44650.45  | 8.00  |
| Other groups              | 124.10     | 2.20  | 3213.75  | 4.73  | 3718.41    | 0.74  | 488647.78  | 4.08  | 4724.29  | 4.28  | 0.00      | 0.00  |
| Larvae of pelecipods      | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Larvae of poliquetos      | 0.00       | 0.00  | 821.47   | 1.21  | 0.00       | 0.00  | 204233.59  | 1.71  | 0.00     | 0.00  | 15689.69  | 2.81  |
| Post larva of paniluridos | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Pendidos                  | 0.00       | 0.00  | 845.52   | 1.25  | 1239.47    | 0.25  | 0.00       | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  |
| Pterópodos                | 0.00       | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00       | 0.00  | 1194.65  | 1.08  | 1743.30   | 0.31  |
| Noctilucas                | 198.21     | 3.51  | 5745.26  | 8.46  | 0.00       | 0.00  | 385774.56  | 3.22  | 7765.21  | 7.03  | 0.00      | 0.00  |
| Zoea                      | 113.76     | 2.01  | 1359.42  | 2.00  | 24789.39   | 4.96  | 31769.67   | 0.27  | 1466.16  | 1.33  | 16773.36  | 3.00  |

**Table EA-3: Density (org/m<sup>3</sup>) and percentage (%), by taxa during the night and day shifts.**

| Taxa                      | Artificial Island |       |          |       | Site 15  |       |            |       | Fishing Site |       |            |       |
|---------------------------|-------------------|-------|----------|-------|----------|-------|------------|-------|--------------|-------|------------|-------|
|                           | Day               |       | Night    |       | Day      |       | Night      |       | Day          |       | Night      |       |
|                           | Total             | %     | Total    | %     | Total    | %     | Total      | %     | Total        | %     | Total      | %     |
| Larva of annelids         | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 28.73        | 0.23  | 0.00       | 0.00  |
| Amphipods                 | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 9133.72    | 0.18  |
| Calanoid copepods         | 29305.77          | 29.47 | 46953.83 | 61.09 | 12510.36 | 50.17 | 4545840.57 | 59.16 | 7622.77      | 60.86 | 2281908.56 | 44.28 |
| Chaetognatha              | 1079.88           | 1.09  | 4180.82  | 5.44  | 824.68   | 3.31  | 133822.30  | 1.74  | 507.55       | 4.05  | 112649.25  | 2.19  |
| Cladoceros                | 67709.85          | 68.09 | 321.60   | 0.42  | 7838.56  | 31.44 | 271762.21  | 3.54  | 191.53       | 1.53  | 2319965.74 | 45.02 |
| Ctenophores               | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 78234.58   | 1.02  | 0.00         | 0.00  | 0.00       | 0.00  |
| Doliolids                 | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 22646.85   | 0.29  | 28.73        | 0.23  | 9133.72    | 0.18  |
| Eufasids                  | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 10656.01   | 0.21  |
| Fish eggs                 | 0.00              | 0.00  | 2572.81  | 3.35  | 0.00     | 0.00  | 811169.01  | 10.56 | 181.95       | 1.45  | 21312.02   | 0.41  |
| Fish larvae               | 384.79            | 0.39  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 0.00       | 0.00  |
| Young Gastropods          | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 0.00       | 0.00  |
| Larvae of gastropods      | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 0.00       | 0.00  |
| Larvae of mollusks        | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 41101.76   | 0.80  |
| Young mollusks            | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 0.00       | 0.00  |
| Young poliquets           | 111.71            | 0.11  | 321.60   | 0.42  | 0.00     | 0.00  | 100881.43  | 1.31  | 0.00         | 0.00  | 41101.76   | 0.80  |
| Misidaces                 | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 45293.70   | 0.59  | 124.49       | 0.99  | 0.00       | 0.00  |
| Mysis                     | 0.00              | 0.00  | 3216.02  | 4.18  | 593.77   | 2.38  | 174998.39  | 2.28  | 679.92       | 5.43  | 62413.78   | 1.21  |
| Oikopleura                | 0.00              | 0.00  | 0.00     | 0.00  | 1434.94  | 5.75  | 183233.61  | 2.38  | 0.00         | 0.00  | 0.00       | 0.00  |
| Ostracods                 | 0.00              | 0.00  | 9004.84  | 11.72 | 667.99   | 2.68  | 220292.09  | 2.87  | 392.63       | 3.13  | 111126.97  | 2.16  |
| Other groups              | 111.71            | 0.11  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 0.00       | 0.00  |
| Larvae of pelecipods      | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 91337.23   | 1.77  |
| Larvae of poliquets       | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 28.73        | 0.23  | 9133.72    | 0.18  |
| Post Larvae of panilurids | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 38.31        | 0.31  | 0.00       | 0.00  |
| Peneids                   | 273.07            | 0.27  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 0.00       | 0.00  |
| Pteropods                 | 0.00              | 0.00  | 0.00     | 0.00  | 0.00     | 0.00  | 0.00       | 0.00  | 0.00         | 0.00  | 10656.01   | 0.21  |
| Noctilucas                | 0.00              | 0.00  | 8040.04  | 10.46 | 1063.83  | 4.27  | 1095284.05 | 14.26 | 2480.27      | 19.80 | 0.00       | 0.00  |
| Zoea braquiuras           | 471.67            | 0.47  | 2251.21  | 2.93  | 0.00     | 0.00  | 0.00       | 0.00  | 220.26       | 1.76  | 21312.02   | 0.41  |

**Table EA-3: Density (org/m<sup>3</sup>) and percentage (%), by taxa during day and night shifts.**

| Taxa                      | Causeway |       |           |       | Chorrillo |       |           |       | Artificial Site |       |          |       |
|---------------------------|----------|-------|-----------|-------|-----------|-------|-----------|-------|-----------------|-------|----------|-------|
|                           | Day      |       | Night     |       | Day       |       | Night     |       | Day             |       | Night    |       |
|                           | Prom.    | %     | Prom.     | %     | Prom.     | %     | Prom.     | %     | Prom.           | %     | Prom.    | %     |
| Larvae of anelids         | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Larvae of asteroideos     | 0.00     | 0.00  | 0.00      | 0.00  | 73.02     | 0.30  | 4312.45   | 1.33  | 0.00            | 0.00  | 0.00     | 0.00  |
| Anphiiipods caprelids     | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 2342.78   | 0.72  | 0.00            | 0.00  | 0.00     | 0.00  |
| Calanoid copepods         | 21339.03 | 61.74 | 112995.91 | 71.33 | 13852.24  | 57.17 | 210682.96 | 64.74 | 49370.05        | 65.79 | 10940.57 | 63.68 |
| Chaetognatha              | 897.09   | 2.60  | 3206.07   | 2.02  | 320.76    | 1.32  | 29819.26  | 9.16  | 4164.76         | 5.55  | 610.81   | 3.56  |
| Cladoceros                | 9922.01  | 28.71 | 14361.92  | 9.07  | 4640.75   | 19.15 | 20660.46  | 6.35  | 14736.59        | 19.64 | 883.75   | 5.14  |
| Cumaceos                  | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 715.50          | 0.95  | 0.00     | 0.00  |
| Doliolids                 | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Eufausids                 | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 45.75    | 0.27  |
| Fish eggs                 | 1459.01  | 4.22  | 9095.53   | 5.74  | 3717.13   | 15.34 | 25711.22  | 7.90  | 3188.50         | 4.25  | 3050.20  | 17.75 |
| Fish larvae               | 0.00     | 0.00  | 1694.61   | 1.07  | 204.71    | 0.84  | 5813.56   | 1.79  | 0.00            | 0.00  | 137.88   | 0.80  |
| Isopods                   | 0.00     | 0.00  | 260.97    | 0.16  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Megalopa of braquiros     | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Misidaceos                | 0.00     | 0.00  | 260.97    | 0.16  | 106.16    | 0.44  | 0.00      | 0.00  | 575.97          | 0.77  | 144.86   | 0.84  |
| Misis                     | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 1846.68   | 0.57  | 0.00            | 0.00  | 165.56   | 0.96  |
| Nauplio of copepods       | 0.00     | 0.00  | 2298.52   | 1.45  | 491.31    | 2.03  | 0.00      | 0.00  | 0.00            | 0.00  | 287.40   | 1.67  |
| Oikopleura                | 421.01   | 1.22  | 1765.52   | 1.11  | 155.44    | 0.64  | 59.88     | 0.02  | 715.50          | 0.95  | 269.03   | 1.57  |
| Ostracods                 | 0.00     | 0.00  | 1627.60   | 1.03  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 137.88   | 0.80  |
| Others                    | 0.00     | 0.00  | 1838.82   | 1.16  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Larvae of pelecipods      | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 576.78          | 0.77  | 82.78    | 0.48  |
| Larvae of poliquets       | 0.00     | 0.00  | 916.94    | 0.58  | 0.00      | 0.00  | 1764.82   | 0.54  | 366.77          | 0.49  | 82.78    | 0.48  |
| Post Larvae of panilurids | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Pteropods                 | 0.00     | 0.00  | 1644.63   | 1.04  | 73.02     | 0.30  | 2906.78   | 0.89  | 0.00            | 0.00  | 105.66   | 0.62  |
| Sifonofores               | 0.00     | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 4685.56   | 1.44  | 0.00            | 0.00  | 0.00     | 0.00  |
| Porcelanids               | 247.96   | 0.72  | 260.97    | 0.16  | 204.71    | 0.84  | 6903.60   | 2.12  | 0.00            | 0.00  | 0.00     | 0.00  |
| Notilucas                 | 0.00     | 0.00  | 1838.82   | 1.16  | 106.16    | 0.44  | 0.00      | 0.00  | 0.00            | 0.00  | 106.99   | 0.62  |
| Larvae of anomuros        | 0.00     | 0.00  | 651.04    | 0.41  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Larvae of pagurids        | 0.00     | 0.00  | 2068.67   | 1.31  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Larvae of braquiuros      | 202.72   | 0.59  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00      | 0.00  | 0.00            | 0.00  | 0.00     | 0.00  |
| Zoea of braquitos         | 74.19    | 0.21  | 1631.09   | 1.03  | 283.65    | 1.17  | 7896.72   | 2.43  | 636.31          | 0.85  | 127.78   | 0.74  |

Table EA-4: Collection information for diurnal and nocturnal phytoplankton samples – Panama Bay

| Nocturnal Samples |               |                   |             |        |                                      | Diurnal Samples |               |                   |             |        |                                      |
|-------------------|---------------|-------------------|-------------|--------|--------------------------------------|-----------------|---------------|-------------------|-------------|--------|--------------------------------------|
| Sample ID         | Sample Number | Location/ Date    | Coordinates |        | FLOW METER<br>(Differential Reading) | Sample ID       | Sample Number | Location/ Date    | Coordinates |        | FLOW METER<br>(Differential Reading) |
|                   |               |                   | X           | Y      |                                      |                 |               |                   | X           | Y      |                                      |
|                   |               | Fishing Grounds   |             |        |                                      |                 |               | Fishing Grounds   |             |        |                                      |
| 1N                | 1             | 24-2-03           | 658061      | 974411 | 00005                                | 1D              | 1             | 26-2-03           | 658061      | 974411 | 00073                                |
| 2N                | 2             | "                 | "           | "      | 00016                                | 2D              | 2             | "                 | "           | "      | 00039                                |
| 3N                | 3             | "                 | "           | "      | 00019                                | 3D              | 3             | "                 | "           | "      | 00030                                |
| 4N                | -             | 7-2-03            | -           | -      | -                                    | 4D              | -             | 30-1-03           | -           | -      | -                                    |
|                   |               | Site 15           |             |        |                                      |                 |               | Site 15           |             |        |                                      |
| 1N                | 4             | 24/2-03           | 659565      | 977170 | 00022                                | 1D              | 1             | 26-2-03           | 659582      | 977241 | 00037                                |
| 2N                | 5             | "                 | "           | "      | 00013                                | 2D              | 2             | "                 | "           | "      | 00048                                |
| 3N                | 6             | "                 | "           | "      | 00016                                | 3D              | 3             | "                 | "           | "      | 00061                                |
| 4N                | -             | 7-2-03            | -           | -      | -                                    | 4D              | -             | 30-1-03           | -           | -      | -                                    |
|                   |               | Artificial Island |             |        |                                      |                 |               | Artificial Island |             |        |                                      |
| 1N                | 7             | 24-2-03           | 655906      | 980595 | 00013                                | 1D              | 1             | 26-2-03           | 658483      | 984347 | 00016                                |
| 2N                | 8             | "                 | "           | "      | 00010                                | 2D              | 2             | "                 | "           | "      | 00032                                |

| Table EA-4. Continued - |               |           |        |        |        |    |            |           |        |        |       |
|-------------------------|---------------|-----------|--------|--------|--------|----|------------|-----------|--------|--------|-------|
| 3N                      | 9             | "         | "      | "      | 00019  | 3D | 3          | "         | "      | "      | 00037 |
| 4N                      | -             | 6-2-03    | -      | -      | -      | 4D | -          | 29-1-03   | -      | -      | -     |
|                         |               | Site 2    |        |        |        |    |            | Site 2    |        |        |       |
| 1N                      | 10            | 24-2-03   | 658507 | 984409 | 00018  | 1D | 1          | 26-2-03   | 658507 | 984409 | 00028 |
| 2N                      | 11            | "         | "      | "      | 00014  | 2D | 2          | "         | "      | "      | 00044 |
| 3N                      | 12            | "         | "      | "      | 00023  | 3D | 3          | "         | "      | "      | 00061 |
|                         |               | Causeway  |        |        |        |    |            | Causeway  |        |        |       |
| 1N                      | 1             | 25-2-03   | 662321 | 984382 | 00046  | 1D | 1          | 27-2-03   | 662321 | 984382 | 00069 |
| 2N                      | 2             | "         | "      | "      | 00032  | 2D | 2          | "         | "      | "      | 00035 |
| 3N                      | 3             | "         | "      | "      | 00046  | 3D | 3          | "         | "      | "      | 00035 |
| 4N                      | -             | 6-2-03    | -      | -      | -      | 4D | Causeway 4 | 28-1-03   | -      | -      | -     |
| 5N                      | Causeway4     | 6-2-03    | -      | -      | -      | 5D | -          | 28-1-03   | -      | -      | -     |
| 6N                      | Causeway<br>2 | 7-2-03    | -      | -      | -      | 6D | Causeway 2 | 29-1-03   | -      | -      | -     |
|                         |               | Chorrillo |        |        |        |    |            | Chorrillo |        |        |       |
| 1N                      | 1             | 25-2-03   | 661088 | 987809 | 00008  | 1D | 1          | 27-2-03   | 661088 | 987809 | 00019 |
| 2N                      | 2             | "         | "      | "      | 00007  | 2D | 2          | "         | "      | "      | 00022 |
| 3N                      | 3             | "         | "      | "      | 387741 | 3D | 3          | "         | "      | "      | 00057 |

**Table EA-5: Absolute frequency of phytoplankton species collected during day and night offshore samples in Panama Bay.**

| Species  | Fishing Grounds Night |     |     |    | Fishing Grounds Day |    |    |    | Site 15 Night |     |     |    | Site 15 Day |    |    |    | Artificial Island Night |    |    |    | Artificial Island Day |    |    |    |
|--|-----------------------|-----|-----|----|---------------------|----|----|----|---------------|-----|-----|----|-------------|----|----|----|-------------------------|----|----|----|-----------------------|----|----|----|
|  | 1N                    | 2N  | 3N  | 4N | 1D                  | 2D | 3D | 4D | 1N            | 2N  | 3N  | 4N | 1D          | 2D | 3D | 4D | 1N                      | 2N | 3N | 4N | 1D                    | 2D | 3D | 4D |
| <b>BACILLARIOPHYTA</b>   |                       |     |     |    |                     |    |    |    |               |     |     |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Actinocyclus</i> spp  |                       |     |     | 1  | 2                   | 4  | 4  |    |               |     |     | 1  |             |    |    |    |                         |    |    |    |                       | 1  | 4  | 1  |
| <i>Actinoptychus senarius</i> (Ehrenberg) Ehrenberg                                  |                       |     |     |    |                     |    |    |    |               |     |     |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Asterionellopsis glacialis</i> (Castracane) Round (en Round <i>et al.</i> , 1990) |                       |     |     |    |                     |    |    |    |               |     |     |    |             |    | 1  |    |                         |    |    |    |                       |    |    |    |
| <i>Bacteriastrum</i> cf. <i>mediterraneum</i> Pavillard                              |                       |     |     |    |                     |    |    |    |               |     |     |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Bacteriistrum delicatulum</i> Cleve   |                       | 1   |     |    |                     | 1  | 5  |    |               |     |     | 5  | 1           |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Bacteriastrum furcatum</i> Shadbolt   |                       | 2   |     | 8  |                     | 1  |    |    |               | 1   |     |    |             | 1  | 2  |    |                         |    |    | 1  |                       |    |    |    |
| <i>Bacteriatrum hyalinum</i> Lauder  |                       |     |     | 4  | 3                   |    |    |    | 1             |     | 3   | 2  | 3           | 1  | 3  | 1  | 1                       |    | 3  |    | 4                     | 2  | 1  |    |
| <i>Cerataulina pelagica</i> (Cleve) Hendey   | 2                     | 1   | 1   |    | 2                   | 1  | 3  |    |               | 1   |     |    |             | 2  | 2  |    |                         | 2  |    |    | 2                     |    |    |    |
| <i>Chaetoceros affinis</i> Lauder  |                       |     |     | 22 | 19                  | 9  | 3  |    |               | 1   | 2   | 6  | 16          | 13 | 15 | 2  |                         |    | 2  | 1  | 9                     | 6  | 5  |    |
| <i>Chaetoceros affinis</i> Lauder var. <i>willei</i> (Gran) Hustedt                  |                       |     |     |    |                     |    |    |    |               |     |     |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros anastomosans</i> Grunow en Van Heurck                                 | 134                   | 114 | 179 |    | 2                   | 14 | 11 |    | 69            | 137 | 178 |    | 65          | 27 | 11 |    | 1                       | 8  | 9  |    | 7                     | 1  | 5  |    |
| <i>Chaetoceros brevis</i> Schütt   | 7                     | 2   | 1   |    | 1                   | 2  | 4  |    | 8             | 1   | 3   |    | 6           | 8  | 8  |    |                         | 1  |    |    | 2                     | 1  | 2  |    |
| <i>Chaetoceros coarctatus</i> Lauder   |                       |     |     |    |                     |    | 1  |    |               |     |     |    |             |    |    |    |                         |    |    |    |                       |    | 2  |    |
| <i>Chaetoceros</i> cf. <i>densus</i> Cleve   |                       |     |     | 3  |                     |    | 1  |    |               |     | 3   |    |             | 1  | 1  |    |                         |    |    | 3  |                       |    |    |    |
| <i>Chaetoceros costatus</i> Pavillard  |                       | 1   |     |    |                     |    |    |    |               |     |     |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros curvisetus</i> Cleve  | 2                     | 4   | 1   | 25 | 11                  | 3  | 18 |    | 3             | 11  | 5   | 25 | 6           | 8  | 3  |    | 8                       | 4  | 13 | 7  | 3                     | 3  | 1  |    |
| <i>Chaetoceros debilis</i> Cleve   |                       |     |     |    | 1                   |    |    |    | 2             |     | 1   |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros decipiens</i> Cleve   |                       | 1   |     |    | 3                   | 3  | 4  |    | 1             | 1   | 1   |    | 5           | 4  | 16 |    | 2                       |    |    |    | 8                     |    | 4  |    |

Table EA-5 – Continued

| Species  | Fishing Grounds Night |    |    |     | Fishing Grounds Day |    |    |    | Site 15 Night |    |    |     | Site 15 Day |    |    |    | Artificial Island Night |    |    |    | Artificial Island Day |    |    |    |
|--|-----------------------|----|----|-----|---------------------|----|----|----|---------------|----|----|-----|-------------|----|----|----|-------------------------|----|----|----|-----------------------|----|----|----|
|  | 1N                    | 2N | 3N | 4N  | 1D                  | 2D | 3D | 4D | 1N            | 2N | 3N | 4N  | 1D          | 2D | 3D | 4D | 1N                      | 2N | 3N | 4N | 1D                    | 2D | 3D | 4D |
| <b>BACILLARIOPHYTA</b>   |                       |    |    |     |                     |    |    |    |               |    |    |     |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros denticulatus</i> forma <i>angusta</i> Hustedt             |                       |    |    |     |                     | 1  | 1  |    |               |    |    |     |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros didymus</i> var. <i>didymus</i> Ehrenberg                 |                       |    |    |     | 1                   |    |    |    |               |    |    |     | 1           | 1  |    |    | 1                       |    |    |    |                       |    |    | 1  |
| <i>Chaetoceros didymus</i> var. <i>protuberans</i> (Lauder) Gran y Yendo |                       |    |    |     |                     |    | 1  |    |               |    |    |     |             |    |    |    | 1                       |    | 2  |    |                       |    |    |    |
| <i>Chaetoceros diversus</i> Cleve  |                       |    |    |     |                     |    |    |    |               |    |    |     |             | 1  |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros filiferum</i> Karsten                                     |                       |    |    |     |                     |    |    |    | 2             |    |    |     |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros lacinosus</i> Schütt                                      | 1                     |    |    |     |                     |    | 1  |    | 1             |    |    |     | 3           | 5  |    |    |                         |    | 1  |    | 3                     |    |    |    |
| <i>Chaetoceros lorenzianus</i> Grunow                                    | 7                     | 8  |    | 4   | 21                  | 27 | 17 |    | 11            | 8  | 4  | 1   | 34          | 26 | 45 |    | 6                       | 4  |    |    | 11                    | 3  | 14 |    |
| <i>Chaetoceros pelagicus</i> Cleve                                       |                       |    |    |     |                     |    |    |    |               |    |    |     | 2           | 1  | 1  |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros peruvianus</i> Cleve                                      | 3                     |    |    |     | 6                   | 7  | 2  |    | 2             | 1  | 2  |     | 10          | 8  | 9  |    |                         |    |    |    | 6                     | 7  | 6  |    |
| <i>Chaetoceros pseudocurvisetus</i> Mangin                               |                       |    |    |     |                     |    |    |    |               | 1  |    |     | 1           | 1  | 1  |    |                         |    |    |    | 2                     |    |    |    |
| <i>Chaetoceros radicans</i> Schütt                                       |                       |    |    |     |                     |    |    |    |               |    |    |     |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros rostratus</i> Lauder                                      |                       |    |    | 5   |                     |    |    |    |               | 1  | 1  |     |             |    |    |    |                         |    | 2  |    |                       |    |    |    |
| <i>Chaetoceros socialis</i> Lauder                                       |                       |    |    | 111 |                     |    |    |    | 26            | 35 |    | 198 | 12          |    |    |    |                         |    | 7  | 81 | 1                     |    |    |    |
| <i>Chaetoceros</i> sp <sub>1</sub>                                       |                       | 1  |    |     |                     | 2  |    |    |               |    |    |     |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Chaetoceros tortissimus</i> Gran                                      | 5                     |    | 2  |     |                     |    | 2  |    | 4             | 6  | 4  |     | 1           | 7  | 1  |    |                         | 1  |    |    | 1                     |    |    |    |
| <i>Chaetoceros whigamii</i> Brightwell                                   |                       |    |    |     |                     |    |    |    |               |    |    |     |             |    |    |    | 1                       | 2  |    |    |                       |    |    |    |

Table EA-5 – Continued

| Species   | Fishing Grounds Night |    |    |    | Fishing Grounds Day |    |    |    | Site 15 Night |    |    |    | Site 15 Day |    |    |     | Artificial Island Night |     |     |     | Artificial Island Day |    |    |     |
|---|-----------------------|----|----|----|---------------------|----|----|----|---------------|----|----|----|-------------|----|----|-----|-------------------------|-----|-----|-----|-----------------------|----|----|-----|
|   | 1N                    | 2N | 3N | 4N | 1D                  | 2D | 3D | 4D | 1N            | 2N | 3N | 4N | 1D          | 2D | 3D | 4D  | 1N                      | 2N  | 3N  | 4N  | 1D                    | 2D | 3D | 4D  |
| <b>BACILLARIOPHYTA</b>                                      |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |     |                         |     |     |     |                       |    |    |     |
| <i>Coscinodiscus asteromphalus</i> Ehrenberg                |                       |    |    |    |                     |    |    |    |               |    | 1  |    |             |    | 2  |     |                         |     |     | 2   |                       | 1  | 1  | 4   |
| <i>Coscinodiscus concinnus</i> W. Smith                     |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |     |                         |     | 3   |     |                       |    |    | 1   |
| <i>Coscinodiscus granii</i> Gough                           | 1                     | 1  | 1  |    |                     |    |    |    |               |    |    |    |             |    |    |     |                         |     |     | 1   | 2                     |    | 1  |     |
| <i>Coscinodiscus oculus iridis</i> Ehrenberg                |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |     |                         |     |     |     |                       |    |    |     |
| <i>Coscinodiscus</i> spp                                    | 1                     |    | 1  | 7  | 7                   | 2  | 1  | 1  | 1             | 1  | 5  |    | 4           | 4  | 1  | 125 | 95                      | 142 | 151 | 152 | 63                    | 50 | 57 | 177 |
| <i>Cylindrotheca closterium</i> (Ehrenberg) Lewin y Reimann | 1                     |    |    | 30 |                     |    | 1  |    | 6             |    | 12 |    | 1           |    | 9  |     |                         | 2   | 2   | 3   | 1                     |    | 1  |     |
| <i>Dactyliosolen fragilissimus</i> (Bergon) Hasle           |                       |    |    |    |                     |    |    |    |               |    |    |    | 1           |    |    |     |                         |     |     |     |                       |    |    |     |
| <i>Ditylum brightwellii</i> (West) Grun                     | 1                     |    |    |    | 7                   | 3  | 3  |    |               |    |    |    | 7           | 1  | 4  |     | 1                       | 2   | 3   |     | 3                     |    | 1  |     |
| <i>Entomoneis alata</i> (Ehrenberg) Ehrenberg               |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |     |                         | 1   |     |     | 2                     |    | 1  |     |
| <i>Eucampia zodiacus</i> Ehrenberg                          | 1                     | 3  | 1  |    |                     | 1  |    |    | 2             |    |    |    |             |    |    |     | 1                       |     |     |     |                       |    |    |     |
| <i>Grammatophora</i> sp                                     |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |     |                         |     |     |     |                       |    | 64 |     |
| <i>Guinardia flaccida</i> (Castracane) H. Peragallo         | 2                     | 2  |    | 1  |                     | 2  | 2  | 1  | 2             | 2  | 2  | 3  | 2           | 3  | 2  |     | 6                       | 2   |     |     | 1                     | 4  | 3  |     |
| <i>Guinardia striata</i> (Stolterfoth) Hasle                | 9                     | 10 | 4  | 1  | 4                   | 13 | 26 |    | 5             | 9  | 5  |    | 15          | 12 | 6  |     | 7                       | 9   | 2   | 2   | 10                    | 1  | 6  |     |
| <i>Helicotheca tamesis</i> (Shrubsole) Ricard               | 2                     | 5  | 1  | 2  | 4                   | 2  | 4  |    | 2             | 1  | 3  |    |             | 1  | 3  | 11  |                         |     |     |     | 1                     |    | 1  | 1   |
| <i>Hemiaulus hauckii</i> Grun                               | 1                     | 1  |    |    | 1                   | 3  | 2  |    | 6             | 1  |    |    | 7           | 6  | 3  |     | 1                       | 3   | 3   |     | 1                     |    |    |     |
| <i>Hemiaulus membranaceus</i> Cleve                         | 2                     | 1  | 2  |    | 2                   |    |    |    |               |    |    |    | 2           | 2  | 3  |     |                         | 1   |     |     |                       |    | 1  |     |
| <i>Hemiaulus sinensis</i> Grev.                             |                       |    |    |    |                     |    | 1  |    |               |    |    |    |             |    |    |     |                         |     |     |     |                       |    |    |     |
| <i>Lauderia annulata</i> Cleve                              |                       | 1  | 4  |    |                     | 4  | 8  |    | 1             | 3  | 3  |    | 10          | 8  | 10 | 1   |                         | 7   | 4   |     | 1                     | 1  |    |     |

Table EA-5 – Continued

| Species  | Fishing Grounds Night |    |    |    | Fishing Grounds Day |    |    |    | Site 15 Night |    |    |    | Site 15 Day |    |    |    | Artificial Island Night |    |    |    | Artificial Island Day |    |    |    |
|--|-----------------------|----|----|----|---------------------|----|----|----|---------------|----|----|----|-------------|----|----|----|-------------------------|----|----|----|-----------------------|----|----|----|
|  | 1N                    | 2N | 3N | 4N | 1D                  | 2D | 3D | 4D | 1N            | 2N | 3N | 4N | 1D          | 2D | 3D | 4D | 1N                      | 2N | 3N | 4N | 1D                    | 2D | 3D | 4D |
| <b>BACILLARIOPHYTA</b>   |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Lectocylindrus danicus</i> Cleve  | 8                     |    | 2  |    | 2                   | 3  | 13 | 1  | 10            | 3  | 3  |    | 13          | 12 | 5  | 2  | 3                       | 4  | 2  | 1  | 5                     | 2  | 4  |    |
| <i>Licmophora</i> sp   | 3                     |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       | 16 |    |    |
| <i>Lioloma pacificum</i> (Cupp) Hasle  | 7                     | 4  | 2  | 15 | 18                  | 5  | 5  |    | 5             | 5  | 4  | 10 | 2           | 10 | 12 | 12 | 4                       | 4  | 4  | 3  | 13                    | 4  | 10 | 1  |
| <i>Lithodesmium undulatum</i> Ehrenberg  |                       |    | 2  |    |                     |    |    |    |               |    |    |    |             |    |    |    | 1                       |    | 2  |    | 4                     | 2  | 2  |    |
| <i>Meuniera membranacea</i> (Cleve) P. C. Silva                                  |                       |    |    |    |                     |    |    |    |               |    |    |    |             | 1  |    |    |                         |    |    |    |                       |    |    |    |
| <i>Neocalyptrella robusta</i> Hernández -Becerril y Meave del Castillo           | 1                     |    | 1  | 1  | 1                   |    | 3  |    | 3             |    | 1  |    | 1           | 2  |    | 1  | 1                       |    | 1  | 2  |                       | 1  |    | 3  |
| <i>Neostreptothea subindica</i> von Stosch                                       |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Nitzschia behrei</i> Hustedt  |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    | 3                     | 1  |    |    |
| <i>Nitzschia cf. ventricosa</i> Kitton   |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Nitzschia reversa</i> W. Smith  |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Nitzschia</i> sp1   |                       | 2  | 2  |    |                     |    | 2  |    | 1             | 2  | 1  |    | 5           | 2  |    |    | 1                       |    |    | 1  | 6                     |    |    |    |
| <i>Nitzschia sigma</i> (Kützing) W. Smith  |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    | 1  |    |                       |    |    |    |
| <i>Odontella mobiliensis</i> (Bailey) Grunow                                     |                       |    |    |    |                     | 1  |    |    |               |    |    |    | 1           | 1  |    |    |                         |    |    |    | 1                     |    |    |    |
| <i>Odontella regia</i> C. A. Agardh  |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Odontella sinensis</i> (Grville) Grunow                                       |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    | 1  |    | 1                       |    | 1  |    | 3                     |    | 2  |    |
| <i>Paralia sulcata</i> (Ehrenberg) Cleve   |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    | 1  |    |                       |    |    |    |
| <i>Petrodictyon gemma</i> (Ehr.) D. G. Mann <i>en</i> Round <i>et al.</i> , 1990 |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Planktoniella muriformis</i> (Loeblich, Wight y Darley) Round                 |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Pleurosigma cf. angulatum</i> (Quekett) Wm. Smith                             |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |

Table EA-5 – Continued

| Species   | Fishing Grounds Night |    |    |    | Fishing Grounds Day |    |    |    | Site 15 Night |    |    |    | Site 15 Day |    |    |    | Artificial Island Night |    |    |    | Artificial Island Day |    |    |    |
|---|-----------------------|----|----|----|---------------------|----|----|----|---------------|----|----|----|-------------|----|----|----|-------------------------|----|----|----|-----------------------|----|----|----|
|   | 1N                    | 2N | 3N | 4N | 1D                  | 2D | 3D | 4D | 1N            | 2N | 3N | 4N | 1D          | 2D | 3D | 4D | 1N                      | 2N | 3N | 4N | 1D                    | 2D | 3D | 4D |
| <b>BACILLARIOPHYTA</b>  |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Pleurosigma naviculaceum</i> Brébisson                                   |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    | 2                       |    |    |    |                       |    |    | 1  |
| <i>Pleurosigma normanii</i> Ralfs   |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Proboscia alata</i> (Brightwell) Sundström                               | 9                     | 19 | 2  | 40 | 20                  | 20 | 10 | 1  | 9             | 6  | 5  | 6  | 15          | 22 | 25 | 50 | 32                      | 21 | 10 | 5  | 30                    | 23 | 30 | 13 |
| <i>Pseudonitzschia pungens</i> (Grunow) Hasle forma <i>pungens</i> (Grunow) |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| Hasle   | 29                    | 12 | 16 | 7  | 46                  | 19 | 21 |    | 42            | 8  | 6  | 2  | 15          | 15 | 15 | 1  | 5                       | 2  | 6  | 8  | 10                    | 5  | 2  | 1  |
| <i>Pseudosolenia calcar-avis</i> (Schultze) Sundström                       | 2                     | 7  | 1  | 3  | 1                   | 2  | 14 | 1  | 2             | 3  | 4  | 7  | 5           | 8  | 4  | 29 | 8                       | 5  | 5  | 1  | 1                     | 6  | 2  | 3  |
| <i>Rizosolenia acuminata</i> (H. Peragallo) H. Peragallo                    |                       |    | 1  |    |                     |    | 4  |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Rizosolenia bergonii</i> H. Pér.   | 2                     | 1  |    |    | 1                   | 1  | 2  |    | 2             | 1  | 2  |    | 4           | 8  | 2  | 1  | 4                       | 4  | 5  |    | 1                     | 1  | 3  |    |
| <i>Rizosolenia hyalina</i> Ostenfeld  | 1                     |    | 1  | 2  | 2                   | 2  |    |    |               | 1  |    |    |             |    | 1  |    | 2                       | 2  | 1  |    | 1                     | 1  |    |    |
| <i>Rizosolenia imbricata</i> Brightwell                                     |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Rizosolenia pungens</i> Cleve-Euler                                      | 1                     |    |    | 1  | 3                   | 1  |    |    | 1             | 1  |    |    | 3           | 7  | 2  |    | 2                       | 5  |    |    | 3                     |    | 1  |    |
| <i>Rizosolenia setigera</i> Brightwell                                      | 1                     | 1  |    |    | 2                   | 4  | 3  |    |               |    | 7  |    | 1           | 2  |    |    | 4                       | 1  | 1  | 4  |                       |    |    |    |
| <i>Rizosolenia striata</i> Greville   |                       | 1  |    | 1  |                     |    | 3  |    |               |    |    |    |             | 1  |    |    |                         |    |    | 3  |                       |    | 1  |    |
| <i>Rizosolenia styliformis</i> Brightwell                                   |                       | 3  |    | 2  | 3                   | 4  | 3  |    |               | 1  |    |    | 5           | 3  | 13 | 3  |                         |    |    | 4  | 1                     |    |    |    |
| <i>Skeletonema costatum</i> (Greville) Cleve                                |                       |    |    |    | 1                   | 2  |    |    | 1             |    |    |    | 5           | 1  | 1  |    | 1                       |    |    |    | 1                     |    | 1  |    |
| <i>Stephanopyxis turris</i> (Grev. And Arn.) Ralfs                          |                       |    |    |    |                     |    |    |    |               |    |    |    | 1           | 2  | 1  |    |                         |    |    |    |                       |    |    |    |
| <i>Synedra goulardi</i> Brébisson   | 2                     | 2  | 2  |    |                     | 4  | 5  |    |               |    |    |    | 3           |    |    |    |                         |    |    |    |                       |    |    |    |
| <i>Thalassionema frauenfeldii</i> (Grunow) Hallegraeff                      |                       |    |    |    |                     |    |    |    |               |    |    |    |             |    |    |    |                         |    |    |    |                       |    | 1  |    |



Table EA-5 – Continued

| Species   | Fishing Grounds Night |            |            |            | Fishing Grounds Day |            |            |            | Site 15 Night |            |            |            | Site 15 Day |            |            |            | Artificial Island Night |            |            |            | Artificial Island Day |            |            |            |
|---|-----------------------|------------|------------|------------|---------------------|------------|------------|------------|---------------|------------|------------|------------|-------------|------------|------------|------------|-------------------------|------------|------------|------------|-----------------------|------------|------------|------------|
|   | 1N                    | 2N         | 3N         | 4N         | 1D                  | 2D         | 3D         | 4D         | 1N            | 2N         | 3N         | 4N         | 1D          | 2D         | 3D         | 4D         | 1N                      | 2N         | 3N         | 4N         | 1D                    | 2D         | 3D         | 4D         |
| <b>DINOPHYTA</b>  |                       |            |            |            |                     |            |            |            |               |            |            |            |             |            |            |            |                         |            |            |            |                       |            |            |            |
| <i>Ornithocercus steini</i> Schütt                      |                       |            |            |            |                     |            | 1          |            |               |            |            |            |             |            | 1          |            |                         |            |            |            |                       |            |            |            |
| <i>Oxytoxum</i> sp                                      |                       |            |            |            |                     |            |            |            |               |            |            |            |             |            |            |            | 1                       |            |            |            | 1                     |            |            |            |
| <i>Peridinium</i> cf <i>granii</i> Ostenfeld            | 6                     | 5          | 10         |            | 22                  | 18         | 10         |            | 8             | 8          | 3          |            | 4           | 1          | 8          | 1          | 16                      | 17         | 10         |            | 28                    | 42         | 20         | 6          |
| <i>Peridinium</i> cf. <i>oceanicum</i> Vanhöffen        |                       | 10         | 1          |            | 1                   | 1          | 4          |            |               |            | 3          |            |             | 2          | 2          |            | 3                       | 3          | 1          |            | 2                     | 4          | 3          |            |
| <i>Peridinium crassipes</i> Kofoid                      |                       |            |            |            |                     |            |            |            |               |            | 1          |            |             |            |            |            |                         |            |            |            |                       |            |            | 2          |
| <i>Peridinium pedunculatum</i> Schütt                   | 1                     | 6          |            |            | 2                   |            |            |            | 4             | 2          | 1          |            | 1           |            |            |            | 1                       | 1          |            |            | 3                     | 3          |            | 1          |
| <i>Peridinium</i> sp <sub>1</sub>                       |                       |            |            |            | 1                   |            |            |            |               |            |            |            |             |            |            |            | 5                       | 4          | 2          |            | 2                     | 1          |            |            |
| <i>Peridinium</i> sp <sub>2</sub>                       |                       |            |            |            |                     |            |            |            |               |            |            |            |             |            |            |            |                         |            |            |            |                       |            |            |            |
| <i>Prorocentrum gracile</i> Schütt                      | 2                     | 2          | 1          |            |                     |            | 5          |            | 2             | 1          | 1          |            | 3           | 1          | 2          |            | 2                       |            |            |            | 2                     | 1          | 3          |            |
| <i>Prorocentrum micans</i> Ehrenberg                    |                       |            |            |            |                     |            |            |            |               |            | 1          |            |             |            |            |            |                         | 1          | 2          |            | 4                     |            |            |            |
| <i>Pyrocystis fusiformis</i> Wyville-Thomson y Blackman |                       |            |            |            |                     | 1          |            |            |               |            |            |            |             |            |            |            |                         |            |            |            |                       |            |            |            |
| <i>Pyrophacus horologium</i> Stein                      | 9                     | 23         | 22         | 1          | 50                  | 89         | 35         |            | 21            | 7          | 19         |            | 7           | 11         | 12         |            |                         |            |            |            | 1                     | 10         | 25         |            |
| <b>TOTAL</b>  | <b>300</b>            | <b>300</b> | <b>300</b> | <b>300</b> | <b>300</b>          | <b>300</b> | <b>300</b> | <b>300</b> | <b>300</b>    | <b>300</b> | <b>300</b> | <b>300</b> | <b>300</b>  | <b>300</b> | <b>300</b> | <b>300</b> | <b>300</b>              | <b>300</b> | <b>300</b> | <b>300</b> | <b>300</b>            | <b>300</b> | <b>300</b> | <b>300</b> |

Table EA-6: Absolute Frequency of Phytoplankton Species in Dirunal and Nocturnal nearshore samples in the Bay of Panama.

| Species  | Site 2 Night |    |    | Site 2 Day |    |    | Causeway Night |    |    |    |    |    | Causeway Day |    |    |    |    |    | Chorrillo Night |    |    | Chorrillo Day |    |    |
|--|--------------|----|----|------------|----|----|----------------|----|----|----|----|----|--------------|----|----|----|----|----|-----------------|----|----|---------------|----|----|
|  | 1N           | 2N | 3N | 1D         | 2D | 3D | 1N             | 2N | 3N | 4N | 5N | 6N | 1D           | 2D | 3D | 4D | 5D | 6D | 1N              | 2N | 3N | 1D            | 2D | 3D |
| <b>BACILLARIOPHYTA</b>   |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Actinocyclus</i> spp  |              |    |    |            |    |    | 81             | 51 | 18 |    |    |    | 19           | 25 | 13 | 1  | 2  |    | 4               | 15 | 76 |               |    |    |
| <i>Actinopterychus senarius</i> (Ehrenberg) Ehrenberg                                |              | 2  | 2  |            | 1  | 2  |                |    |    |    |    |    |              |    |    |    |    |    |                 | 1  |    |               |    | 1  |
| <i>Asterionellopsis glacialis</i> (Castracane) Round (en Round <i>et al.</i> , 1990) |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Bacteriastrium</i> cf. <i>mediterraneum</i> Pavillard                             |              |    |    |            |    |    |                |    |    |    |    |    | 1            | 1  |    |    |    |    |                 |    |    |               |    | 1  |
| <i>Bacteriastrium delicatulum</i> Cleve  |              |    |    |            |    |    | 1              |    |    |    |    |    | 4            |    | 4  |    |    |    |                 |    |    |               |    | 1  |
| <i>Bacteriastrium furcatum</i> Shadbolt  | 1            |    |    |            |    |    |                |    |    | 1  |    |    |              |    |    |    |    |    |                 |    |    | 1             |    |    |
| <i>Bacteriatrum hyalinum</i> Lauder  | 1            |    |    |            |    |    |                |    |    | 1  |    |    |              |    | 4  |    |    |    |                 |    |    |               |    |    |
| <i>Cerataulina pelagica</i> (Cleve) Hendey   |              |    |    |            |    |    |                | 1  |    |    |    |    |              |    | 1  | 2  |    |    |                 |    |    |               |    |    |
| <i>Chaetoceros affinis</i> Lauder  |              |    |    |            |    |    | 1              | 3  |    | 2  | 3  | 11 | 15           | 17 |    |    |    |    |                 | 1  |    | 4             | 2  | 6  |
| <i>Chaetoceros affinis</i> Lauder var. <i>willè</i> (Gran) Hustedt                   |              |    |    |            |    |    |                |    |    |    |    |    | 1            | 1  |    |    |    |    |                 |    |    |               |    |    |
| <i>Chaetoceros anastomosans</i> Grunow en Van Heurck                                 | 4            |    |    |            |    |    | 2              | 2  | 2  |    |    | 34 | 45           | 31 |    |    |    |    |                 |    |    | 15            | 7  |    |
| <i>Chaetoceros brevis</i> Schütt   | 7            |    |    |            |    |    |                |    | 2  |    |    | 1  | 9            | 3  |    |    |    |    |                 |    |    | 3             | 2  |    |
| <i>Chaetoceros coarctatus</i> Lauder   |              |    |    |            |    |    |                | 1  | 1  |    |    | 3  | 2            | 7  |    |    |    |    |                 |    |    | 2             | 2  | 2  |
| <i>Chaetoceros</i> cf. <i>densus</i> Cleve   |              |    |    |            |    |    | 1              |    |    |    | 3  |    | 1            |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Chaetoceros eros costatus</i> Pavillard   |              |    |    |            |    |    |                |    |    |    |    |    | 1            |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Chaetoceros curvisetus</i> Cleve  | 2            | 2  | 9  | 1          | 1  |    | 1              | 2  | 2  | 34 | 4  | 55 | 17           | 3  | 13 |    |    |    | 3               | 2  | 3  | 11            | 7  | 4  |
| <i>Chaetoceros debilis</i> Cleve   |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Chaetoceros decipiens</i> Cleve   |              |    |    |            |    |    | 1              | 1  | 1  |    |    | 2  | 1            | 5  |    |    |    |    |                 |    |    |               | 2  |    |

Table EA-6 – Continued

| Species   | Site 2 Night |    |    | Site 2 Day |    |    | Causeway Night |    |    |    |     |    | Causeway Day |    |    |    |    |    | Chorrillo Night |    |    | Chorrillo Day |    |    |   |   |   |
|---|--------------|----|----|------------|----|----|----------------|----|----|----|-----|----|--------------|----|----|----|----|----|-----------------|----|----|---------------|----|----|---|---|---|
|   | 1N           | 2N | 3N | 1D         | 2D | 3D | 1N             | 2N | 3N | 4N | 5N  | 6N | 1D           | 2D | 3D | 4D | 5D | 6D | 1N              | 2N | 3N | 1D            | 2D | 3D |   |   |   |
| BACILLARIOPHYTA   |              |    |    |            |    |    |                |    |    |    |     |    |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros denticulatus forma angusta</i> Hustedt             |              |    |    |            |    |    |                |    |    |    |     |    | 1            | 1  | 1  |    |    |    |                 |    |    |               |    |    | 1 |   |   |
| <i>Chaetoceros didymus var. didymus</i> Ehrenberg                 |              |    |    |            |    |    |                |    |    |    |     |    | 1            |    | 1  |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros didymus var. protuberans</i> (Lauder) Gran y Yendo |              |    |    |            |    |    |                |    |    |    |     |    | 1            |    |    |    |    |    |                 |    |    |               |    |    |   | 1 |   |
| <i>Chaetoceros diversus</i> Cleve                                 |              |    |    |            |    |    |                | 1  |    |    |     |    |              |    | 1  |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros filiferum</i> Karsten                              |              |    |    |            |    |    |                |    |    |    |     |    |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros lacinosus</i> Schütt                               |              |    |    |            |    |    |                |    |    |    |     |    |              |    | 1  |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros lorenzianus</i> Grunow                             | 1            |    |    |            |    |    |                | 1  | 6  | 1  | 3   | 25 | 23           | 24 |    |    |    |    | 1               |    |    |               |    |    | 8 | 4 | 5 |
| <i>Chaetoceros pelagicus</i> Cleve                                |              |    |    |            |    |    |                |    |    |    |     |    | 1            |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros peruvianus</i> Cleve                               |              |    |    |            |    |    |                | 1  |    |    |     | 5  | 6            | 4  |    |    |    |    |                 |    |    |               |    |    | 5 | 3 | 1 |
| <i>Chaetoceros pseudocurvisetus</i> Mangin                        |              |    |    |            |    |    |                |    |    |    |     |    |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros radicans</i> Schütt                                |              |    |    |            |    |    |                |    |    |    |     |    |              | 2  |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros rostratus</i> Lauder                               |              |    |    |            |    |    |                |    |    |    | 2   | 2  |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros socialis</i> Lauder                                | 1            |    |    |            |    |    |                |    |    | 37 | 151 |    |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros sp1</i>  |              |    |    |            |    |    |                |    |    |    |     |    |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros tortissimus</i> Gran                               | 1            |    |    |            |    |    |                |    |    |    |     | 1  |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |
| <i>Chaetoceros whigamii</i> Brightwell                            |              |    |    |            |    |    |                |    |    |    |     |    |              |    |    |    |    |    |                 |    |    |               |    |    |   |   |   |

Table EA-6 – Continued

| Species   | Site 2 Night |     |     | Site 2 Day |     |     | Causeway Night |    |    |    |     |    | Causeway Day |    |    |     |     |     | Chorrillo Night |     |     | Chorrillo Day |    |     |  |
|---|--------------|-----|-----|------------|-----|-----|----------------|----|----|----|-----|----|--------------|----|----|-----|-----|-----|-----------------|-----|-----|---------------|----|-----|--|
|   | 1N           | 2N  | 3N  | 1D         | 2D  | 3D  | 1N             | 2N | 3N | 4N | 5N  | 6N | 1D           | 2D | 3D | 4D  | 5D  | 6D  | 1N              | 2N  | 3N  | 1D            | 2D | 3D  |  |
| BACILLARIOPHYTA   |              |     |     |            |     |     |                |    |    |    |     |    |              |    |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Coscinodiscus asteromphalus</i> Ehrenberg                |              |     |     |            |     |     | 3              |    | 3  | 5  | 2   | 1  |              |    | 1  | 1   | 3   | 3   | 7               | 3   | 15  |               |    |     |  |
| <i>Coscinodiscus concinnus</i> W. Smith                     |              |     |     |            |     |     |                |    | 8  | 4  |     |    |              |    |    |     |     |     |                 | 4   |     |               | 1  |     |  |
| <i>Coscinodiscus granii</i> Gough                           | 1            |     | 2   | 3          |     | 2   | 1              | 4  | 2  |    |     |    | 4            |    |    | 1   |     |     | 2               | 1   | 4   |               | 1  | 1   |  |
| <i>Coscinodiscus oculus iridis</i> Ehrenberg                |              |     |     |            |     |     | 3              |    |    |    |     |    |              |    |    |     |     |     | 1               | 2   | 1   |               |    |     |  |
| <i>Coscinodiscus</i> spp                                    | 196          | 255 | 253 | 267        | 268 | 276 | 100            | 30 | 4  | 60 | 233 | 15 | 25           | 5  |    | 244 | 251 | 267 | 215             | 245 | 151 | 36            | 81 | 142 |  |
| <i>Cylindrotheca closterium</i> (Ehrenberg) Lewin y Reimann |              |     |     |            | 1   |     |                |    |    | 20 | 27  | 35 | 8            | 9  | 4  |     |     |     |                 |     |     |               |    |     |  |
| <i>Dactiliosolen fragilissimus</i> (Bergon) Hasle           |              |     |     |            |     |     |                |    |    |    |     |    |              |    |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Ditylum brightwellii</i> (West) Grun                     |              |     |     |            |     |     |                |    | 2  | 1  |     |    | 1            | 1  | 3  |     |     |     |                 |     |     |               | 1  |     |  |
| <i>Entomoneis alata</i> (Ehrenberg) Ehrenberg               |              |     |     |            |     |     |                |    |    |    |     |    |              |    |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Eucampia zoodiacus</i> Ehrenberg                         |              |     |     |            |     |     |                |    |    |    |     |    | 1            |    |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Grammatophora</i> sp                                     |              |     |     |            |     |     |                |    |    |    |     |    |              |    |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Guinardia flaccida</i> (Castracane) H. Peragallo         |              |     |     |            |     |     |                | 1  |    |    |     | 2  |              | 3  | 2  |     |     |     |                 |     |     | 1             |    |     |  |
| <i>Guinardia striata</i> (Stolterfoth) Hasle                | 2            | 1   |     |            |     |     |                | 1  | 1  | 7  | 2   | 7  | 10           | 10 | 6  |     |     |     |                 |     |     |               |    |     |  |
| <i>Helicotheca tamesis</i> (Shrubsole) Ricard               |              |     |     |            |     |     |                |    | 1  |    |     |    |              |    |    |     |     |     | 1               |     |     |               |    | 2   |  |
| <i>Hemiaulus hauckii</i> Grun                               | 2            |     |     |            |     |     |                |    |    |    |     |    | 2            | 1  |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Hemiaulus membranaceus</i> Cleve                         |              |     |     |            |     |     |                |    |    |    |     |    | 1            |    |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Hemiaulus sinensis</i> Grev.                             |              |     |     |            |     |     |                |    |    |    |     |    |              |    |    |     |     |     |                 |     |     |               |    |     |  |
| <i>Lauderia annulata</i> Cleve                              | 1            |     | 1   |            |     |     |                |    |    |    |     |    | 10           | 7  | 3  |     |     |     |                 |     |     |               |    | 2   |  |

Table EA-6 – Continued

| Species  | Site 2 Night |    |    | Site 2 Day |    |    | Causeway Night |    |    |    |    |    | Causeway Day |    |    |    |    |    | Chorrillo Night |    |    | Chorrillo Day |    |    |
|--|--------------|----|----|------------|----|----|----------------|----|----|----|----|----|--------------|----|----|----|----|----|-----------------|----|----|---------------|----|----|
|  | 1N           | 2N | 3N | 1D         | 2D | 3D | 1N             | 2N | 3N | 4N | 5N | 6N | 1D           | 2D | 3D | 4D | 5D | 6D | 1N              | 2N | 3N | 1D            | 2D | 3D |
| BACILLARIOPHYTA  |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Lectocilyndrus danicus</i> Cleve  |              |    |    |            |    |    | 2              | 1  | 1  | 1  |    |    | 7            | 12 | 13 |    |    |    | 1               |    |    | 2             | 1  | 1  |
| <i>Licmophora</i> sp   | 3            |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Lioloma pacificum</i> (Cupp) Hasle  |              |    |    | 1          | 2  |    | 1              | 2  | 11 | 1  | 3  | 2  | 1            | 12 | 13 |    |    |    | 3               |    | 2  | 5             | 4  | 7  |
| <i>Lithodesmium undulatum</i> Ehrenberg  |              |    |    | 1          |    |    | 1              |    |    |    | 1  |    |              |    |    |    |    |    |                 |    |    | 3             | 1  |    |
| <i>Meuniera membranacea</i> (Cleve) P. C. Silva                                  |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Neocalyptrella robusta</i> Hernández - Becerril y Meave del Castillo          |              | 1  |    |            |    |    |                |    | 1  |    |    |    | 1            |    |    |    |    |    |                 |    |    | 1             |    |    |
| <i>Neostreptothea subindica</i> von Stosch                                       | 1            |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 | 1  |    |               |    |    |
| <i>Nitzschia behrei</i> Hustedt  |              |    |    |            | 2  |    |                |    |    |    | 9  |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Nitzschia cf. ventricosa</i> Kitton   |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    | 1  |    |    |                 |    |    |               |    |    |
| <i>Nitzschia reversa</i> W. Smith  |              |    |    |            |    |    |                |    |    |    | 84 | 1  |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Nitzschia</i> sp1   | 3            |    |    |            |    |    |                |    |    |    |    |    | 1            | 2  |    |    |    |    |                 |    |    | 2             |    |    |
| <i>Nitzschia sigma</i> (Kützing) W. Smith  |              |    |    |            | 1  |    |                |    |    |    |    |    |              | 1  | 1  |    |    |    |                 |    |    | 1             |    |    |
| <i>Odontella mobiliensis</i> (Bailey) Grunow                                     |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    | 1  |
| <i>Odontella regia</i> C. A. Agardh  |              |    |    |            | 1  |    |                |    |    |    |    |    | 1            |    |    |    |    |    |                 |    |    | 2             |    |    |
| <i>Odontella sinensis</i> (Grville) Grunow                                       |              |    |    |            |    |    | 1              |    | 3  |    |    |    |              |    |    |    |    |    | 6               |    | 5  |               | 5  |    |
| <i>Paralia sulcata</i> (Ehrenberg) Cleve   | 1            |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Petrodictyon gemma</i> (Ehr.) D. G. Mann <i>en</i> Round <i>et al.</i> , 1990 |              |    |    |            |    | 1  |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |
| <i>Planktoniella muriformis</i> (Loeblich, Wight y Darley) Round                 |              |    |    |            |    |    |                |    |    |    |    |    |              |    | 1  |    |    |    | 1               |    |    |               |    | 1  |
| <i>Pleurosigma cf. angulatum</i> (Quekett) Wm. Smith                             |              | 1  |    |            |    |    |                |    |    |    | 1  |    |              |    |    |    |    |    |                 |    |    |               |    | 1  |

Table EA-6 – Continued

| Species  | Site 2 Night |    |    | Site 2 Day |    |    | Causeway Night |    |    |    |    |    | Causeway Day |    |    |    |    |    | Chorrillo Night |    |    | Chorrillo Day |    |    |  |
|--|--------------|----|----|------------|----|----|----------------|----|----|----|----|----|--------------|----|----|----|----|----|-----------------|----|----|---------------|----|----|--|
|  | 1N           | 2N | 3N | 1D         | 2D | 3D | 1N             | 2N | 3N | 4N | 5N | 6N | 1D           | 2D | 3D | 4D | 5D | 6D | 1N              | 2N | 3N | 1D            | 2D | 3D |  |
| <b>BACILLARIOPHYTA</b>   |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Pleurosigma naviculaceum</i> Brébisson  |              |    |    |            | 1  |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Pleurosigma normanii</i> Ralfs  |              |    |    |            |    |    | 1              |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Prosbocia alata</i> (Brightwell) Sundström  | 13           | 2  | 3  | 2          | 3  | 3  | 3              | 11 | 35 | 2  | 4  | 4  | 8            | 18 | 36 |    |    | 1  |                 | 1  | 11 | 15            | 6  |    |  |
| <i>Pseudonitzschia pungens</i> (Grunow) Hasle forma <i>pungens</i> (Grunow)<br>Hasle | 6            |    |    | 2          | 1  |    |                |    | 2  | 5  | 1  | 1  | 15           | 15 | 7  |    |    |    |                 |    | 1  |               | 1  |    |  |
| <i>Pseudosolenia calcar-avis</i> (Schultze) Sundström                                | 1            | 2  | 1  |            | 1  |    | 1              | 4  | 2  | 5  | 2  | 2  | 6            | 3  | 4  | 1  |    |    | 1               | 1  | 2  | 1             | 1  |    |  |
| <i>Rizosolenia acuminata</i> (H. Peragallo) H. Peragallo                             |              |    |    |            |    |    | 1              |    |    |    |    |    | 1            |    |    |    |    |    |                 |    |    |               | 1  |    |  |
| <i>Rizosolenia bergonii</i> H. Pér.  | 2            |    | 1  |            |    |    | 2              | 1  |    |    |    |    | 1            | 4  | 4  |    |    |    |                 |    |    |               | 1  |    |  |
| <i>Rizosolenia hyalina</i> Ostenfeld   |              | 1  |    |            |    |    |                |    | 1  |    |    |    |              |    |    |    |    |    |                 |    |    |               | 1  |    |  |
| <i>Rizosolenia imbricata</i> Brightwell  |              |    | 1  |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Rizosolenia pungens</i> Cleve-Euler   |              |    |    | 1          | 1  |    |                |    |    |    |    |    | 1            | 1  | 1  |    |    |    |                 |    |    |               |    |    |  |
| <i>Rizosolenia setigera</i> Brightwell   | 2            |    |    |            |    |    |                |    | 10 | 5  | 5  |    |              |    |    |    |    |    | 1               |    |    |               |    |    |  |
| <i>Rizosolenia striata</i> Greville  |              |    |    |            | 1  |    |                |    | 2  | 1  | 2  |    |              |    |    |    |    |    |                 |    |    | 1             |    |    |  |
| <i>Rizosolenia styliformis</i> Brightwell  |              |    |    |            |    |    |                |    | 1  | 5  | 5  | 2  | 2            | 4  | 1  |    |    |    |                 |    |    |               |    |    |  |
| <i>Skeletonema costatum</i> (Greville) Cleve   |              |    |    | 2          | 7  | 2  | 1              |    | 1  |    |    | 1  |              | 6  |    |    |    | 1  |                 |    |    | 8             | 3  | 4  |  |
| <i>Stephanopyxis turris</i> (Grev. And Arn.) Ralfs                                   |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               | 1  |    |  |
| <i>Synedra gouldardii</i> Brébisson  |              |    |    |            |    |    |                |    |    |    |    |    | 2            | 1  | 3  |    |    |    |                 |    |    |               |    |    |  |
| <i>Thalassionema frauenfeldii</i> (Grunow) Hallegraeff                               |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |

Table EA-6 – Continued

| Species  | Site 2 Night |    |    | Site 2 Day |    |    | Causeway Night |    |    |    |    |    | Causeway Day |    |    |    |    |    | Chorrillo Night |    |    | Chorrillo Day |    |    |  |
|--|--------------|----|----|------------|----|----|----------------|----|----|----|----|----|--------------|----|----|----|----|----|-----------------|----|----|---------------|----|----|--|
|  | 1N           | 2N | 3N | 1D         | 2D | 3D | 1N             | 2N | 3N | 4N | 5N | 6N | 1D           | 2D | 3D | 4D | 5D | 6D | 1N              | 2N | 3N | 1D            | 2D | 3D |  |
| <b>BACILLARIOPHYTA</b>                                       |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Thalassionema nitzschioides</i> Grun                      |              |    |    |            |    | 1  |                |    |    |    |    |    |              | 1  |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Thalassiosira</i> sp                                      |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Thalassiosira eccentrica</i> (Ehr.) Cleve                 |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <b>DINOPHYTA</b>   |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Amphisolenia bidentata</i> Schröder                       |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Ceratium candelabrum</i> (Ehrenberg) Stein                |              |    |    |            |    |    |                |    | 2  |    |    |    | 1            |    |    |    |    |    |                 |    |    |               | 1  |    |  |
| <i>Ceratium furca</i> (Ehrenberg) Claparède y Lachmann       | 9            | 5  | 6  | 7          | 3  | 3  | 3              | 8  | 20 | 2  | 3  | 10 | 1            | 14 |    | 1  |    |    | 7               | 3  | 5  | 84            | 75 | 45 |  |
| <i>Ceratium fusus</i> (Ehrenberg) Dujardin                   |              |    |    |            |    |    | 2              | 3  | 20 |    |    | 3  | 4            |    |    |    | 1  |    | 2               | 1  | 2  | 15            | 18 | 7  |  |
| <i>Ceratium horridum</i> Gran                                |              |    |    |            |    |    | 1              |    | 4  |    | 1  |    | 1            | 8  |    |    |    |    | 2               |    |    | 3             | 2  | 3  |  |
| <i>Ceratium karstenii</i> Pavillard                          |              |    |    |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Ceratium pentagonum</i> Gourret                           |              |    |    |            |    |    |                | 1  | 2  |    |    | 1  | 3            |    |    |    |    |    |                 |    |    |               | 1  |    |  |
| <i>Ceratium trichoceros</i> (Ehrenberg) Kofoid               | 1            |    |    | 1          |    | 5  | 1              | 1  | 7  |    |    | 1  | 1            | 12 |    |    |    |    | 1               |    |    | 11            | 9  | 10 |  |
| <i>Ceratium tripos</i> (O. F. Müller) Nitzsch                |              |    |    |            |    |    | 2              | 12 | 17 |    |    | 3  | 1            | 9  |    |    |    |    | 3               | 2  |    | 10            | 5  | 3  |  |
| <i>Ceratium tripos</i> forma <i>semipulchellum</i> Jörgensen |              |    | 1  |            |    |    |                |    |    |    |    |    |              |    |    |    |    |    |                 |    |    |               |    |    |  |
| <i>Dinophysis caudata</i> Stein                              |              | 2  |    |            |    |    |                | 2  | 1  |    |    | 1  |              |    |    |    | 1  |    | 1               | 1  | 2  |               |    |    |  |
| <i>Noctiluca scintillans</i> (Macartney) Kofoid y Swezy      | 7            | 4  | 3  | 2          | 3  |    | 8              | 7  | 11 |    | 2  | 1  | 7            | 2  | 2  | 50 | 40 | 27 | 7               | 7  | 16 | 8             | 10 | 3  |  |

Table EA-6 – Continued

| Species  | Site 2 Night |     |     | Site 2 Day |     |     | Causeway Night |     |     |     |     |     | Causeway Day |     |     |     |     |     | Chorrillo Night |     |     | Chorrillo Day |     |     |
|--|--------------|-----|-----|------------|-----|-----|----------------|-----|-----|-----|-----|-----|--------------|-----|-----|-----|-----|-----|-----------------|-----|-----|---------------|-----|-----|
|  | 1N           | 2N  | 3N  | 1D         | 2D  | 3D  | 1N             | 2N  | 3N  | 4N  | 5N  | 6N  | 1D           | 2D  | 3D  | 4D  | 5D  | 6D  | 1N              | 2N  | 3N  | 1D            | 2D  | 3D  |
| DINOPHYTA  |              |     |     |            |     |     |                |     |     |     |     |     |              |     |     |     |     |     |                 |     |     |               |     |     |
| Ornithocercus steini Schütt                        |              |     |     |            |     |     |                |     |     |     |     |     |              |     |     |     |     |     |                 |     |     |               |     |     |
| Oxytoxum sp  |              |     |     |            |     |     |                |     | 1   |     |     |     |              |     | 1   |     |     |     |                 |     |     |               |     |     |
| Peridinium cf granii Ostenfeld                     | 6            | 9   | 10  | 2          | 2   |     | 12             | 15  | 33  |     |     |     | 1            | 2   |     |     | 1   | 6   | 2               |     | 3   | 9             | 3   |     |
| Peridinium cf. oceanicum Vanhöffen                 | 3            |     |     |            |     |     | 1              | 3   | 5   |     |     |     | 3            | 4   | 1   |     |     | 2   |                 |     | 1   |               |     |     |
| Peridinium crassipes Kofoid                        | 9            |     |     |            |     |     | 5              | 2   | 14  |     |     |     | 1            |     |     |     |     | 14  |                 | 2   | 3   | 2             |     |     |
| Peridinium pendunculatus Schütt                    | 3            |     |     |            |     |     | 7              | 8   | 15  |     |     |     | 1            | 1   | 1   | 1   | 1   |     | 2               | 2   |     | 8             | 4   | 8   |
| Peridinium sp <sub>1</sub>                         | 6            |     | 5   | 1          | 2   |     |                |     |     |     |     |     |              |     |     |     |     |     | 3               | 3   |     |               |     |     |
| Peridinium sp <sub>3</sub>                         | 1            |     |     |            |     |     |                |     |     |     |     |     |              |     |     |     |     |     |                 |     |     |               |     | 1   |
| Prorocentrum gracile Schütt                        | 1            | 3   | 2   |            |     |     |                | 11  | 8   |     |     |     | 4            | 6   |     |     |     | 4   | 3               |     | 2   | 4             | 4   |     |
| Prorocentrum micans Ehrenberg                      | 2            |     |     | 7          |     | 3   |                |     | 1   |     |     |     |              |     | 2   |     |     |     |                 |     |     | 1             |     |     |
| Pyrocystis fusiformis Wyville - Thomson y Blackman |              |     |     |            |     |     |                |     |     |     |     |     |              |     |     |     |     |     |                 |     |     |               |     |     |
| Pyrophacus horologium Stein                        |              | 10  |     |            |     |     | 50             | 109 | 35  |     |     |     | 26           | 23  | 21  |     |     | 2   | 4               | 6   | 25  | 13            | 21  |     |
| TOTAL  | 300          | 300 | 300 | 300        | 300 | 300 | 300            | 300 | 300 | 300 | 300 | 300 | 300          | 300 | 300 | 300 | 300 | 300 | 300             | 300 | 300 | 300           | 300 | 300 |

**Table EA-7: Abundance of macrofauna collected at Palo Seco (West) in low water, at high tide zone.**

| TAXA                        | R11 | R12 | R13 | R14 | R15 | R16 | TOTAL |
|-----------------------------|-----|-----|-----|-----|-----|-----|-------|
| POLYCHAETS                  |     |     |     |     |     |     |       |
| Nereidae                    | 2   | 2   |     |     |     |     | 4     |
| MOLLUSCS                    |     |     |     |     |     |     |       |
| Bivalvia                    |     |     |     |     |     |     |       |
| <i>Protothaca asperimma</i> | 1   | 1   | 1   | 1   | 1   |     | 5     |
| <i>Protothaca sp. (1)</i>   | 1   |     |     |     |     |     | 1     |
| <i>Mytella guyanensis</i>   | 1   | 1   | 1   | 1   |     |     | 4     |
| Bivalvia (1)                |     |     |     |     | 1   |     | 1     |
| CRUSTACEA                   |     |     |     |     |     |     |       |
| Isopods                     | 7   | 3   | 3   | 7   |     | 3   | 23    |
|                             |     |     |     |     |     |     |       |
| <b>TOTAL</b>                | 12  | 7   | 5   | 9   | 2   | 3   | 38    |

**Table EA-8: List Abundance of macrofauna collected from from the Palo Seco station at the low tide.**

| TAXA                  | B21 | B22 | B23 | B24 | B25 | TOTAL |
|-----------------------|-----|-----|-----|-----|-----|-------|
| POLYCHAETS            |     |     |     |     |     |       |
| Nereidae              | 2   | 3   |     |     | 1   | 6     |
| Ophedidae             |     |     |     | 1   |     | 1     |
| Nephtyidae            | 1   |     |     | 1   |     | 2     |
| Cossurridae           | 2   | 1   |     | 1   | 1   | 5     |
| MOLLUSC               |     |     |     |     |     |       |
| Bivalvia              |     |     |     |     |     |       |
| <i>Tellina sp.(2)</i> | 1   | 1   |     |     |     | 2     |
| Larva of bivalvo      |     |     |     |     | 1   | 1     |
| CRUSTACEA             |     |     |     |     |     |       |
| Cladocera             |     |     |     |     | 1   | 1     |
| Amphipod              |     | 1   |     | 2   | 1   | 4     |
| Porcelanidae          |     |     |     |     | 1   | 1     |
|                       |     |     |     |     |     |       |
| <b>TOTAL</b>          | 6   | 6   | 0   | 5   | 6   | 23    |

Table EA-9: List and abundance of macrofauna collected in Palo Seco East during high tide.

| TAXA                        | R1 | R2 | R3 | R4 | R5 | R6 | TOTAL |
|-----------------------------|----|----|----|----|----|----|-------|
| POLYCHAETS                  |    |    |    |    |    |    |       |
| Nereidae                    | 3  | 1  | 2  | 1  | 1  |    | 8     |
| Capitellidae                | 2  |    | 1  | 2  | 1  | 1  | 7     |
| MOLLUSC                     |    |    |    |    |    |    |       |
| Bivalvia                    |    |    |    |    |    |    |       |
| <i>Anadara sp</i>           | 1  | 1  |    | 1  |    |    | 3     |
| <i>Mytilus sp.</i>          |    | 1  | 1  |    | 1  |    | 3     |
| <i>Protothaca asperimma</i> | 1  | 1  |    | 1  | 2  |    | 5     |
| <i>Tellina sp</i>           | 1  | 1  | 1  |    | 2  |    | 5     |
| CRUSTACEA                   |    |    |    |    |    |    |       |
| Amphipods                   | 3  | 1  | 3  | 1  | 1  | 1  | 10    |
| Copepods                    | 2  | 1  |    | 1  | 1  | 3  | 8     |
| <b>TOTAL</b>                | 13 | 7  | 8  | 7  | 9  | 5  | 49    |

**Table EA-10: List and abundance of macrofauna collected from 6 samples at the station of Kobbe Beach, at the high tide zone.**

| TAXA                   | C1 | C2 | C3 | C4 | C5 | C6 | TOTAL |
|------------------------|----|----|----|----|----|----|-------|
| POLYCHAETS             |    |    |    |    |    |    |       |
| Nereidae               | 2  | 1  | 1  | 1  |    |    | 5     |
| Cosurridae             | 1  | 1  | 2  |    | 1  |    | 5     |
| Nephtyidae             | 1  |    | 2  |    |    | 2  | 5     |
| Capitellidae           | 1  | 2  |    | 1  | 1  | 4  | 9     |
| MOLLUSC                |    |    |    |    |    |    |       |
| Bivalvia               |    |    |    |    |    |    |       |
| <i>Donax sp.</i>       | 2  | 1  |    | 1  |    |    | 4     |
| <i>Protothaca sp.</i>  | 5  | 1  | 1  | 1  | 2  |    | 10    |
| <i>Tellina sp. (1)</i> | 2  |    | 1  |    | 3  |    | 6     |
| <i>Anadara sp.</i>     | 1  |    |    |    |    |    | 1     |
| <i>Nuculana sp.</i>    |    | 1  | 1  |    |    | 1  | 3     |
| Gastropoda             |    |    |    |    |    |    |       |
| <i>Nassarius sp.</i>   | 1  |    |    | 1  | 1  |    | 3     |
| CRUSTACEA              |    |    |    |    |    |    |       |
| AMPHIPOD               | 2  | 6  |    |    |    | 6  | 14    |
| Copepodo               |    | 2  | 3  |    | 1  |    | 6     |
| EQUINODERMATA          |    |    |    |    |    |    |       |
| Ofiuroideo sp.         |    | 1  |    | 1  |    |    | 2     |
| ECHIURA                | 1  | 2  |    | 1  | 1  | 1  | 6     |
|                        |    |    |    |    |    |    |       |
| <b>TOTAL</b>           | 19 | 18 | 11 | 7  | 10 | 14 | 79    |

**Table EA-11: List and abundance of macrofauna collected at station Kobbe Beach, at the low tide zone.**

| TAXA                        | R19 | R20 | R21 | R22 | R23 | R24 | TOTAL |
|-----------------------------|-----|-----|-----|-----|-----|-----|-------|
| POLYCHAETS                  |     |     |     |     |     |     |       |
| Serpulidae                  |     | 1   |     |     |     |     | 1     |
| Pisionidae                  |     | 2   |     |     | 2   |     | 4     |
| Capitellidae                |     |     | 1   |     |     |     | 1     |
| MOLLUSC                     |     |     |     |     |     |     |       |
| Bivalvia                    |     |     |     |     |     |     |       |
| <i>Nucula sp</i>            | 1   |     |     |     |     | 1   | 2     |
| <i>Mytella guyanensis</i>   |     |     |     |     | 1   |     | 1     |
| <i>Prothotaca asperimma</i> | 2   | 2   | 4   | 5   | 1   |     | 14    |
| <i>Tellina sp. (1)</i>      |     | 2   | 1   | 2   | 3   |     | 8     |
| Crassinella                 |     | 2   |     |     |     |     | 2     |
| CRUSTACEA                   |     |     |     |     |     |     |       |
| Isopods                     |     | 2   |     | 1   | 1   |     | 4     |
| Ostracods                   | 1   | 3   |     |     |     |     | 4     |
| EQUINODERMATA               |     |     |     |     |     |     |       |
| Ofiuroideo sp.              |     |     |     |     |     | 2   | 2     |
|                             |     |     |     |     |     |     |       |
| <b>TOTAL</b>                | 4   | 14  | 6   | 8   | 8   | 3   | 43    |

Table EA-12: List and Abundance of macrofauna collected at Site 2.

| TAXA                        | R1 | R2 | R3 | R4 | R5 | R6 | TOTAL |
|-----------------------------|----|----|----|----|----|----|-------|
| NEMATODA                    | 3  | 3  | 4  | 2  | 2  | 1  | 15    |
| POLYCHAETS                  |    |    |    |    |    |    |       |
| Nereidae                    | 6  | 3  | 4  |    | 5  | 4  | 22    |
| Phyllodoceidae              | 6  | 1  | 7  | 3  | 4  | 3  | 24    |
| Glyceridae                  | 6  |    | 7  | 5  | 6  | 2  | 26    |
| Nephtyidae                  | 4  | 1  | 4  | 3  | 9  | 3  | 24    |
| Arenicolidae                | 2  | 1  | 1  | 1  | 1  | 2  | 8     |
| Cossuridae                  | 1  | 1  | 2  | 1  | 1  | 1  | 7     |
| Sabellidae                  | 2  | 1  | 4  | 1  | 4  | 2  | 14    |
| Goniodidae                  | 3  | 2  | 1  | 2  | 1  | 1  | 10    |
| Ophelidae                   | 2  | 1  | 3  |    | 2  | 1  | 9     |
| Capitellidae                | 3  |    | 1  | 3  | 1  | 2  | 10    |
| Lumbrineridae               | 2  |    | 1  | 2  | 1  | 1  | 7     |
| Cirratulidae                | 4  | 6  | 4  | 2  | 1  | 3  | 20    |
| Owenidae                    |    | 1  | 2  |    | 1  | 1  | 5     |
| Serpulidae                  | 1  | 2  | 1  | 1  | 2  | 1  | 8     |
| MOLLUSC                     |    |    |    |    |    |    |       |
| Bivalvia                    |    |    |    |    |    |    |       |
| <i>Anadara sp.</i>          | 1  | 2  | 1  | 2  |    | 1  | 7     |
| <i>Tellina sp. (1)</i>      | 1  | 1  | 1  | 2  | 1  | 2  | 8     |
| <i>Protothaca asperimma</i> | 1  | 1  | 2  | 2  | 2  | 1  | 9     |
| <i>Crassinella sp.</i>      |    | 1  |    | 1  | 1  | 2  | 5     |
| CRUSTACEA                   |    |    |    |    |    |    |       |
| Amphipod                    | 1  | 2  | 1  | 3  | 3  | 2  | 12    |
| Copepod calanoidea          | 1  |    |    | 1  | 2  | 1  | 5     |
| Porcellanidae               |    | 1  | 1  |    |    |    | 2     |
| <i>Callinectes sp.</i>      | 1  |    | 1  | 1  |    |    | 3     |
| ECHIURA                     | 1  | 1  | 2  |    |    |    | 4     |
| <b>TOTAL</b>                | 45 | 26 | 47 | 38 | 45 | 31 | 264   |

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Table EA-13: List and abundance of macrofauna collected at the Artificial Island station.

| TAXA           | R1 | R2 | R3 | R4 | R5 | R6 | TOTAL |
|----------------|----|----|----|----|----|----|-------|
| NEMATODS       | 3  | 3  | 6  | 3  | 1  | 3  | 19    |
| POLYCHAETS     |    |    |    |    |    |    |       |
| Cossuridae     | 1  | 1  |    | 1  | 1  |    | 4     |
| Nephtyidae     | 2  | 5  | 4  | 4  | 2  | 5  | 22    |
| Capitellidae   | 3  | 1  | 1  | 2  | 4  | 2  | 13    |
| Nereidae       | 2  | 2  | 1  | 3  |    |    | 8     |
| Glyceridae     | 3  | 1  |    | 2  |    |    | 6     |
| Spionidae      | 4  |    |    |    |    |    | 4     |
| Pilargidae     | 2  | 1  |    |    | 2  |    | 5     |
| Goniodidae     |    | 2  |    |    |    | 2  | 4     |
| Phyllodoceidae |    | 1  | 3  | 5  |    | 1  | 10    |
| Dorvidallidae  |    | 1  |    | 1  | 1  |    | 3     |
| Starnospidae   |    |    |    | 1  |    |    | 1     |
| Ophellidae     |    |    |    | 1  |    | 1  | 2     |
| Cirratulidae   |    |    |    |    | 2  | 1  | 3     |
| Lumbrineridae  |    |    |    |    |    | 2  | 2     |
| Sabellidae     |    |    |    |    |    | 3  | 3     |
| Magelonidae    |    |    | 3  |    | 1  | 2  | 6     |
| MOLLUSCA       |    |    |    |    |    |    |       |
| Bivalvia       |    |    |    |    |    |    |       |

Table EA-13 (continued)

| TAXA                    | R1 | R2 | R3 | R4 | R5 | R6 | TOTAL |
|-------------------------|----|----|----|----|----|----|-------|
| <i>Tellina sp (1)</i>   |    |    |    |    |    | 1  | 1     |
| Larva of bivalve        | 1  |    | 1  |    |    |    | 2     |
| Gastropoda              |    |    |    |    |    |    |       |
| Larva of gastropod      | 1  |    |    |    |    |    | 1     |
|                         |    |    |    |    |    |    |       |
| CRUSTACEA               |    |    |    |    |    |    |       |
| Amphipod                |    | 1  |    | 3  |    |    | 4     |
| <i>Trachypenaes sp.</i> |    |    |    | 2  |    |    | 2     |
| <i>Callinectes sp.</i>  |    | 1  | 1  |    |    |    | 2     |
| Larva of Brachyura      |    | 1  |    |    |    |    | 1     |
| EQUINODERMATA           |    |    |    |    |    |    |       |
| Ophiuroideo sp          |    |    |    |    |    | 1  | 1     |
| ECHIURA                 | 1  |    |    | 3  |    | 4  | 8     |
| CHORDATA                |    |    |    |    |    |    |       |
| Pisces                  |    |    |    |    |    |    |       |
| Gobidae                 | 1  |    |    |    |    |    | 1     |
|                         |    |    |    |    |    |    |       |
| <b>TOTAL</b>            | 24 | 21 | 20 | 31 | 14 | 28 | 138   |

Table EA-14: List and abundance of macrofauna collected from Site 15 station.

| TAXA                        | R1 | R2 | R3 | R4 | R5 | R6 | TOTAL |
|-----------------------------|----|----|----|----|----|----|-------|
| NEMATODS                    |    |    | 2  |    |    | 2  | 4     |
| POLYCHAETS                  |    |    |    |    |    |    |       |
| Cossuridae                  |    | 1  |    |    |    |    | 1     |
| Nephtyidae                  | 2  | 3  | 2  |    |    |    | 7     |
| Nereidae                    |    |    |    | 1  |    | 1  | 2     |
| Goniodidae                  | 1  | 2  | 1  |    |    | 1  | 5     |
| Phyllodoceidae              |    |    | 1  |    |    | 1  | 2     |
| Polyodontidae               |    |    |    |    | 1  |    | 1     |
| Magelonidae                 |    |    | 1  |    |    |    | 1     |
| Capitellidae                |    | 3  |    |    |    |    | 3     |
| Glyceridae                  | 1  | 3  |    |    |    |    | 4     |
| MOLLUSC                     |    |    |    |    |    |    |       |
| Bivalvia                    |    |    |    |    |    |    |       |
| <i>Protothaca asperimma</i> |    | 1  |    |    |    |    | 1     |
| Larva of bivalve            |    | 1  |    |    |    |    | 1     |
| Gastropod                   |    | 2  |    |    |    |    |       |
| Larva de gastropod          |    |    |    |    |    |    | 2     |
| CRUSTACEA                   |    |    |    |    |    |    |       |
| Anfipodo                    | 1  | 3  | 2  | 1  | 1  |    | 8     |
| Copepod Calanoideo          | 1  |    | 1  |    | 1  |    | 3     |
|                             |    |    |    |    |    |    |       |
| <b>TOTAL</b>                | 6  | 19 | 10 | 2  | 3  | 5  | 45    |

**Table EA-15: List and abundance of macrofauna collected from Fishing Grounds station.**

| TAXA               | C1 | C2 | C3 | C4 | C5 | C6 | TOTAL |
|--------------------|----|----|----|----|----|----|-------|
| NEMATODS           | 4  | 3  | 1  | 1  | 5  | 1  | 15    |
| POLYCHAETS         |    |    |    |    |    |    |       |
| Spionidae          | 12 | 10 | 6  | 7  | 4  | 4  | 43    |
| Capitellidae       | 1  | 2  |    |    | 2  | 3  | 8     |
| Arenicollidae      |    | 1  |    | 2  |    | 2  | 5     |
| Glyceridae         |    |    |    | 2  |    | 2  | 4     |
| Sabellidae         |    |    |    | 2  |    | 1  | 3     |
| Goniadidae         |    |    |    | 2  |    |    | 2     |
| Pilargidae         |    |    |    |    |    | 4  | 4     |
| MOLUSCS            |    |    |    |    |    |    |       |
| Bivalvia           |    |    |    |    |    |    |       |
| Tellina sp (1)     |    |    | 1  |    |    |    | 1     |
| Larva of bivalve   |    |    |    | 1  |    |    | 1     |
| CRUSTACEOS         |    |    |    |    |    |    |       |
| Amphipods          | 4  | 2  | 6  | 1  | 1  | 1  | 15    |
| Copepod Calanoideo | 2  | 1  | 1  | 3  | 1  | 1  | 9     |
| Ostracods          | 1  | 3  |    | 1  | 1  |    | 6     |
| Squilla sp.        |    |    |    | 1  |    |    | 1     |
| ECHIUROIDEA        | 1  | 1  |    | 2  |    | 1  | 5     |
|                    |    |    |    |    |    |    |       |
| <b>TOTAL</b>       | 2  | 23 | 15 | 25 | 14 | 20 | 122   |

**Table EA-16: List and abundance of macrofauna collected at Chorrillo.**

| TAXA                        | R1 | R2 | R3 | R4 | R5 | R6 | TOTAL |
|-----------------------------|----|----|----|----|----|----|-------|
| NEMATODS                    |    | 1  |    | 3  |    | 2  | 6     |
| OLYGOCHAETS                 |    |    | 1  |    |    |    | 1     |
| POLYCHAETS                  |    |    |    |    |    |    |       |
| Nereidadae                  |    | 2  |    | 3  |    |    | 5     |
| Capitellidae                |    |    |    | 2  |    |    | 2     |
| Phyllodocidae               | 5  | 2  | 12 | 2  | 2  | 13 | 36    |
| Onuphidae                   |    |    |    |    | 2  |    | 2     |
| MOLLUSC                     |    |    |    |    |    |    |       |
| Bivalvia                    |    |    |    |    |    |    |       |
| <i>Mytella guyanensis</i>   |    |    | 1  |    |    |    | 1     |
| <i>Solen sp.</i>            |    |    |    |    | 1  | 9  | 10    |
| <i>Protothaca asperimma</i> |    |    |    | 1  | 2  |    | 3     |
| CRUSTACEA                   |    |    |    |    |    |    |       |
| Amphipod                    |    |    | 2  |    | 1  |    | 3     |
| ECHIURA                     |    |    |    |    |    | 2  | 2     |
| CHORDATA                    |    |    |    |    |    |    |       |
| Pisces                      |    |    |    |    | 1  |    | 1     |
|                             |    |    |    |    |    |    |       |
| <b>TOTAL</b>                | 5  | 5  | 16 | 11 | 9  | 26 | 72    |

Table EA-17: List and abundance of macrofauna collected from the Causeway station.

| TAXA                        | R1       | R2       | R3       | R4        | R5       | R6       | TOTAL     |
|-----------------------------|----------|----------|----------|-----------|----------|----------|-----------|
| OLYGOCHAETS                 |          |          |          | 1         |          |          | 1         |
| POLYCHAETS                  |          |          |          |           |          |          |           |
| Onuphidae (1)               |          |          | 3        |           |          |          | 3         |
| Onuphidae (2)               |          | 1        |          |           |          |          | 1         |
| Onuphidae (3)               |          |          |          |           | 3        |          | 3         |
| Phyllodocidae               | 6        | 3        | 3        | 6         | 4        | 2        | 24        |
| Magelonidae                 |          |          |          |           |          | 2        | 2         |
| Nereidae                    | 1        |          |          |           |          |          | 1         |
| MOLLUSC                     |          |          |          |           |          |          |           |
| Bivalvia                    |          |          |          |           |          |          |           |
| <i>Arca sp.</i>             | 2        |          | 1        |           |          |          | 3         |
| <i>Tellina sp. (1)</i>      |          | 1        | 1        |           |          |          | 2         |
| <i>Solen sp.</i>            |          |          | 1        |           |          |          | 1         |
| <i>Protothaca asperimma</i> |          |          |          | 1         |          |          | 1         |
| CRUSTACEA                   |          |          |          |           |          |          |           |
| Isopodo                     |          | 1        |          |           |          |          | 1         |
| Anfipodo                    |          | 2        |          | 2         |          |          | 4         |
| <i>Squilla sp.</i>          | 1        |          |          |           | 1        |          | 2         |
| ECHINODERMATA               |          |          |          |           |          |          |           |
| Ophiuroideo                 | 1        |          |          | 1         |          |          | 2         |
| <b>TOTAL</b>                | <b>1</b> | <b>8</b> | <b>9</b> | <b>11</b> | <b>8</b> | <b>4</b> | <b>51</b> |

Table EA-18: Flora Species Identified at Site T1

## Flora Species Recorded

| CLASS MAGNOLIOPSIDA           |                                  |                   | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|-------------------------------|----------------------------------|-------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY                        | SPECIES                          | COMMON NAME       |    |             |               |     |               |       |      |
| ACANTHACEAE                   | <i>Aphelandra sinclairiana</i>   | camaroncillo      | *  | G4          | N4            |     |               |       |      |
|                               | <i>Trichantera gigantea</i>      | palo de agua      | *  |             |               |     |               |       |      |
| ANACARDIACEAE                 | <i>Anacardium excelsum</i>       | espavé            | *  | G5          | N5            |     |               |       |      |
|                               | <i>Mangifera indica</i> (c)      | mango             | *  | G5          | NE            |     |               |       |      |
|                               | <i>Spondias mombin</i>           | iobo              | *  | G5          | N5            |     |               |       |      |
| ANNONACEAE                    | <i>Annona hayesii</i>            | chirimoya         | *  | G3          | N3            |     |               |       |      |
|                               | <i>Annona spraguei</i>           | chirimoya         | *  | G3          | N3            |     |               |       |      |
| APOCYNACEAE                   | <i>Stemmadenia grandiflora</i>   |                   | *  | G5          | N5            |     |               |       |      |
|                               | <i>Thevetia ahouai</i>           | huevo de gato     | *  | G5          | N5            |     |               |       |      |
| ARALIACEAE                    | <i>Dendropanax arboreus</i>      | mufiequito        | *  | G5          | N5            |     |               |       |      |
|                               | <i>Schefflera morototoni</i>     |                   | *  | G5          | N4            |     |               |       |      |
| BIGNONIACEAE                  | <i>Jacaranda copaia</i>          | pie de elefante   | *  | G5          | N4            |     |               |       |      |
|                               | <i>Parmentiera cereifera</i>     |                   | *  |             |               |     |               |       |      |
|                               | <i>Tabebuia rosea</i>            | roble             | *  | G5          | N5            |     |               |       |      |
| BOMBACACEAE                   | <i>Cavanillesia platanifolia</i> | cuipo             | *  | G5          | N4            |     |               |       |      |
| BORAGINACEAE                  | <i>Cordia alliodora</i>          | laurel            | *  | G5          | N5            |     |               |       |      |
| BURSERACEAE                   | <i>Bursera simaruba</i>          | almácigo - carate | *  | G5          | N5            |     |               |       |      |
|                               | <i>Protium tenuifolium</i>       | chutra - cicuadro | *  | G3          | N3            |     |               |       |      |
| CECROPIACEAE                  | <i>Cecropia obtusifolia</i>      | guarumo           | *  | G5          | N5            |     |               |       |      |
| CHRYSOBALANACEAE              | <i>Hirtella americana</i>        | camaroncillo      | *  | G5          | N5            |     |               |       |      |
|                               | <i>Hirtella racemosa</i>         | camaroncillo      | *  | G5          | N5            |     |               |       |      |
|                               | <i>Hirtella triandra</i>         | camaroncillo      | *  | G5          | N5            |     |               |       |      |
| CLUSIACEAE                    | <i>Clusia sp.</i>                |                   | *  |             |               |     |               |       |      |
| COCHLOSPERMACEAE              | <i>Cochlospermum vitifolium</i>  | poro - poro       | *  | G5          | N5            |     |               |       |      |
| COMBRETACEAE                  | <i>Terminalia amazonia</i>       | amarillo          | *  | G5          | N4            |     |               |       |      |
| CONNARACEAE                   | <i>Connarus panamensis</i>       |                   | *  | G5          | N5            |     |               |       |      |
|                               | <i>Connarus sp.</i>              |                   | *  |             |               |     |               |       |      |
| EUPHORBACEAE                  | <i>Acalypha diversifolia</i>     |                   | *  | G5          | N5            |     |               |       |      |
|                               | <i>Adelia triloba</i>            |                   | *  | G5          | N5            |     |               |       |      |
|                               | <i>Alchornea latifolia</i>       |                   | *  |             |               |     |               |       |      |
|                               | <i>Croton draco</i>              | sangrillo         | *  | G5          | N4            |     |               |       |      |
|                               | <i>Hveronima alchorneoides</i>   |                   | *  |             |               |     |               |       |      |
|                               | <i>Mabea occidentales</i>        |                   | *  | G5          | N4            |     |               |       |      |
|                               | <i>Margaritaria nobilis</i>      |                   | *  |             |               |     |               |       |      |
| <i>Phyllanthus acuminatus</i> |                                  | *                 |    |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE          | <i>Bauhinia sp.</i>              | escalera de mono  | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE          | <i>Cassia moschata</i>           | caña fistula      | *  | G4          | N3            |     |               |       |      |
| FAB-CAESALPINIOIDEAE          | <i>Hymenaea courbaril</i>        | algarrobo         | *  | G5          | N4            |     |               |       |      |
| FAB-CAESALPINIOIDEAE          | <i>Swartzia simplex</i>          | naranjillo        | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE                 | <i>Andira inermis</i>            | harino            | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE                 | <i>Lonchocarpus latifolius</i>   | peronil           | *  |             |               |     |               |       |      |
| FAB-FABOIDEAE                 | <i>Machaerium kegelii</i>        | falsa uña de gato | *  | G3          | N3            |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Acacia melanoceras</i>        | cachito           | *  | G4          | N2            |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Cojoba rufescens</i>          | coralillo         | *  | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Enterolobium cyclocarpum</i>  | corotú            | *  | G5          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Enterolobium schomburkii</i>  | corotú            | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Inga goldmanii</i>            |                   | *  | G3          | N3            |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Inga hayesii</i>              | guabo             | *  | G3          | N3            |     |               |       | LR   |
| FAB-MIMOSOIDEAE               | <i>Inga nobilis</i>              |                   | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Inga ruiziana</i>             |                   | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE               | <i>Inga vera</i>                 |                   | *  |             |               |     |               |       |      |

Flora Species Recorded

| CLASS MAGNOLIOPSIDA |                                  |                      | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|---------------------|----------------------------------|----------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                          | COMMON NAME          |    |             |               |     |               |       |      |
| FLACOURTIACEAE      | <i>Casearia aculeata</i>         | pica lengua          | *  | G5          | N5            |     |               |       |      |
|                     | <i>Casearia commersoniana</i>    | corta lengua - mauro | *  | G5          | N5            |     |               |       |      |
|                     | <i>Casearia quianensis</i>       |                      | *  |             |               |     |               |       |      |
|                     | <i>Casearia sylvestris</i>       |                      | *  | G5          | N5            |     |               |       |      |
|                     | <i>Hasseltia floribunda</i>      | parimontón           | *  | G5          | N5            |     |               |       |      |
|                     | <i>Lacistema aggregatum</i>      | huesito              | *  | G5          | N5            |     |               |       |      |
|                     | <i>Lindackeria laurina</i>       | carbonero            | *  | G5          | N4            |     |               |       |      |
|                     | <i>Tetrathylacium johansenii</i> | palo de chancho      | *  | G4          | N3            |     |               |       |      |
|                     | <i>Zuelania guidonea</i>         | árbol caspa          | *  | G5          | N3            |     |               |       |      |
| LAURACEAE           | <i>Phoebe cinnamomifolia</i>     | sigua blanca         | *  | G5          | N5            |     |               |       |      |
| LECYTHIDACEAE       | <i>Gustavia superba</i>          | membrillo            | *  | G5          | N4            |     |               |       |      |
| MELASTOMACEAE       | <i>Miconia argentea</i>          | papelillo            | *  | G5          | N5            |     |               |       |      |
| MELIACEAE           | <i>Cedrela odorata</i>           | cedro amargo         | *  | G4          | N4            |     | X             |       | VU   |
|                     | <i>Guarea guidonea</i>           | cedro                | *  | G4          | N4            |     |               |       |      |
|                     | <i>Trichilia pleeana</i>         |                      | *  | G4          | N4            |     |               |       |      |
| MONIMIACEAE         | <i>Siparuna pauciflora</i>       | pasmo                | *  | G5          | N4            |     |               |       |      |
| MORACEAE            | <i>Brosimum alicastrum</i>       | berbá - cacique      | *  | G5          | N4            |     |               |       |      |
|                     | <i>Castilla elastica</i>         | árbol de goma        | *  | G5          | N3            |     |               |       |      |
|                     | <i>Ficus insipida</i>            | higuerón             | *  | G5          | N4            |     |               |       |      |
|                     | <i>Ficus trigonata</i>           |                      | *  |             |               |     |               |       |      |
|                     | <i>Maclura tinctoria</i>         | palo mora            | *  | G5          | N4            |     |               |       |      |
|                     | <i>Trophis caucana</i>           |                      | *  | G5          | N4            |     |               |       |      |
| MYRSINACEAE         | <i>Stylogyne standleyi</i>       |                      | *  | G4          | N3            |     |               |       |      |
| MYRTACEAE           | <i>Eugenia oerstediana</i>       |                      | *  |             |               |     |               |       |      |
| NYCTAGINACEAE       | <i>Neea delicatula</i>           |                      | *  | G4          | N3            |     |               |       |      |
| OCHNACEAE           | <i>Ouratea lucens</i>            | caidita              | *  | G5          | N5            |     |               |       |      |
| PASSIFLORACEAE      | <i>Passiflora ambigua</i>        | pasionaria           | *  | G3          | N3            |     |               |       |      |
|                     | <i>Passiflora foetida</i>        | calzoncillo          | *  | G5          | N5            |     |               |       |      |
|                     | <i>Passiflora vitifolia</i>      | pasionaria           | *  | G5          | N5            |     |               |       |      |
| PIPERACEAE          | <i>Piper aequale</i>             | hinojo               | *  | G5          | N5            |     |               |       |      |
|                     | <i>Piper auritum</i>             | hinojo               | *  | G5          | N5            |     |               |       |      |
|                     | <i>Piper cordulatum</i>          | hinojo               | *  | G2          | N2            |     |               |       |      |
|                     | <i>Piper culebratum</i>          | hinojo               | *  |             |               |     |               |       |      |
|                     | <i>Piper reticulatum</i>         | hinojo               | *  | G5          | N4            |     |               |       |      |
| POLYGONACEAE        | <i>Coccoloba manzanillensis</i>  | hueso - uvito        | *  | G2          | N2            | N   |               |       |      |
|                     | <i>Triplaris cumingiana</i>      | quayabo hormiguero   | *  | G4          | N3            |     |               |       |      |
| RUBIACEAE           | <i>Alibertia edulis</i>          | madroño - trompito   | *  | G5          | N4            |     |               |       |      |
|                     | <i>Alseis blackiana</i>          | mameicillo           | *  | G3          | N3            |     |               |       |      |
|                     | <i>Antirhea trichantha</i>       | mazanuco             | *  | G2          | N2            |     |               |       |      |
|                     | <i>Coutarea hexandra</i>         |                      | *  |             |               |     |               |       |      |
|                     | <i>Pentagonia macrophylla</i>    | hoja de murciélago   | *  | G4          | N4            |     |               |       |      |
|                     | <i>Posoqueria latifolia</i>      | boca de vieja        | *  | G5          | N5            |     |               |       |      |
| RUTACEAE            | <i>Psychotria marginata</i>      |                      | *  | G4          | N4            |     |               |       |      |
|                     | <i>Zanthoxylum ekmanii</i>       | tachuelo             | *  |             |               |     |               |       |      |
|                     | <i>Zanthoxylum panamense</i>     | cicudro - tachuelo   | *  | G3          | N3            |     |               |       |      |
| SAPINDACEAE         | <i>Cupania latifolia</i>         | gorqojero            | *  |             |               |     |               |       |      |
|                     | <i>Cupania rufescens</i>         | gorqojero colorao    | *  | G5          | N3            |     |               |       |      |
|                     | <i>Cupania scrobiculata</i>      | gorqojero            | *  |             |               |     |               |       |      |
|                     | <i>Cupania sylvatica</i>         | gorqojero            | *  | G3          | N3            |     |               |       |      |
|                     | <i>Matayba scrobiculata</i>      | matillo              | *  | G4          | N3            |     |               |       |      |
|                     | <i>Sapindus saponaria</i>        | jaboncillo           | *  | G5          | N3            |     |               |       |      |

Flora Species Recorded

| CLASS MAGNOLIOPSIDA |                                  |                  | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|---------------------|----------------------------------|------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                          | COMMON NAME      |    |             |               |     |               |       |      |
| SAPOTACEAE          | <i>Chrysophyllum cainito</i> (c) | caimito          | *  | G5          | N5            |     |               |       |      |
| SIMAROUBACEAE       | <i>Simaba cedron</i>             | cedrón           | *  | G4          | N3            |     |               |       |      |
| STERCULIACEAE       | <i>Guazuma ulmifolia</i>         | negrito          | *  | G5          | N5            |     |               |       |      |
|                     | <i>Herrania purpurea</i>         | cacao de monte   | *  | G3          | N3            |     |               |       |      |
| THEOPHRASTACEAE     | <i>Clavija mezii</i>             |                  | *  |             |               |     |               |       |      |
| TILIACEAE           | <i>Apeiba aspera</i>             | peine de mono    | *  | G5          | N4            |     |               |       |      |
|                     | <i>Luehea seemannii</i>          | guácimo colorado | *  | G5          | N4            |     |               |       |      |
|                     | <i>Luehea speciosa</i>           | guácimo          | *  | G5          | N4            |     |               |       |      |
| ULMACEAE            | <i>Celtis schippii</i>           |                  | *  |             |               |     |               |       |      |
| URTICACEAE          | <i>Urera baccifera</i>           | hortiga          | *  | G5          | N4            |     |               |       |      |
| VERBENACEAE         | <i>Vitex cymosa</i>              |                  | *  |             |               |     |               |       |      |
| VIOLACEAE           | <i>Hybanthus prunifolius</i>     |                  | *  |             |               |     |               |       |      |
|                     | <i>Rinorea sylvatica</i>         |                  | *  | G4          | N3            |     |               |       |      |
| VOCHYSIACEAE        | <i>Vochysia ferruginea</i>       | flor de mayo     | *  | G5          | N4            |     |               |       |      |

| CLASE LILIOPSIDA |                                      |                  | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|------------------|--------------------------------------|------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY           | SPECIES                              | COMMON NAME      |    |             |               |     |               |       |      |
| ARACEAE          | <i>Dieffenbachia longispatha</i>     | otoe lagarto     | *  | G4          | N3            |     |               |       |      |
|                  | <i>Montrichardia arborescens</i> (a) | castaño          | *  | G4          | N4            |     |               |       |      |
| ARECACEAE        | <i>Astrocaryum standleyanum</i>      | chunga           | *  | G4          | N2            |     |               |       |      |
|                  | <i>Attalea butyracea</i>             | palma real       | *  | G3          | N3            |     |               |       |      |
|                  | <i>Bactris barronis</i>              |                  | *  | G2          | N2            | N   |               |       |      |
|                  | <i>Bactris major</i>                 | caña brava       | *  | G5          | N3            |     |               |       |      |
|                  | <i>Cryosophila warszewiczii</i>      | palma quaquara   | *  | G3          | N3            |     |               |       |      |
|                  | <i>Eleais oleifera</i>               | palma aceitera   | *  | G5          | N3            |     |               |       |      |
|                  | <i>Oenocarpus mapora</i>             | maquenque        | *  | G4          | N3            |     |               |       |      |
| BROMELIACEAE     | <i>Aechmea magdalenae</i>            | pita             | *  | G5          | N3            |     |               |       |      |
|                  | <i>Tillandsia flexuosa</i>           | barba de chivo   | *  | G4          | N3            |     |               |       |      |
| CYCLANTHACEAE    | <i>Carludovica palmata</i>           | sombrero panamá  | *  | G5          | N3            |     |               |       |      |
| CYPERACEAE       | <i>Cyperus sp.</i>                   |                  | *  |             |               |     |               |       |      |
|                  | <i>Scleria sp.</i>                   | cortadera        | *  |             |               |     |               |       |      |
| HELICONIACEAE    | <i>Heliconia latispatha</i>          | chichica         | *  | G5          | N4            |     |               |       |      |
|                  | <i>Heliconia platystachys</i>        | platanillo       | *  | G4          | N4            |     |               |       |      |
| ORCHIDACEAE      | <i>Brassavola nodosa</i>             | dama de la noche | *  | G4          | N3            |     |               | All   |      |
|                  | <i>Catasetum viridiflavum</i>        | orquidea         | *  | G3          | N3            |     |               | All   |      |
|                  | <i>Dichaea panamensis</i>            | orquidea         | *  |             |               |     |               | All   |      |
|                  | <i>Epidendrum difforme</i>           | orquidea         | *  |             |               |     |               | All   |      |
|                  | <i>Notylia pentachne</i>             | orquidea         | *  | G2          | N2            |     |               | All   |      |
|                  | <i>Oeceoclades maculata</i>          | orquidea         | *  | G3          | N3            |     |               | All   |      |
|                  | <i>Oncidium stipitatum</i>           | orquidea         | *  | G3          | N3            |     |               | All   |      |
| POACEAE          | <i>Bambusa sp.</i>                   | bambú            | *  |             |               |     |               |       |      |
|                  | <i>Chusquea sp.</i>                  | caricillo        | *  |             |               |     |               |       |      |
|                  | <i>Scleria sp.</i>                   |                  | *  |             |               |     |               |       |      |
| ZINGIBERACEAE    | <i>Costus sp.</i>                    | gengibre         | *  |             |               |     |               |       |      |
|                  | <i>Costus villosissimus</i>          |                  | *  | G5          | N5            |     |               |       |      |

Nota: RG: Global Rank, RN: Nacional Rank, END: Endémic Species; N: National; EPL: Protected by National Wildlife Laws, CITES: Apéndice I (AI), Apéndice II (AII); UICN: CR: Critically in Danger; E: In Danger; I: Indetermined, R: Rare, V: Vulnerable. Cultivated Species (c). Naturalized Species (n). Aquatic (a).

Table EA-19: Bird Species Identified at Site T1

| GAME BIRDS     |                |                                  |                        | T1 | Global | National | END | EPL<br>Panama | CITES | UICN |
|----------------|----------------|----------------------------------|------------------------|----|--------|----------|-----|---------------|-------|------|
| ORDER          | FAMILY         | SPECIES                          | COMMON NAME            |    | Rank   | Rank     |     |               |       |      |
| TINAMIFORMES   | TINAMIDAE      | <i>Crypturellus soui</i>         | tinamú chico           | *  | G5     | N4       |     |               |       |      |
|                |                | <i>Tinamus major</i>             | tinamú grande          | *  | G5     | N4       |     |               |       |      |
| COLUMBIFORMES  | COLUMBIDAE     | <i>Columba cayennensis</i>       | paloma colorada        | *  | G5     | N5       |     | x             |       |      |
|                |                | <i>Columba speciosa</i>          | paloma escamosa        | *  | G5     | N4       |     |               |       |      |
|                |                | <i>Columba nigrirostris</i>      | paloma piquicorta      | *  | G4     | N4       |     |               |       |      |
|                |                | <i>Leptotila v. verreauxi</i>    | paloma rabiblanca      | *  | G5     | N5       |     |               |       |      |
|                |                | <i>Leptotila cassini</i>         | paloma pechigris       | *  | G4     | N4       |     |               |       |      |
|                |                | <i>Geotrygon montana</i>         | paloma-perdiz roja     | *  | G5     | N5       |     |               |       |      |
| GALLIFORMES    | ODONTOPHORIDAE | <i>Odontophorus gujanensis</i>   | codorniz jaspada       | *  |        |          |     |               |       |      |
|                | CRACIDAE       | <i>Crax rubra</i>                | pavón grande           | *  |        |          |     |               |       |      |
|                |                | <i>Penelope purpurascens</i>     | pava crestada          | *  | G4     | N2       |     |               |       |      |
|                |                | <i>Ortalis chereiceps</i>        | chachalaca cabecigris  | *  | G5     | N3       |     | x             |       |      |
| PICIFORMES     | RAMPHASTIDAE   | <i>Pteroglossus t. torquatus</i> | tucancillo collarero   | *  |        |          |     |               |       |      |
|                |                | <i>Ramphastos sulfuratus</i>     | tucán pico iris        | *  | G4     | N4       |     |               |       | All  |
|                |                | <i>Ramphastos swainsonii</i>     | tucán de swainson      | *  |        |          |     |               |       |      |
| PSITTACIFORMES | PSITTACIDAE    | <i>Amazona autumnalis</i>        | amazona frentirrojo    | *  | G4     | N4       |     |               |       |      |
|                |                | <i>Amazona farinosa</i>          | amazona harinoso       | *  | G4     | N4       |     |               |       | All  |
|                |                | <i>Amazona ochrocephala</i>      | amazona coroniamarillo | *  | G4     | N4       |     | x             |       | All  |
|                |                | <i>Brotopteryx i. jugularis</i>  | perico barbinaranja    | *  | G5     | N5       |     | x             |       | All  |
|                |                | <i>Pionopsitta haematotis</i>    | loro cabecipardo       | *  | G4     | N4       |     | x             |       | All  |
|                |                | <i>Poinus menstrus</i>           | loro cabeciazul        | *  | G5     | N5       |     |               |       |      |

| FOREST BIRDS    |            |                                       |                          | T1 | Global | National | END | EPL<br>Panama | CITES | UICN |
|-----------------|------------|---------------------------------------|--------------------------|----|--------|----------|-----|---------------|-------|------|
| ORDER           | FAMILY     | SPECIES                               | COMMON NAME              |    | Rank   | Rank     |     |               |       |      |
| CHARADRIIFORMES | JACANIDAE  | <i>Jacana jacana hypomelaena</i>      | jacana carunculada       | *  | G5     | N5       |     |               |       |      |
| CICONIIFORMES   | ARDEIDAE   | <i>Ardea h. herodias</i>              | garza azul mayor         | *  | G5     | NN       |     |               |       |      |
|                 |            | <i>Casmerodius albus egretta</i>      | garceta grande           | *  | G5     | N5       |     |               |       |      |
|                 |            | <i>Egretta caerulea</i>               | garza azul chica         | *  | G5     | N5       |     |               |       |      |
|                 |            | <i>Egretta t. thula</i>               | garceta nivea            | *  | G5     | N5       |     |               |       |      |
|                 |            | <i>Trigrisoma l. lineatum</i>         | garza tigre castaña      | *  |        |          |     |               |       |      |
| PELICANIFORMES  | ANHINGIDAE | <i>Anhinga anhinga</i>                | aninga                   | *  | G5     | N4       |     |               |       |      |
| FALCONIFORMES   | FALCONIDAE | <i>Herpotheres cachinnas</i>          | halcón reidor            | *  | G4G5   | N3       |     |               |       | All  |
|                 |            | <i>Micrastur mirandollei</i>          | halcón-montés dorsogrís  | *  |        |          |     |               |       | All  |
|                 |            | <i>Micrastur ruficollis</i>           | halcón-montés barreleado | *  |        |          |     |               |       | All  |
|                 |            | <i>Micrastur semitorquatus</i>        | halcón-montés collarero  | *  | G3G5   | N4       |     |               |       | All  |
| CUCULIFORMES    | CUCULIDAE  | <i>Dromococcyx phasianellus</i>       | cuculillo faisán         | *  |        |          |     |               |       |      |
| CORACIIFORMES   | MOMOTIDAE  | <i>Baryphthengus martii semirufus</i> | momoto rufo              | *  | G4     | N4       |     |               |       |      |
|                 |            | <i>Electron platyrhynchum minor</i>   | momoto piquiancho        | *  | G4     | N4       |     |               |       |      |
|                 |            | <i>Momotus momota conexus</i>         | momoto coroniazulado     | *  | G4G5   | N4       |     |               |       |      |
| PICIFORMES      | BUCCONIDAE | <i>Notharchus pectoralis</i>          | buco pechinegro          | *  |        |          |     |               |       |      |
|                 | PICIDAE    | <i>Ceileus loricatus</i>              | carpintero canelo        | *  |        |          |     |               |       |      |

| FOREST BIRDS  |                  |                                       |                                | T1 | Global | National | END | EPL<br>Panama | CITES | IUCN |
|---------------|------------------|---------------------------------------|--------------------------------|----|--------|----------|-----|---------------|-------|------|
| ORDER         | FAMILY           | SPECIES                               | COMMON NAME                    |    | Rank   | Rank     |     |               |       |      |
| PASSERIFORMES | CORVIDAE         | <i>Cyanocorax affinis zeledoni</i>    | urraca pechinegra              | *  | G4     | N4       |     |               |       |      |
|               | COTINGIDAE       | <i>Querula purpurea</i>               | querula gorgimorada            | *  |        |          |     |               |       |      |
|               | DENDROCOLAPTIDAE | <i>Dendrocolaptes certhia</i>         | trepatroncos barreteado        | *  |        |          |     |               |       |      |
|               |                  | <i>Xiphorhynchus l. lachrymosus</i>   | trepatroncos pinto             | *  |        |          |     |               |       |      |
|               | EMBERIZIDAE      | <i>Cyanerpes cyaneus carneipes</i>    | mielero patirrojo              | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Eucometis penicillata cristata</i> | tangara cabecigris             | *  | G4     | N4       |     |               |       |      |
|               |                  | <i>Euphonia luteicapilla</i>          | ayfonia coroniamarilla         | *  | G4     | N4       |     |               |       |      |
|               |                  | <i>Ramphocelus d. dimidiatus</i>      | sangre de toro                 | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Tachyphonus luctuosus</i>          | tangara hombrilblanca          | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Thraupis episcopus cana</i>        | tangara azuleja                | *  | G5     | N5       |     |               |       |      |
|               | FORMICARIDAE     | <i>Gymnophrys leucapsis</i>           | hormiguero bicolor             | *  |        |          |     |               |       |      |
|               |                  | <i>Hylloezus perspicillatus</i>       | lororo de anteojos             | *  |        |          |     |               |       |      |
|               |                  | <i>Hylophylax n. naevioides</i>       | hormiguero collarajo           | *  | G4     | N4       |     |               |       |      |
|               |                  | <i>Microtopias quixensis virgata</i>  | hormiguero alipunteado         | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Mymotherula axillaris</i>          | hormiguero flaqueado           | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Mymotherula fulviventris</i>       | hormiguero leonado             | *  |        |          |     |               |       |      |
|               |                  | <i>Myrmeciza exsul</i>                | hormiguero dorsicastaño        | *  | G4     | N4       |     |               |       |      |
|               |                  | <i>Phaenostictus mcleannani</i>       | hormiguero ocelado             | *  |        |          |     |               |       |      |
|               |                  | <i>Formicarius analis</i>             | formicario carinegro           | *  | G5     | N5       |     |               |       |      |
|               | FURNARIDAE       | <i>Automolus ochrolaemus</i>          | hojarrasquero gorgipálido      | *  |        |          |     |               |       |      |
|               |                  | <i>Sclerurus guatemalensis</i>        | tirahojas gorgiescamoso        | *  |        |          |     |               |       |      |
|               | HIRUNDINIDAE     | <i>Sclerurus mexicanus</i>            | tirahojas gorgicastaño         | *  | G4     | N3       |     |               |       |      |
|               |                  | <i>Progne chalybea</i>                | martín pechigris               | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Stelgidopteryx ruficollis</i>      | golondrina-alirrasposa sureña  | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Stelgidopteryx s. serripennis</i>  | golondrina-alirrasposa norteña | *  | G5     | NN       |     |               |       |      |
|               | ICTERIDAE        | <i>Tachycineta a. albilinea</i>       | golondrina manglera            | *  | G3     | N3       |     |               |       |      |
|               |                  | <i>Cacicus cela vitellinus</i>        | cacique lomiamarillo           | *  |        |          |     |               |       |      |
|               | MUSCICAPIDAE     | <i>Cacicus uropygialis</i>            | cacique lomiescarlata          | *  |        |          |     |               |       |      |
|               |                  | <i>Turdus grayi casius</i>            | mirio pardo                    | *  | G5     | N5       |     |               |       |      |
|               | PIPRIDAE         | <i>Chiroxiphia lanceolata</i>         | saltarín coludo                | *  | G4     | N4       |     |               |       |      |
|               |                  | <i>Pipra coronata</i>                 | saltarín coroniceleste         | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Pipra mentalis ignifera</i>        | saltarín cabecirrojo           | *  | G4     | N4       |     |               |       |      |
|               | SYLVIIDAE        | <i>Microbates cinereiventris</i>      | soterillo caricafé             | *  |        |          |     |               |       |      |
|               | TROGLODYTIDAE    | <i>Cyphorhinus phaeocephalus</i>      | soterreyes canoro              | *  |        |          |     |               |       |      |
|               |                  | <i>Henicorhina leucosticta</i>        | soterrey-selvatico pechiblanco | *  |        |          |     |               |       |      |
|               |                  | <i>Henicorhina leucophrys</i>         | soterrey-selvático pechigris   | *  | G5     | N4       |     |               |       |      |
|               | TYRANNIDAE       | <i>Microcerculus marginatus</i>       | soterrey-ruiseñor sureño       | *  | G5     | N4       |     |               |       |      |
|               |                  | <i>Attila spadiceus</i>               | atila lomiamarillo             | *  |        |          |     |               |       |      |
|               |                  | <i>Elaenia flavogaster</i>            | elania penachuda               | *  | G5     | N5       |     |               |       |      |
|               |                  | <i>Onipodectes subbrunneus</i>        | alitorcido pardo               | *  |        |          |     |               |       |      |
|               |                  | <i>Conopias albivittata</i>           | mosquero blanquianillado       | *  |        |          |     |               |       |      |
|               | VIREONIDAE       | <i>Onychorhynchus coronatus</i>       | mosquero real                  | *  |        |          |     |               |       |      |
|               |                  | <i>Hylophilus ochraceiceps</i>        | verdillo coronileonado         | *  |        |          |     |               |       |      |

Note:

RG: Global Rank; RN: National Rank; BBS: Migratory species in decline (Breeding Bird Survey)  
 END: Endemic; N: National; B: Binacional, Costa Rica and Panamá; B2: Southern Pacific portion of Central America; EPL: Protected by National Wildlife Laws  
 CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger, EN: In Danger, VU: Vulnerable.

Table EA-20: Mammal Species Identified at Site T1

| CLASS MAMMALIA         |                     |                                  |                           | T1 | Global | National | END | EPL    | CITES   | IUCN |
|------------------------|---------------------|----------------------------------|---------------------------|----|--------|----------|-----|--------|---------|------|
| ORDER                  | FAMILY              | SPECIES                          | COMMON NAME               |    | Rank   | Rank     |     | Panama |         |      |
| DIDELPHIMORPHIA        | DIDELPHIDAE         | <i>Didelphis marsupialis</i>     | zorra común               | *  | G5     | N5       |     |        |         |      |
| XENARTHRA              | MYRMECOPHAGIDAE     | <i>Tamandua mexicana</i>         | hormiguero                | *  | G5     | N3       |     | X      |         |      |
|                        |                     | <i>Cyclopes didactylus</i>       | tapa cara                 | *  | G4     | N4       |     | X      |         |      |
|                        | BRADYPODIDAE        | <i>Bradypus variegatus</i>       | perezoso de tres dedos    | *  | G5     | N5       |     |        |         |      |
|                        | CHOLOEPIDAE         | <i>Choloepus hoffmanni</i>       | perezoso de dos dedos     | *  | G4     | N4       |     |        |         | DD   |
| CHIROPTERA             | PHYLLOSTOMIDAE      | <i>Dasylops novemcinctus</i>     | armadillo de nueve bandas | *  | G5     | N5       |     | X      |         |      |
|                        |                     | <i>Corollia castanea</i>         | murciélago frugívoro      | *  | G5     | N5       |     |        |         |      |
|                        |                     | <i>Carollia perspicillata</i>    | murciélago frugívoro      | *  | G5     | N5       |     |        |         |      |
|                        |                     | <i>Artibeus jamaicensis</i>      | murciélago frugívoro      | *  | G5     | N5       |     |        |         |      |
| PRIMATES               | CALLITRICIDAE       | <i>Artibeus lituratus</i>        | murciélago frugívoro      | *  | G5     | N5       |     |        |         |      |
|                        | CEBIDAE             | <i>Saguinus geoffroyi</i>        | mono titi                 | *  | G3     | N3       |     | X      | AI      |      |
|                        |                     | <i>Alouatta palliata</i>         | mono aullador             | *  | G3     | N3       |     | X      | AI      |      |
|                        |                     | <i>Aotus lemurinus</i>           | mono jujuná               | *  | G4     | N4       |     | X      | AI      | VU   |
|                        |                     | <i>Ateles geoffroyi</i>          | mono araña colorado       | *  | G3     | N3       |     | X      | AI - AI | VU   |
| <i>Cebus capucinus</i> | mono cariblanco     | *                                | G4                        | N4 |        | X        | AI  |        |         |      |
| RODENTIA               | AGOUTIDAE           | <i>Agouti paca</i>               | conejo pintado            | *  | G5     | N5       |     | X      |         |      |
|                        | DASYPROCTIDAE       | <i>Dasyprocta punctata</i>       | ñeque                     | *  | G5     | N5       |     | X      |         |      |
|                        | ECHIMYIDAE          | <i>Proechimys semispinosus</i>   | rata espinosa - mocangué  | *  | G5     | N5       |     |        |         |      |
|                        | ERETHIZONTIDAE      | <i>Coendou rothschildi</i>       | puerco espín              | *  | G3     | N3       | N   |        |         |      |
|                        | HYDROCHAERIDAE      | <i>Hydrochaeris hydrochaeris</i> | capybara - poncho         | *  | G5     | N5       |     | X      |         |      |
|                        | MURIDAE             | <i>Oryzomys sp.</i>              | rata arrocerera           | *  |        |          |     |        |         |      |
| LAGOMORPHA             | SCIURIDAE           | <i>Sciurus granatensis</i>       | ardilla colorada          | *  | G5     | N5       |     |        |         |      |
| CARNIVORA              | FELIDAE             | <i>Lepus sylvaticus</i>          | muleto                    | *  | G5     | G5       |     |        |         |      |
|                        |                     | <i>Leopardus pardalis</i>        | manigordo                 | *  | G3     | N3       |     | X      | AI      | VU   |
|                        |                     | <i>Leopardus wiedii</i>          | tigrillo                  | *  |        |          |     | X      | AI      | VU   |
|                        | MUSTELIDAE          | <i>Panthera onca</i>             | jaguar                    | *  | G3     | N3       |     | X      | AI      | VU   |
|                        |                     | <i>Eira barbara</i>              | tayra                     | *  | G5     | N2       |     |        |         |      |
|                        | PROCYONIDAE         | <i>Lontra longicaudis</i>        | nutria - gato de agua     | *  | G4     | N3       |     | X      | AI      | VU   |
|                        | <i>Nasua narica</i> | gato solo                        | *                         | G5 | N5     |          | X   |        |         |      |
| PERISSODACTYLA         | TAPIRIDAE           | <i>Tapirus bairdii</i>           | macho de monte            | *  | G3     | N3       |     | X      | AI      | VU   |
| ARTIODACTYLA           | TAYASSUIDAE         | <i>Tayassu tajacu</i>            | saíno                     | *  | G5     | N5       |     | X      | AI      |      |
|                        | CERVIDAE            | <i>Mazama americana</i>          | venado corzo              | *  | G5     | N5       |     | X      |         | DD   |
|                        |                     | <i>Odocolleus virginianus</i>    | venado cola blanca        | *  | G5     | N5       |     | X      |         |      |

Note:

END: Endémico; N: Nacional; B: Binacional, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger; EN: In danger, VU: Vulnerable.

Table EA-21: Amphibian and Reptile Species Identified at Site T1

| CLASS REPTILIA |                       |                              |                  | T1 | Global | National | END | EPL    | CITES   | IUCN |
|----------------|-----------------------|------------------------------|------------------|----|--------|----------|-----|--------|---------|------|
| FAMILY         | FAMILIA               | SPECIES                      | COMMON NAME      |    | Rank   | Rank     |     | Panama |         |      |
| CROCODYLIA     | CROCODYLIDAE          | <i>Crocodylus acutus</i>     | lagarto aguja    | *  | G2     | N2       |     | X      | AI      | VU   |
| SQUAMATA       | BOIDAE                | <i>Boa constrictor</i>       | boa              | *  | G5     | N4       |     | X      | AI - AI |      |
|                | COLUBRIDAE            | <i>Oxybelis brevirostris</i> | bejuquilla verde | *  | G5     | N5       |     |        |         |      |
|                |                       | <i>Spilotes pullatus</i>     | cazadora         | *  | G5     | N4       |     |        |         |      |
|                | CORYTOPHANIDAE        | <i>Basiliscus basiliscus</i> | meracho          | *  | G4     | N4       |     |        |         |      |
|                | ELAPIDAE              | <i>Micrurus nigrocinctus</i> | coral            | *  | G5     | N4       |     |        |         |      |
|                | IGUANIDAE             | <i>Iguana iguana</i>         | iguana verde     | *  | G4     | N3       |     | X      | AI      |      |
| TEIIDAE        | <i>Ameiva ameiva</i>  | borriquero                   | *                | G5 | N5     |          |     |        |         |      |
| VIPERIDAE      | <i>Bothrops asper</i> | serpiente equis              | *                | G5 | N5     |          |     |        |         |      |
| TESTUDINES     | EMYDIDAE              | <i>Trachemys scripta</i>     | tortuga          | *  | G5     | N4       |     |        |         |      |

| CLASS AMPHIBIANS |                 |                                     |             | T1 | Global | National | END | EPL    | CITES | IUCN |
|------------------|-----------------|-------------------------------------|-------------|----|--------|----------|-----|--------|-------|------|
| FAMILY           | FAMILIA         | SPECIES                             | COMMON NAME |    | Rank   | Rank     |     | Panama |       |      |
| ANURA            | BUFONIDAE       | <i>Bufo typhonius</i>               | sapo        | *  | G5     | N4       |     |        |       |      |
|                  | DENDROBATIDAE   | <i>Colostethus inguinalis</i>       |             | *  | G3G4   | N3       |     |        |       |      |
|                  | LEPTODACTYLIDAE | <i>Eleutherodactylus fitzingeri</i> |             | *  | G5     | N4       |     |        |       |      |

Note:

END: Endémico; N: Nacional; B: Binacional, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger; EN: In danger, VU: Vulnerable.

Table EA-22: Flora Species Identified at Site T2

Flora Species Recorded

| CLASS MAGNOLIOPSIDA  |                                  |                   | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|----------------------|----------------------------------|-------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY               | SPECIES                          | COMMON NAME       |    |             |               |     |               |       |      |
| ACANTHACEAE          | <i>Aphelandra sinclairiana</i>   | camaroncillo      | *  | G4          | N4            |     |               |       |      |
| ANACARDIACEAE        | <i>Anacardium excelsum</i>       | espavé            | *  | G5          | N5            |     |               |       |      |
|                      | <i>Astronium graveolens</i>      | zorro             | *  | G4          | N3            |     |               |       |      |
|                      | <i>Mangifera indica</i> (c)      | mango             | *  | G5          | NE            |     |               |       |      |
|                      | <i>Spondias mombin</i>           | jobo              | *  | G5          | N5            |     |               |       |      |
|                      | <i>Tapirira guianensis</i>       | palo gusano       | *  | G3          | N2            |     |               |       |      |
| ANNONACEAE           | <i>Annona hayesii</i>            | chirimoya         | *  | G3          | N3            |     |               |       |      |
|                      | <i>Annona spraguei</i>           | chirimoya         | *  | G3          | N3            |     |               |       |      |
|                      | <i>Xylopia frutescens</i>        | malequeto macho   | *  | G5          | N4            |     |               |       |      |
| APOCYNACEAE          | <i>Stemmadenia grandiflora</i>   |                   | *  | G5          | N5            |     |               |       |      |
|                      | <i>Thevetia ahouai</i>           | huevo de gato     | *  | G5          | N5            |     |               |       |      |
| ARALIACEAE           | <i>Dendropanax arboreus</i>      | muñequito         | *  | G5          | N5            |     |               |       |      |
|                      | <i>Schefflera morototoni</i>     | guarumo de pava   | *  | G5          | N4            |     |               |       |      |
|                      | <i>Sciadodendron excelsum</i>    | jobo lagarto      | *  | G4          | N3            |     |               |       |      |
| ARISTOLOCHIACEAE     | <i>Aristolochia sp.</i>          | farolito          | *  |             |               |     |               |       |      |
| ASTERACEAE           | <i>Vernonanthura patens</i>      |                   | *  | G5          | N5            |     |               |       |      |
| BIGNONIACEAE         | <i>Godmania aesculifolia</i>     | cacho del diablo  | *  |             |               |     |               |       |      |
|                      | <i>Jacaranda copaia</i>          | pie de elefante   | *  | G5          | N4            |     |               |       |      |
|                      | <i>Tabebuia guayacan</i>         | guayacán          | *  | G5          | N4            |     |               |       |      |
| BOMBACACEAE          | <i>Cavanillesia platanifolia</i> | cuiipo            | *  | G5          | N4            |     |               |       |      |
|                      | <i>Ochroma pyramidale</i> (c)    | balso             | *  | G5          | N5            |     |               |       |      |
|                      | <i>Pachira quinata</i>           | cedro espino      | *  | G5          | N2            |     |               |       | VU   |
|                      | <i>Pseudobombax septenatum</i>   | barrigón          | *  | G5          | N4            |     |               |       |      |
| BORAGINACEAE         | <i>Cordia alliodora</i>          | laurel            | *  | G5          | N5            |     |               |       |      |
| BURSERACEAE          | <i>Bursera simaruba</i>          | almácigo - carate | *  | G5          | N5            |     |               |       |      |
|                      | <i>Protium tenuifolium</i>       | chutra - cicuadro | *  | G3          | N3            |     |               |       |      |
|                      | <i>Carica sp.</i>                | papaya de monte   | *  |             |               |     |               |       |      |
| CECROPIACEAE         | <i>Cecropia obtusifolia</i>      | guarumo           | *  | G5          | N5            |     |               |       |      |
|                      | <i>Cecropia peltata</i>          | guarumo           | *  | G5          | N5            |     |               |       |      |
| CHRYSOBALANACEAE     | <i>Hirtella americana</i>        | camaroncillo      | *  | G5          | N5            |     |               |       |      |
|                      | <i>Hirtella racemosa</i>         | camaroncillo      | *  | G5          | N5            |     |               |       |      |
| CLUSIACEAE           | <i>Clusia sp.</i>                |                   | *  |             |               |     |               |       |      |
| COMBRETACEAE         | <i>Terminalia amazonia</i>       | amarillo          | *  | G5          | N4            |     |               |       |      |
| CONNARACEAE          | <i>Connarus panamensis</i>       |                   | *  | G5          | N5            |     |               |       |      |
|                      | <i>Connarus sp.</i>              |                   | *  |             |               |     |               |       |      |
| DILLENACEAE          | <i>Davilla sp.</i>               |                   | *  |             |               |     |               |       |      |
| ERYTHROXYLACEAE      | <i>Erythroxylum sp.</i>          |                   | *  |             |               |     |               |       |      |
| EUPHORBIACEAE        | <i>Acalypha diversifolia</i>     |                   | *  | G5          | N5            |     |               |       |      |
|                      | <i>Alchornea latifolia</i>       |                   | *  |             |               |     |               |       |      |
|                      | <i>Croton draco</i>              | sangrillo         | *  | G5          | N4            |     |               |       |      |
|                      | <i>Hura crepitans</i>            | tronador          | *  | G5          | N4            |     |               |       |      |
|                      | <i>Hyeronima alchorneoides</i>   |                   | *  |             |               |     |               |       |      |
|                      | <i>Sapium glandulosum</i>        | cauchillo         | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Cassia moschata</i>           | caña fistula      | *  | G4          | N3            |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Swartzia simplex</i>          | naranjillo        | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Dalbergia retusa</i>          | cocobolo          | *  | G4          | N4            |     | X             |       | VU   |
| FAB-FABOIDEAE        | <i>Flemingia strobilifera</i>    |                   | *  | G5          | NE            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Cojoba rufescens</i>          | coralillo         | *  | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Enterolobium cyclocarum</i>   | corotú            | *  | G5          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga hayesii</i>              | quabo             | *  | G3          | N3            |     |               |       | LR   |

| CLASS MAGNOLIOPSIDA |                                    |                       | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|---------------------|------------------------------------|-----------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                            | COMMON NAME           |    |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Inga laurina</i>                | quabito cansa boca    | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Inga sapindoides</i>            | quabo de monte        | *  | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Inga sp.</i>                    | quabo de monte        | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Inga vera</i>                   |                       | *  |             |               |     |               |       |      |
| FLACOURTIACEAE      | <i>Casearia commersoniana</i>      | corta lengua - mauro  | *  | G5          | N5            |     |               |       |      |
|                     | <i>Casearia sp.</i>                |                       | *  |             |               |     |               |       |      |
|                     | <i>Casearia sylvestris</i>         |                       | *  | G5          | N5            |     |               |       |      |
|                     | <i>Hasseltia floribunda</i>        | parimontón            | *  | G5          | N5            |     |               |       |      |
|                     | <i>Lacistema aggregatum</i>        | huesito               | *  | G5          | N5            |     |               |       |      |
|                     | <i>Tetrathylacium johansenii</i>   | palo de chancho       | *  | G4          | N3            |     |               |       |      |
|                     | <i>Xylosma sp.</i>                 | roseto - cachito      | *  |             |               |     |               |       |      |
|                     | <i>Zuelania guidonea</i>           | árbol caspa           | *  | G5          | N3            |     |               |       |      |
| LAURACEAE           | <i>Phoebe cinnamomifolia</i>       | sigua blanca          | *  | G5          | N5            |     |               |       |      |
| LECYTHIDACEAE       | <i>Gustavia superba</i>            | membrillo             | *  | G5          | N4            |     |               |       |      |
| MALVACEAE           | <i>Hampea appendiculata</i>        |                       | *  | G5          | N5            |     |               |       |      |
| MELASTOMATACEAE     | <i>Clidemia sp.</i>                |                       | *  |             |               |     |               |       |      |
|                     | <i>Miconia argentea</i>            | papelillo             | *  | G5          | N5            |     |               |       |      |
| MELIACEAE           | <i>Guarea glabra</i>               | cedro macho           | *  | G5          | N5            |     |               |       |      |
|                     | <i>Guarea guidonea</i>             | cedro                 | *  | G4          | N4            |     |               |       |      |
|                     | <i>Trichilia pleeana</i>           |                       | *  | G4          | N4            |     |               |       |      |
| MORACEAE            | <i>Brosimum guianense</i>          | cacique               | *  | G5          | N3            |     |               |       |      |
|                     | <i>Castilla elastica</i>           | árbol de goma         | *  | G5          | N3            |     |               |       |      |
|                     | <i>Ficus insipida</i>              | hiquerón              | *  | G5          | N4            |     |               |       |      |
|                     | <i>Trophis racemosa</i>            | lechosa               | *  | G5          | N4            |     |               |       |      |
| MYRISTICACEAE       | <i>Virola sebifera</i>             | velario colorado      | *  | G5          | N3            |     |               |       |      |
| MYRSINACEAE         | <i>Ardisia sp.</i>                 | raspa lengua          | *  |             |               |     |               |       |      |
|                     | <i>Stylogyne standleyi</i>         |                       | *  | G4          | N3            |     |               |       |      |
| MYRTACEAE           | <i>Calycolpus warszewiczianus</i>  | quavabillo            | *  | G3          | N3            |     |               |       |      |
|                     | <i>Eugenia nesiotica</i>           |                       | *  | G2          | N2            | N   |               |       |      |
|                     | <i>Myrcia gatunensis</i>           | pimiento              | *  | G2          | N2            |     |               |       |      |
| OCHNACEAE           | <i>Ouratea lucens</i>              | caidita               | *  | G5          | N5            |     |               |       |      |
| PASSIFLORACEAE      | <i>Passiflora ambigua</i>          | pasionaria            | *  | G3          | N3            |     |               |       |      |
|                     | <i>Passiflora vitifolia</i>        | pasionaria            | *  | G5          | N5            |     |               |       |      |
| PIPERACEAE          | <i>Piper aequale</i>               | hinojo                | *  | G5          | N5            |     |               |       |      |
|                     | <i>Piper marginatum</i>            | hinojo                | *  | G5          | N5            |     |               |       |      |
|                     | <i>Piper reticulatum</i>           | hinojo                | *  | G5          | N4            |     |               |       |      |
| POLYGONACEAE        | <i>Coccoloba manzanillensis</i>    | hueso - uvito         | *  | G2          | N2            | N   |               |       |      |
|                     | <i>Coccoloba sp.</i>               |                       | *  |             |               |     |               |       |      |
|                     | <i>Triplaris cumingiana</i>        | guayabo hormiguero    | *  | G4          | N3            |     |               |       |      |
| RUBIACEAE           | <i>Alibertia edulis</i>            | madroño - trompito    | *  | G5          | N4            |     |               |       |      |
|                     | <i>Alseis blackiana</i>            | mamecillo             | *  | G3          | N3            |     |               |       |      |
|                     | <i>Antirhea trichantha</i>         | mazanuco              | *  | G2          | N2            |     |               |       |      |
|                     | <i>Cephaelis tomentosa</i>         | labios ardientes      | *  | G4          | N4            |     |               |       |      |
|                     | <i>Coussarea curvigemma</i>        | huesito               | *  | G3          | N3            |     |               |       |      |
|                     | <i>Faramea occidentalis</i>        | benjamín - garrotillo | *  | G5          | N3            |     |               |       |      |
|                     | <i>Posoqueria latifolia</i>        | boca de vieja         | *  | G5          | N5            |     |               |       |      |
|                     | <i>Rosenbergiodendron formosum</i> |                       | *  | G4          | N3            |     |               |       |      |
|                     | <i>Zanthoxylum setulosum</i>       | tachuelo - arcabú     | *  |             |               |     |               |       |      |
| SAPINDACEAE         | <i>Cupania cinerea</i>             | gorgojero             | *  | G5          | N3            |     |               |       |      |
|                     | <i>Cupania rufescens</i>           | gorgojero colorao     | *  | G5          | N3            |     |               |       |      |
|                     | <i>Cupania scrobiculata</i>        | gorgojero             | *  |             |               |     |               |       |      |
|                     | <i>Cupania sylvatica</i>           | gorgojero             | *  | G3          | N3            |     |               |       |      |
|                     | <i>Matayba glaberrima</i>          | matillo               | *  | G3          | N3            |     |               |       |      |

| CLASS MAGNOLIOPSIDA |                                  |                  | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|---------------------|----------------------------------|------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                          | COMMON NAME      |    |             |               |     |               |       |      |
| SAPOTACEAE          | <i>Chrysophyllum argenteum</i>   | caimito de monte | *  | G2T4        | N3            |     |               |       |      |
|                     | <i>Chrysophyllum cainito</i> (c) | caimito          | *  | G5          | N5            |     |               |       |      |
| SIMAROUBACEAE       | <i>Quasia amara</i>              | amargo           | *  |             |               |     |               |       |      |
| STERCULIACEAE       | <i>Guazuma ulmifolia</i>         | negrito          | *  | G5          | N5            |     |               |       |      |
|                     | <i>Herrania purpurea</i>         | cacao de monte   | *  | G3          | N3            |     |               |       |      |
|                     | <i>Sterculia apetala</i>         | árbol panamá     | *  | G5          | N4            |     |               |       |      |
| THEOPHRASTACEAE     | <i>Clavija mezii</i>             |                  | *  |             |               |     |               |       |      |
| TILIACEAE           | <i>Luehea seemannii</i>          | guácimo colorado | *  | G5          | N4            |     |               |       |      |
|                     | <i>Luehea speciosa</i>           | guácimo          | *  | G5          | N4            |     |               |       |      |
| VIOLACEAE           | <i>Rinorea sylvatica</i>         |                  | *  | G4          | N3            |     |               |       |      |
| VOCHYSIACEAE        | <i>Vochysia ferruginea</i>       | flor de mayo     | *  | G5          | N4            |     |               |       |      |

| CLASS LILIOPSIDA |                                      |                  | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|------------------|--------------------------------------|------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY           | SPECIES                              | COMMON NAME      |    |             |               |     |               |       |      |
| ARACEAE          | <i>Dieffenbachia longispatha</i>     | otoe lagarto     | *  | G4          | N3            |     |               |       |      |
|                  | <i>Montrichardia arborescens</i> (a) | castaño          | *  | G4          | N4            |     |               |       |      |
|                  | <i>Philodendron sp.</i>              |                  | *  |             |               |     |               |       |      |
| ARECACEAE        | <i>Astrocaryum standleyanum</i>      | chunga           | *  | G4          | N2            |     |               |       |      |
|                  | <i>Attalea butyracea</i>             | palma real       | *  | G3          | N3            |     |               |       |      |
|                  | <i>Bactris coloradonis</i>           |                  | *  | G2          | N2            |     |               |       |      |
|                  | <i>Bactris major</i>                 | caña brava       | *  | G5          | N3            |     |               |       |      |
|                  | <i>Cryosophila warszewiczii</i>      | palma quaquara   | *  | G3          | N3            |     |               |       |      |
|                  | <i>Desmoncus isthmus</i>             | matamba          | *  | G3          | N3            |     |               |       |      |
|                  | <i>Elaeis oleifera</i>               | palma aceitera   | *  | G5          | N3            |     |               |       |      |
|                  | <i>Oenocarpus mapora</i>             | maquenque        | *  | G4          | N3            |     |               |       |      |
| BROMELIACEAE     | <i>Aechmea magdalenae</i>            | pita             | *  | G5          | N3            |     |               |       |      |
| CYCLANTHACEAE    | <i>Carludovica palmata</i>           | sombrero panamá  | *  | G5          | N3            |     |               |       |      |
| CYPERACEAE       | <i>Cyperus sp.</i>                   |                  | *  |             |               |     |               |       |      |
| MARANTACEAE      | <i>Calathea sp.</i>                  | bijao            | *  |             |               |     |               |       |      |
| ORCHIDACEAE      | <i>Brassavola nodosa</i>             | dama de la noche | *  | G4          | N3            |     |               | AI    |      |
|                  | <i>Dichaea panamensis</i>            | orquidea         | *  |             |               |     |               | AI    |      |
|                  | <i>Epidendrum difforme</i>           | orquidea         | *  |             |               |     |               | AI    |      |
|                  | <i>Oncidium stipitatum</i>           | orquidea         | *  | G3          | N3            |     |               | AI    |      |
| POACEAE          | <i>Chusquea sp.</i>                  | caricillo        | *  |             |               |     |               |       |      |
|                  | <i>Scleria sp.</i>                   |                  | *  |             |               |     |               |       |      |
| ZINGIBERACEAE    | <i>Costus sp.</i>                    | genqibre         | *  |             |               |     |               |       |      |

**Nota:** RG: Global Rank; RN: Nacional Rank, END: Endémic Species; N: National; EPL: Protected by National Wildlife Laws, CITES: Apéndice I (AI), Apéndice II (AII); IUCN: CR: Critically in Danger; E: In Danger; I: Indetermined, R: Rare, V: Vulnerable. Cultivated Species (c), Naturalized Species (n), Aquatic (a).

Table EA-23: Bird Species Identified at Site T2

| GAME BIRDS                 |                  |                                       |                              | T2 | Global | National | END | EPL    | CITES | UICN |
|----------------------------|------------------|---------------------------------------|------------------------------|----|--------|----------|-----|--------|-------|------|
| ORDER                      | FAMILY           | SPECIES                               | COMMON NAME                  |    | Rank   | Rank     |     | Panama |       |      |
| COLUMBIFORMES              | COLUMBIDAE       | <i>Columba cayennensis</i>            | paloma colorada              | *  | G5     | N5       |     | X      |       |      |
|                            |                  | <i>Leptotila v. verreauxi</i>         | paloma rabiblanca            | *  | G5     | N5       |     |        |       |      |
| PICIFORMES                 | RAMPHASTIDAE     | <i>Ramphastos sulfuratus</i>          | tucán pico iris              | *  | G4     | N4       |     |        |       | All  |
| PSITTACIFORMES             | PSITTACIDAE      | <i>Amazona farinosa</i>               | amazona harinoso             | *  | G4     | N4       |     |        |       | All  |
|                            |                  | <i>Amazona ochrocephala</i>           | amazona coroniamarillo       | *  | G4     | N4       |     | X      |       | All  |
|                            |                  | <i>Brotoeris j. jugularis</i>         | perico barbinaranja          | *  | G5     | N5       |     | X      |       | All  |
| FOREST BIRDS               |                  |                                       |                              | T2 | Global | National | END | EPL    | CITES | UICN |
| ORDER                      | FAMILY           | SPECIES                               | COMMON NAME                  |    | Rank   | Rank     |     | Panama |       |      |
| CHARADRIIFORMES            | JACANIDAE        | <i>Jacana jacana hypomelaena</i>      | jacana carunculada           | *  | G5     | N5       |     |        |       |      |
| CICONIIFORMES              | ARDEIDAE         | <i>Ardea h. herodias</i>              | garza azul mayor             | *  | G5     | NN       |     |        |       |      |
|                            |                  | <i>Casmerodius albus egretta</i>      | garceta grande               | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Egretta caerulea</i>               | garza azul chica             | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Egretta t. thula</i>               | garceta nívea                | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Trigrisoma l. lineatum</i>         | garza tigre castaña          | *  |        |          |     |        |       |      |
| PELICANIFORMES             | ANHINGIDAE       | <i>Anhinga anhinga</i>                | aninga                       | *  | G5     | N4       |     |        |       |      |
| APODIFORMES                | TROCHILIDAE      | <i>Amazilia t. tzacatl</i>            | amazilia colirrufa           | *  | G5     | N5       |     |        |       | All  |
|                            |                  | <i>Phaethornis superciliosus</i>      | ermitaño collirajo           | *  | G5     | N5       |     |        |       |      |
| PASSERIFORMES              | DENDROCOLAPTIDAE | <i>Deconychura longicauda</i>         | trepatroncos collirajo       | *  |        |          |     |        |       |      |
|                            |                  | <i>Cyanerpes cyaneus cameipes</i>     | mielero patirrojo            | *  | G5     | N5       |     |        |       |      |
|                            | EMBERIZIDAE      | <i>Eucometis penicillata cristata</i> | tangara cabecigris           | *  | G4     | N4       |     |        |       |      |
|                            |                  | <i>Ramphocelus d. dimidiatus</i>      | sangre de toro               | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Tachyphonus luctuosus</i>          | tangara hombrilblanca        | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Thraupis episcopus cana</i>        | tangara azulaja              | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Hylophylax n. naevioides</i>       | hormiguero coliarejo         | *  | G4     | N4       |     |        |       |      |
|                            | FORMICARIDAE     | <i>Myrmeciza exsul</i>                | hormiguero dorsicastaño      | *  | G4     | N4       |     |        |       |      |
|                            |                  | <i>Riparia riparia</i>                | martín arenero               | *  | G5     | NN/BBS   |     |        |       |      |
|                            | HIRUNDINIDAE     | <i>Stelgidopteryx ruficollis</i>      | golondrina-airrasposa sureña | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Tachycineta a. albilinea</i>       | golondrina manglera          | *  | G3     | N3       |     |        |       |      |
|                            | ICTERIDAE        | <i>Cacicus cela vitellinus</i>        | cacique lomiamarillo         | *  |        |          |     |        |       |      |
|                            | MUSCICAPIDAE     | <i>Turdus grayi casius</i>            | mirlo pardo                  | *  | G5     | N5       |     |        |       |      |
|                            | PIPRIDAE         | <i>Chiroxiphia lanceolata</i>         | saltarín coludo              | *  | G4     | N4       |     |        |       |      |
|                            |                  | <i>Pipra coronata</i>                 | saltarín coroniceleste       | *  | G5     | N5       |     |        |       |      |
|                            |                  | <i>Pipra mentalis ignifera</i>        | saltarín cabecirrojo         | *  | G4     | N4       |     |        |       |      |
|                            | TYRANNIDAE       | <i>Conopias albocittata</i>           | mosquero blanquianillado     | *  |        |          |     |        |       |      |
| <i>Myiozetetes similis</i> |                  | mosquero social                       | *                            | G5 | N5     |          |     |        |       |      |
|                            |                  | <i>Tyrannus melancholicus</i>         | tirano tropical              | *  | G5     | N5       |     |        |       |      |

Note:  
 RG: Global Rank; RN: National Rank; BBS: Migratory species in decline (Breeding Bird Survey)  
 END: Endémico; N: National; B: Binacional, Costa Rica and Panamá; B2: Southern Pacific portion of Central America; EPL: Protected by National Wildlife Laws  
 CITES: Apéndice 1 (1), Apéndice 2 (2); UICN: CR: Critically in Danger; EN: In Danger; VU: Vulnerable.

Table EA-24: Mammal Species Identified at Site T2

| CLASS MAMMALIA |                 |                                  |                           | T2 | Global | National | END | EPL    | CITES | UICN |
|----------------|-----------------|----------------------------------|---------------------------|----|--------|----------|-----|--------|-------|------|
| ORDER          | FAMILY          | SPECIES                          | COMMON NAME               |    | Rank   | Rank     |     | Panama |       |      |
| XENARTHRA      | MYRMECOPHAGIDAE | <i>Tamandua mexicana</i>         | hormiguero                | *  | G5     | N3       |     | X      |       |      |
|                |                 | <i>Dasyopus novemcinctus</i>     | armadillo de nueve bandas | *  | G5     | N5       |     | X      |       |      |
| CHIROPTERA     | PHYLLOSTOMIDAE  | <i>Carollia perspicillata</i>    | murciélago frugívoro      | *  | G5     | N5       |     |        |       |      |
|                |                 | <i>Artibeus jamaicensis</i>      | murciélago frugívoro      | *  | G5     | N5       |     |        |       |      |
|                |                 | <i>Artibeus lituratus</i>        | murciélago frugívoro      | *  | G5     | N5       |     |        |       |      |
| RODENTIA       | DASYPROCTIDAE   | <i>Dasyprocta punctata</i>       | ñeque                     | *  | G5     | N5       |     | X      |       |      |
|                | ECHIMYIDAE      | <i>Proechimys semispinosus</i>   | rata espinosa - mocagué   | *  | G5     | N5       |     |        |       |      |
|                | HYDROCHAERIDAE  | <i>Hydrochaeris hydrochaeris</i> | capibara - poncho         | *  | G5     | N5       |     | X      |       |      |
| LAGOMORPHA     | LEPORIDAE       | <i>Sylvilagus brasiliensis</i>   | muleto                    | *  | G5     | G5       |     |        |       |      |
| CARNIVORA      | PROCYONIDAE     | <i>Nasua narica</i>              | gato solo                 | *  | G5     | N5       |     | X      |       |      |
|                |                 | <i>Procyon lotor</i>             | mapache - gato mangladero | *  | G5     | N5       |     | X      |       |      |
| ARTIODACTYLA   | TAYASSUIDAE     | <i>Tayassu tajacu</i>            | saino                     | *  | G5     | N5       |     | X      |       | All  |
|                | CERVIDAE        | <i>Odocoileus virginianus</i>    | venado cola blanca        | *  | G5     | N5       |     | X      |       |      |

Note:  
 END: Endémico; N: National; B: Binacional, Costa Rica y Panamá; B2: Southern Pacific Side of Central  
 EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); UICN: CR: Critically in Danger; EN: In danger; VU: Vulnerable.

Table EA-25: Amphibian and Reptile Species Identified at Site T2

| CLASS REPTILIA |                       |                              |                      | T2 | Global | National | END | EPL    | CITES    | UICN |
|----------------|-----------------------|------------------------------|----------------------|----|--------|----------|-----|--------|----------|------|
| FAMILY         | FAMILIA               | SPECIES                      | COMMON NAME          |    | Rank   | Rank     |     | Panama |          |      |
| CROCODYLIA     | CROCODYLIDAE          | <i>Crocodylus acutus</i>     | lagarto aguia        | *  | G2     | N2       |     | X      | AI       | VU   |
|                | BOIDAE                | <i>Boa constrictor</i>       | boa                  | *  | G5     | N4       |     | X      | AI - AII |      |
| SQUAMATA       | COLUBRIDAE            | <i>Oxybelis brevirostris</i> | bejuquilla verde     | *  | G5     | N5       |     |        |          |      |
|                |                       | <i>Oxybelis aeneus</i>       | bejuquilla chocolate | *  | G5     | N4       |     |        |          |      |
|                | CORYTOPHANIDAE        | <i>Basiliscus basiliscus</i> | meracho              | *  | G4     | N4       |     |        |          |      |
|                | GEKKONIDAE            | <i>Gonatodes albogularis</i> | cabeza naranja       | *  | G5     | N4       |     |        |          |      |
|                |                       | <i>Iguana iguana</i>         | iguana verde         | *  | G4     | N3       |     | X      | AII      |      |
|                | TEIIDAE               | <i>Ameiva ameiva</i>         | borriquero           | *  | G5     | N5       |     |        |          |      |
|                |                       | <i>Ameiva festiva</i>        | borriquero           | *  | G5     | N4       |     |        |          |      |
| VIPERIDAE      | <i>Bothrops asper</i> | serpiente equis              | *                    | G5 | N5     |          |     |        |          |      |
| TESTUDINES     | EMYDIDAE              | <i>Trachemys scripta</i>     | tortuga              | *  | G5     | N4       |     |        |          |      |

| CLASS AMPHIBIANS |               |                                |              | T2 | Global | National | END | EPL    | CITES | UICN |
|------------------|---------------|--------------------------------|--------------|----|--------|----------|-----|--------|-------|------|
| ORDEN            | FAMILIA       | ESPECIE                        | NOMBRE COMUN |    | Rank   | Rank     |     | Panama |       |      |
| ANURA            | BUFONIDAE     | <i>Bufo marinus</i>            | sapo         | *  | G5     | N5       |     |        |       |      |
|                  |               | <i>Bufo typhonius</i>          | sapo         | *  | G5     | N4       |     |        |       |      |
|                  | DENDROBATIDAE | <i>Colostethus iniquinalis</i> |              | *  | G3G4   | N3       |     |        |       |      |

Note:

END: Endémic; N: National; B: Binational, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In danger, VU: Vulnerable.

Table EA-26: Flora Species Identified at Site T4

| Vegetation           |                                  |                    | Global Rank | National Rank | END | EPL Panameñas | CITES | UICN |
|----------------------|----------------------------------|--------------------|-------------|---------------|-----|---------------|-------|------|
| Family               | Species                          | Common Name        |             |               |     |               |       |      |
| ACANTHACEAE          | <i>Aphelandra scabra</i>         |                    | G5          | N5            |     |               |       |      |
| ANACARDIACEAE        | <i>Anacardium excelsum</i>       | espavé             | G5          | N5            |     |               |       |      |
|                      | <i>Astronium graveolens</i>      | zorro              | G4          | N3            |     |               |       |      |
|                      | <i>Spondias mombin</i>           | jobo               | G5          | N5            |     |               |       |      |
| ANNONACEAE           | <i>Annona havessii</i>           | chirimova          | G3          | N3            |     |               |       |      |
|                      | <i>Annona spraguei</i>           | chirimoya          | G3          | N3            |     |               |       |      |
| ARACEAE              | <i>Dieffenbachia longispatha</i> | otoe lagarto       | G4          | N3            |     |               |       |      |
| ARALIACEAE           | <i>Dendronanax arboreus</i>      | muñequito          | G5          | N5            |     |               |       |      |
|                      | <i>Schefflera morototoni</i>     | guarumo de pava    | G5          | N4            |     |               |       |      |
| ARECACEAE            | <i>Astrocaryum standleyanum</i>  | chunga             | G4          | N2            |     |               |       |      |
|                      | <i>Bactris major</i>             | caña brava         | G5          | N3            |     |               |       |      |
|                      | <i>Desmoncus isthmius</i>        | matamba            | G3          | N3            |     |               |       |      |
|                      | <i>Elaeis oleifera</i>           | palma aceitera     | G5          | N3            |     |               |       |      |
|                      | <i>Oenocarpus mapora</i>         | maquenque          | G4          | N3            |     |               |       |      |
|                      | <i>Roystonea regia</i> (c)       | palma real         | G4          | NE            |     |               |       |      |
| BIGNONIACEAE         | <i>Godmania aesculifolia</i>     | cacho del diablo   |             |               |     |               |       |      |
|                      | <i>Pithecoctenium crucigerum</i> |                    | G5          | N5            |     |               |       |      |
|                      | <i>Tabebuia rosea</i>            | roble              | G5          | N5            |     |               |       |      |
| BOMBACACEAE          | <i>Ochroma pyramidale</i> (c)    | balso              | G5          | N5            |     |               |       |      |
|                      | <i>Pseudobombax septenatum</i>   | barrigón           | G5          | N4            |     |               |       |      |
| BORAGINACEAE         | <i>Cordia alliodora</i>          | laurel             | G5          | N5            |     |               |       |      |
| BROMELIACEAE         | <i>Tillandsia flexuosa</i>       | barba de chivo     | G4          | N3            |     |               |       |      |
| CECROPIACEAE         | <i>Cecropia peltata</i>          | guarumo            | G5          | N5            |     |               |       |      |
| CRYSOBALANACEAE      | <i>Hirtella racemosa</i>         | camaroncillo       | G5          | N5            |     |               |       |      |
| COCHLOSPERMACEAE     | <i>Cochlospermum vitifolium</i>  | poro - poro        | G5          | N5            |     |               |       |      |
| COMBRETACEAE         | <i>Terminalia oblonga</i>        | guayabo de montaña | G5          | N5            |     |               |       |      |
| CONNARACEAE          | <i>Connarus panamensis</i>       |                    | G5          | N5            |     |               |       |      |
| CYCLANTHACEAE        | <i>Carludovica palmata</i>       | sombrero panamá    | G5          | N3            |     |               |       |      |
| CYPERACEAE           | <i>Cyperus sp.</i>               |                    |             |               |     |               |       |      |
| EUPHORBIACEAE        | <i>Croton billbergianus</i>      | sangrillo          | G5          | N5            |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Swartzia simplex</i>          | naraniillo         | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Andira inermis</i>            | harino             | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Erythrina fusca</i>           | palo santo         | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Hymenaea courbaril</i>        | algarrobo          | G5          | N4            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Ormosia macrocalyx</i>        | coralillo          |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Albizia adinocephala</i>      |                    | G4          | N2            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Cassia moschata</i>           | caña fistula       | G4          | N3            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Coioba rufescens</i>          | coralillo          | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Enterolobium cyclocarpum</i>  | corotú             | G5          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga acuminata</i>            | guabo de monte     | G3          | N3            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga punctata</i>             | guabito cansa boca | G5          | N5            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga sapindoides</i>          | guabo de monte     | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga sp.</i>                  | guabo de monte     |             |               |     |               |       |      |
| FLACOURTIACEAE       | <i>Casearia arguta</i>           | pica lengua        | G4          | N3            |     |               |       |      |
|                      | <i>Lacistema aggregatum</i>      | huesito            | G5          | N5            |     |               |       |      |
|                      | <i>Zuelania guidonea</i>         | árbol caspa        | G5          | N3            |     |               |       |      |
| HELICONIACEAE        | <i>Heliconia latispatha</i>      | chichica           | G5          | N4            |     |               |       |      |
| LAURACEAE            | <i>Nectandra turbacensis</i>     | sigua              | G3          | N3            |     |               |       |      |
|                      | <i>Ocotea puberula</i>           | sigua              | G3          | N3            |     |               |       |      |
|                      | <i>Phoebe cinnamomifolia</i>     | sigua blanca       | G5          | N5            |     |               |       |      |
| LECYTHIDACEAE        | <i>Gustavia superba</i>          | membrillo          | G5          | N4            |     |               |       |      |
| MALPIGHIACEAE        | <i>Bunchosia corniflora</i>      |                    |             |               |     |               |       |      |
| MARANTACEAE          | <i>Calathea latifolia</i>        | bijao              | G5          | N5            |     |               |       |      |
| MELASTOMATACEAE      | <i>Miconia argentea</i>          | papelillo          | G5          | N5            |     |               |       |      |
| MELIACEAE            | <i>Guarea glabra</i>             | cedro macho        | G5          | N5            |     |               |       |      |
| MORACEAE             | <i>Ficus insipida</i>            | higuerón           | G5          | N4            |     |               |       |      |
|                      | <i>Ficus maxima</i>              | higuerón           | G3          | N3            |     |               |       |      |
|                      | <i>Ficus sp.</i>                 | higuerón           |             |               |     |               |       |      |

| Vegetation (Cont.) |                                  |                       | Global | National | END | EPL       | CITES | UICN |
|--------------------|----------------------------------|-----------------------|--------|----------|-----|-----------|-------|------|
| Family             | Species                          | Common Name           | Rank   | Rank     |     | Panaméñas |       |      |
| MYRISTICACEAE      | <i>Virola sebifera</i>           | velario colorado      | G5     | N3       |     |           |       |      |
| MYRSINACEAE        | <i>Ardisia sp.</i>               | raspa lengua          |        |          |     |           |       |      |
| MYRTACEAE          | <i>Myrcia gatunensis</i>         | pimiento              | G2     | N2       | N   |           |       |      |
| NYCTAGINACEAE      | <i>Neea sp.</i>                  |                       |        |          |     |           |       |      |
| ORCHIDACEAE        | <i>Dichaea panamensis</i>        | orquidea              |        |          |     | x         |       |      |
|                    | <i>Epidendrum difforme</i>       | orquidea              |        |          |     | x         |       |      |
| PASSIFLORACEAE     | <i>Passiflora ambigua</i>        | pasionaria            | G3     | N3       |     |           |       |      |
|                    | <i>Passiflora foetida</i>        | calzoncillo           | G5     | N5       |     |           |       |      |
|                    | <i>Passiflora vitifolia</i>      | pasionaria            | G5     | N5       |     |           |       |      |
| PIPERACEAE         | <i>Piper marginatum</i>          | hinojo                | G5     | N5       |     |           |       |      |
|                    | <i>Piper reticulatum</i>         | hinojo                | G5     | N4       |     |           |       |      |
| POACEAE            | <i>Chusquea sp.</i>              | caricillo             |        |          |     |           |       |      |
|                    | <i>Hyparrhenia rufa</i>          | paia faragua          | G5     | NE       |     |           |       |      |
|                    | <i>Panicum maximum</i>           | paia de guinea        | G5     | NE       |     |           |       |      |
|                    | <i>Paspalum plicatulum</i>       | paspalum              | G5     | N4       |     |           |       |      |
|                    | <i>Saccharum spontaneum (n)</i>  | paia canalera         | G5     | NE       |     |           |       |      |
| POLYGONACEAE       | <i>Coccoloba obovata</i>         |                       | G4     | N4       |     |           |       |      |
|                    | <i>Coccoloba sp.</i>             |                       |        |          |     |           |       |      |
| RUBIACEAE          | <i>Triplaris cumingiana</i>      | guayabo hormiguero    | G4     | N3       |     |           |       |      |
|                    | <i>Alibertia edulis</i>          | madroño - trompito    | G5     | N4       |     |           |       |      |
|                    | <i>Antirhea trichantha</i>       | mazanuco              | G2     | N2       |     |           |       |      |
|                    | <i>Faramea occidentalis</i>      | benjamín - garrotillo | G5     | N3       |     |           |       |      |
|                    | <i>Genipa americana</i>          | iaqua                 | G5     | N4       |     |           |       |      |
|                    | <i>Psychotria sp.</i>            | cafecillo             |        |          |     |           |       |      |
| RUTACEAE           | <i>Zanthoxylum setulosum</i>     | tachuelo - arcabú     |        |          |     |           |       |      |
| SAPINDACEAE        | <i>Cupania rufescens</i>         | gorgojero colorao     | G5     | N3       |     |           |       |      |
|                    | <i>Cupania scrobiculata</i>      | gorgojero             |        |          |     |           |       |      |
|                    | <i>Cupania sylvatica</i>         | gorgojero             | G3     | N3       |     |           |       |      |
|                    | <i>Matayba glaberrima</i>        | matillo               | G3     | N3       |     |           |       |      |
| SAPOTACEAE         | <i>Matayba scrobiculata</i>      | matillo               | G4     | N3       |     |           |       |      |
|                    | <i>Chrysophyllum cainito (c)</i> | caimito               | G5     | N5       |     |           |       |      |
| STERCULIACEAE      | <i>Guazuma ulmifolia</i>         | negrito               | G5     | N5       |     |           |       |      |
|                    | <i>Herrania purpurea</i>         | cacao de monte        | G3     | N3       |     |           |       |      |
|                    | <i>Sterculia apetala</i>         | árbol panamá          | G5     | N4       |     |           |       |      |
| TILIACEAE          | <i>Apeiba tibourbou</i>          | neine de mono         | G5     | N5       |     |           |       |      |
|                    | <i>Luehea seemannii</i>          | guácimo colorado      | G5     | N4       |     |           |       |      |
|                    | <i>Luehea speciosa</i>           | guácimo               | G5     | N4       |     |           |       |      |
| ZINGIBERACEAE      | <i>Costus sp.</i>                | gengibre              |        |          |     |           |       |      |

Note:

GR: Global Rank; NR: National Rank, END: Endemic Species N: Nacional; CITES: Apéndice 1 (1), Apéndice (2); IUCN:CR: Critically Endangered; E: Endangered; I: Indetermined, R: Rare, V: Vulnerable.

Species (n): Introduced species accepted as part of natural resources

Species (c): Species used for landscaping and other uses

Table EA-27: Bird Species Identified at Site T4

| Game Birds                                |                  |  |                           | Global Rank | National Rank | END | EPL National | CITES | UICN |
|---|------------------|--|---------------------------|-------------|---------------|-----|--------------|-------|------|
| ORDER                                     | Family           | Species                                    | Common Name               |             |               |     |              |       |      |
| COLUMBIFORMES                             | COLUMBIDAE       | <i>Leptotila v. verreauxi</i>              | paloma rabiblanca         | G5          | N5            |     |              |       |      |
| PICIFORMES                                | RAMPHASTIDAE     | <i>Pteroglossus t. torquatus</i>           | tucancillo collarceo      | G4          | N4            |     |              |       |      |
|   |                  | <i>Ramphastos sulfuratus</i>               | tucán pico iris           | G4          | N4            |     |              | AII   |      |
| PSITTACIFORMES                            | PSITTACIDAE      | <i>Amazona ochrocephala</i>                | amazona coroniamarillo    | G4          | N4            |     | x            | AII   |      |
|   |                  | <i>Brotogeris j. jugularis</i>             | perico barbinaranja       | G5          | N5            |     | x            | AII   |      |
| Wild Birds                                |                  |  |                           | Global Rank | National Rank | END | EPL National | CITES | UICN |
| ORDER                                     | Family           | Species                                    | Common Name               |             |               |     |              |       |      |
| CICONIIFORMES                             | ARDEIDAE         | <i>Egretta caerulea</i>                    | garza azul chica          | G5          | N5            |     |              |       |      |
|   |                  | <i>Egretta t. thula</i>                    | garceta nívea             | G5          | N5            |     |              |       |      |
| FALCONIFORMES                             | CATHARTIDAE      | <i>Coragyps atratus</i>                    | gallinazo negro           | G5          | N5            |     |              |       |      |
|   | FALCONIDAE       | <i>Milvago chimachima</i>                  | caracara cabeciamarilla   | G5          | N5            |     |              | AII   |      |
| COLUMBIFORMES                             | COLUMBIDAE       | <i>Columbina talpacoti</i>                 | tortolita rojiza          | G5          | N5            |     |              |       |      |
| CAPRIMULGIFORMES                          | CUCULIDAE        | <i>Playa cayana thermophila</i>            | cuco ardilla              | G5          | N5            |     |              |       |      |
| APODIFORMES                               | TROCHILIDAE      | <i>Amazilia t. tzacatl</i>                 | amazilia colirufa         | G5          | N5            |     |              | AII   |      |
|   |                  | <i>Chlorostilbon assimilis</i>             | esmeralda jardinera       | G4          | N4            | B2  |              |       |      |
|   |                  | <i>Phaethornis longuemareus</i>            | ermitaño chico            | G5          | N5            |     |              |       |      |
|   |                  | <i>Phaethornis superciliosus</i>           | ermitaño colilargo        | G5          | N5            |     |              |       |      |
| TROGONIFORMES                             | TROGONIDAE       | <i>Trogon massena hoffmanni</i>            | trogón colipizara         | G4          | N4            |     |              |       |      |
| CORACIIFORMES                             | ALCEDINIDAE      | <i>Chloroceryle americana</i>              | martín pescador verde     | G5          | N5            |     |              |       |      |
| PICIFORMES                                | BUCCONIDAE       | <i>Notharchus macrorhynchus</i>            | buco cuelliblanco         | G5          | N4            |     |              |       |      |
|   | PICIDAE          | <i>Melanerpes rubricapillus</i>            | carpintero coronirrojo    | G5          | N5            |     |              |       |      |
| PASSERIFORMES                             | DENDROCOLAPTIDAE | <i>Deconychura longicauda</i>              | trepatroncos colilargo    |             |               |     |              |       |      |
|   |                  | <i>Xiphorhynchus guttatus namus</i>        | trepatroncos gorgianteado | G5          | N5            |     |              |       |      |
|   | EMBERIZIDAE      | <i>Cyanerpes cyaneus carneipes</i>         | mielero patirrojo         | G5          | N5            |     |              |       |      |
|   |                  | <i>Eucometis penicillata cristata</i>      | tangara cabecigris        | G4          | N4            |     |              |       |      |
|   |                  | <i>Euphonia luteicapilla</i>               | eufonia coroniamarilla    | G4          | N4            |     |              |       |      |
|   |                  | <i>Ramphocelus d. dimidiatus</i>           | sangre de toro            | G5          | N5            |     |              |       |      |
|   |                  | <i>Tachyphonus luctuosus</i>               | tangara hombriblanca      | G5          | N5            |     |              |       |      |
|   |                  | <i>Thraupis episcopus cana</i>             | tangara azulcía           | G5          | N5            |     |              |       |      |
|   |                  | <i>Thraupis palmarum atripennis</i>        | tangara palmera           | G5          | N5            |     |              |       |      |
|   |                  | <i>Volatinia jacarina splendens</i>        | semillero negriazulado    | G5          | N5            |     |              |       |      |
|   | FORMICARIIDAE    | <i>Hylophylax n. naevioides</i>            | hormiguero collarceo      | G4          | N4            |     |              |       |      |
|   |                  | <i>Microrhopias quixensis virgata</i>      | hormiguero alipunteado    | G5          | N5            |     |              |       |      |
|   |                  | <i>Myrmeciza exsul</i>                     | hormiguero dorsicastaño   | G4          | N4            |     |              |       |      |
|   |                  | <i>Thamophilus doliatus nigricristatus</i> | batará barreteado         | G5          | N5            |     |              |       |      |
|   | ICTERIDAE        | <i>Cacicus cela vitellinus</i>             | cacique lomiamarillo      |             |               |     |              |       |      |
|   | MUSCICAPIDAE     | <i>Turdus gravi casius</i>                 | mirlo pardo               | G5          | N5            |     |              |       |      |
|   | PARULIDAE        | <i>Seiurus n. noveboracensis</i>           | reinita-acuática norteña  | G5          | NN            |     |              |       |      |
|   | PIPRIDAE         | <i>Pipra coronata</i>                      | saltarín coroniceleste    | G5          | N5            |     |              |       |      |
|   |                  | <i>Pipra mentalis ignifera</i>             | saltarín cabecirrojo      | G4          | N4            |     |              |       |      |
|   | TYRANNIDAE       | <i>Elaenia flavogaster pallidorsalis</i>   | elania penachuda          | G5          | N5            |     |              |       |      |
| <i>Myiarchus panamensis</i>               |                  | copetón panameño                           | G4                        | N4          |               |     |              |       |      |
| <i>Myiozetetes similis columbianus</i>    |                  | mosquero social                            | G5                        | N5          |               |     |              |       |      |
| <i>Tyrannus melancholicus chloronotus</i> |                  | tirano tropical                            | G5                        | N5          |               |     |              |       |      |

**Table EA-28: Mammal Species Identified at Site T4**

| Mammals         |                 |                                |                           | Global | National | END | EPL        | CITES | UICN |
|-----------------|-----------------|--------------------------------|---------------------------|--------|----------|-----|------------|-------|------|
| ORDER           | Family          | Species                        | Common Name               | Rank   | Rank     |     | Parameters |       |      |
| DIDELPHIMORPHIA | DIDELPHIDAE     | <i>Didelphis marsupialis</i>   | zona común                | G5     | N5       |     |            |       |      |
| XENARTHRA       | MYRMECOPHAGIDAE | <i>Tomomachus mexicana</i>     | hormiguero                | G5     | N3       |     | x          |       |      |
|                 | BRADYPODIDAE    | <i>Bradypus variegatus</i>     | perezoso de tres dedos    | G5     | N5       |     |            |       |      |
|                 | DASYPODIDAE     | <i>Dasypus novemcinctus</i>    | armadillo de nueve bandas | G5     | N5       |     | x          |       |      |
| CHIROPTERA      | PHYLLOSTOMIDAE  | <i>Carollia perspicillata</i>  | murciélago frugívoro      | G5     | N5       |     |            |       |      |
|                 |                 | <i>Artibeus jamaicensis</i>    | murciélago frugívoro      | G5     | N5       |     |            |       |      |
|                 |                 | <i>Artibeus lituratus</i>      | murciélago frugívoro      | G5     | N5       |     |            |       |      |
| RODENTIA        | DASYPROCTIDAE   | <i>Dasyprocta punctata</i>     | ñeque                     | G5     | N5       |     | x          |       |      |
|                 | MURIDAE         | <i>Oryzomys sp.</i>            | rata anocera              |        |          |     |            |       |      |
|                 | SCURIDAE        | <i>Sciurus granatensis</i>     | ardilla colorada          | G5     | N5       |     |            |       |      |
| LACCMORPHA      | LEPORIDAE       | <i>Sylvilegus brasiliensis</i> | muleto                    | G5     | G5       |     |            |       |      |
| CARNIVORA       | PROCYONIDAE     | <i>Nesuta narica</i>           | gato solo                 | G5     | N5       |     | x          |       |      |
|                 |                 | <i>Potos flavus</i>            | kinjakou - cusumbí        | G5     | N5       |     |            |       |      |
| ARTIODACTYLA    | CERVIDAE        | <i>Odocoileus virginianus</i>  | venado cola blanca        | G5     | N5       |     | x          |       |      |

**Table EA-29: Amphibian and Reptile Species Identified at Site T4**

| REPTILES              |                 |                                     |                       | Global          | National | END | EPL        | CITES    | UICN |  |
|-----------------------|-----------------|-------------------------------------|-----------------------|-----------------|----------|-----|------------|----------|------|--|
| ORDER                 | Family          | Species                             | Common Name           | Rank            | Rank     |     | Parameters |          |      |  |
| SQUAMATA              | BOIDAE          | <i>Boa constrictor</i>              | boa                   | G5              | N4       |     | x          | AI - AII |      |  |
|                       | COLUBRIDAE      | <i>Oxybelis aeneus</i>              | bejuquilla chocolate  | G5              | N4       |     |            |          |      |  |
|                       | CORYTOPHANIDAE  | <i>Basiliscus basiliscus</i>        | maracho               | G4              | N4       |     |            |          |      |  |
|                       | GEKKONIDAE      | <i>Gonatodes albogularis</i>        | cabeza naranja        | G5              | N4       |     |            |          |      |  |
|                       | IGUANIDAE       | <i>Iguana iguana</i>                | iguana verde          | G4              | N3       |     | x          | AII      |      |  |
|                       | TEIIDAE         |                                     | <i>Ameiva ameiva</i>  | boriguero       | G5       | N5  |            |          |      |  |
|                       |                 |                                     | <i>Ameiva festiva</i> | boriguero       | G5       | N4  |            |          |      |  |
|                       | VIPERIDAE       |                                     | <i>Bothrops asper</i> | serpiente equis | G5       | N5  |            |          |      |  |
|                       | BUFONIDAE       |                                     | <i>Bufo marinus</i>   | sapo            | G5       | N5  |            |          |      |  |
| <i>Bufo typhonius</i> |                 |                                     | sapo                  | G5              | N4       |     |            |          |      |  |
| ANURA                 | DENDROBATIDAE   | <i>Colostethus inguinalis</i>       |                       | G3G4            | N3       |     |            |          |      |  |
|                       | LEPTODACTYLIDAE | <i>Eleutherodactylus fitzingeri</i> |                       | G5              | N4       |     |            |          |      |  |
| TESTUDINES            | EMYDIDAE        | <i>Trachemys scripta</i>            | tortuga               | G5              | N4       |     |            |          |      |  |

Table EA-30: Flora Identified at Site T7

| CLASS MAGNOLIOPSIDA  |                                  |                       | T7 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|----------------------|----------------------------------|-----------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY               | SPECIES                          | COMMON NAME           |    |             |               |     |               |       |      |
|                      | <i>Trichantera gigantea</i>      | palo de agua          | *  |             |               |     |               |       |      |
| ANACARDIACEAE        | <i>Anacardium excelsum</i>       | espavé                | *  | G5          | N5            |     |               |       |      |
|                      | <i>Astronium graveolens</i>      | zorro                 | *  | G4          | N3            |     |               |       |      |
|                      | <i>Mangifera indica</i> (c)      | mango                 | *  | G5          | NE            |     |               |       |      |
|                      | <i>Spondias mombin</i>           | jobo                  | *  | G5          | N5            |     |               |       |      |
|                      | <i>Spondias purpurea</i> (c)     | ciruela traquedora    | *  |             |               |     |               |       |      |
| ANNONACEAE           | <i>Annona hayesii</i>            | chirimoya             | *  | G3          | N3            |     |               |       |      |
|                      | <i>Annona muricata</i> (c)       | guanabana             | *  | G5          | N4            |     |               |       |      |
|                      | <i>Annona spraguei</i>           | chirimoya             | *  | G3          | N3            |     |               |       |      |
|                      | <i>Desmopsis panamensis</i>      | yaya                  | *  |             |               |     |               |       |      |
|                      | <i>Xylopia frutescens</i>        | malegueto macho       | *  | G5          | N4            |     |               |       |      |
| APOCYNACEAE          | <i>Thevetia ahioua</i>           | huevo de gato         | *  | G5          | N5            |     |               |       |      |
| ARALIACEAE           | <i>Dendropanax arboreus</i>      | muñequito             | *  | G5          | N5            |     |               |       |      |
|                      | <i>Sciadodendron excelsum</i>    | jobo lagarto          | *  | G4          | N3            |     |               |       |      |
| ASTERACEAE           | <i>Vernonanthura patens</i>      |                       | *  | G5          | N5            |     |               |       |      |
| BIGNONIACEAE         | <i>Godmania aesculifolia</i>     | cacho del diablo      | *  |             |               |     |               |       |      |
| BOMBACACEAE          | <i>Cavanillesia platanifolia</i> | cujipo                | *  | G5          | N4            |     |               |       |      |
|                      | <i>Pachira quinata</i>           | cedro espino          | *  | G5          | N2            |     |               |       | VU   |
|                      | <i>Pachira sessilis</i>          | vuco de monte         | *  | G5          | N4            |     |               |       |      |
|                      | <i>Pseudobombax septenatum</i>   | barrigón              | *  | G5          | N4            |     |               |       |      |
| BORAGINACEAE         | <i>Cordia alliodora</i>          | laurel                | *  | G5          | N5            |     |               |       |      |
| BURSERACEAE          | <i>Bursera simaruba</i>          | almácigo - carate     | *  | G5          | N5            |     |               |       |      |
| CECROPIACEAE         | <i>Cecropia peltata</i>          | guarumo               | *  | G5          | N5            |     |               |       |      |
| CHRYSOBALANACEAE     | <i>Hirtella racemosa</i>         | camaroncillo          | *  | G5          | N5            |     |               |       |      |
| CLUSIACEAE           | <i>Vismia sp.</i>                |                       | *  |             |               |     |               |       |      |
| COCHLOSPERMACEAE     | <i>Cochlospermum vitifolium</i>  | poro - poro           | *  | G5          | N5            |     |               |       |      |
| COMBRETACEAE         | <i>Terminalia amazonia</i>       | amarillo              | *  | G5          | N4            |     |               |       |      |
| CONNARACEAE          | <i>Connarus panamensis</i>       |                       | *  | G5          | N5            |     |               |       |      |
| DILLENIACEAE         | <i>Davilla sp.</i>               |                       | *  |             |               |     |               |       |      |
| ELAEOCARPACEAE       | <i>Mutingia calabura</i>         | periquito -majaguillo | *  |             |               |     |               |       |      |
| ERYTHROXYLACEAE      | <i>Erythroxylum sp.</i>          |                       | *  |             |               |     |               |       |      |
| EUPHORBIACEAE        | <i>Adelia triloba</i>            |                       | *  | G5          | N5            |     |               |       |      |
|                      | <i>Phyllanthus acuminatus</i>    |                       | *  |             |               |     |               |       |      |
|                      | <i>Sapium glandulosum</i>        | cauchillo             | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Bauhinia sp.</i>              | escalera de mono      | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Cassia moschata</i>           | caña fistula          | *  | G4          | N3            |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Hymenaea courbaril</i>        | algarrobo             | *  | G5          | N4            |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Swartzia simplex</i>          | narajillo             | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Andira inermis</i>            | harino                | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Crotalaria sp.</i>            |                       | *  |             |               |     |               |       |      |
| FAB-FABOIDEAE        | <i>Dalbergia retusa</i>          | cocobolo              | *  | G4          | N4            |     | X             |       | VU   |
| FAB-FABOIDEAE        | <i>Erythrina fusca</i>           | palo santo            | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Flemingia strobilifera</i>    |                       | *  | G5          | NE            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Lennea viridiflora</i>        | algarrobillo          | *  |             |               |     | N             |       |      |
| FAB-MIMOSOIDEAE      | <i>Acacia melanoceras</i>        | cachito               | *  | G4          | N2            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Adenopodia polystachya</i>    |                       | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Albizia adinocephala</i>      |                       | *  | G4          | N2            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Chloroleucon mangense</i>     |                       | *  |             |               |     |               |       |      |

| CLASS MAGNOLIOPSIDA |                                    |                       | T7 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|---------------------|------------------------------------|-----------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                            | COMMON NAME           |    |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Cojoba rufescens</i>            | coralillo             | *  | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Enterolobium cyclocarpum</i>    | corotú                | *  | G5          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Inga hayesii</i>                | guabo                 | *  | G3          | N3            |     |               |       | LR   |
| FAB-MIMOSOIDEAE     | <i>Inga laurina</i>                | guabito cansa boca    | *  |             |               |     |               |       |      |
| FLACOURTIACEAE      | <i>Casearia arguta</i>             | pica lengua           | *  | G4          | N3            |     |               |       |      |
|                     | <i>Casearia commersoniana</i>      | corta lengua - mauro  | *  | G5          | N5            |     |               |       |      |
|                     | <i>Lacistema aggregatum</i>        | huesito               | *  | G5          | N5            |     |               |       |      |
|                     | <i>Zuelania guidonea</i>           | árbol caspa           | *  | G5          | N3            |     |               |       |      |
| LAURACEAE           | <i>Phoebe cinnamomifolia</i>       | sigua blanca          | *  | G5          | N5            |     |               |       |      |
| LECYTHIDACEAE       | <i>Gustavia superba</i>            | membrillo             | *  | G5          | N4            |     |               |       |      |
| LOGANIACEAE         | <i>Strychnos sp.</i>               |                       | *  |             |               |     |               |       |      |
| MALPIGHIACEAE       | <i>Byrsonima crassifolia (c)</i>   | nance                 | *  | G5          | N5            |     |               |       |      |
| MELASTOMATACEAE     | <i>Clidemia sp.</i>                |                       | *  |             |               |     |               |       |      |
|                     | <i>Miconia argentea</i>            | papelillo             | *  | G5          | N5            |     |               |       |      |
|                     | <i>Miconia minutiflora</i>         | copo de nieve         | *  | G4          | N4            |     |               |       |      |
| MELIACEAE           | <i>Cedrela odorata</i>             | cedro amargo          | *  | G4          | N4            |     | X             |       | VU   |
|                     | <i>Guarea glabra</i>               | cedro macho           | *  | G5          | N5            |     |               |       |      |
| MORACEAE            | <i>Ficus insipida</i>              | higuerón              | *  | G5          | N4            |     |               |       |      |
|                     | <i>Trophis racemosa</i>            | lechosa               | *  | G5          | N4            |     |               |       |      |
| MYRSINACEAE         | <i>Ardisia sp.</i>                 | raspa lengua          | *  |             |               |     |               |       |      |
| MYRTACEAE           | <i>Calycolpus warszewiczianus</i>  | quayabillo            | *  | G3          | N3            |     |               |       |      |
|                     | <i>Myrcia gatunensis</i>           | pimiento              | *  | G2          | N2            |     |               |       |      |
| OCHNACEAE           | <i>Ouratea lucens</i>              | caidita               | *  | G5          | N5            |     |               |       |      |
| PASSIFLORACEAE      | <i>Passiflora ambigua</i>          | pasionaria            | *  | G3          | N3            |     |               |       |      |
|                     | <i>Passiflora foetida</i>          | calzoncillo           | *  | G5          | N5            |     |               |       |      |
|                     | <i>Passiflora vitifolia</i>        | pasionaria            | *  | G5          | N5            |     |               |       |      |
| PIPERACEAE          | <i>Piper aduncum</i>               | hinojo                | *  | G5          | N5            |     |               |       |      |
|                     | <i>Piper aequale</i>               | hinojo                | *  | G5          | N5            |     |               |       |      |
|                     | <i>Piper hirtelloiellum</i>        | hinojo                | *  |             |               | N   |               |       |      |
|                     | <i>Piper marginatum</i>            | hinojo                | *  | G5          | N5            |     |               |       |      |
|                     | <i>Piper reticulatum</i>           | hinojo                | *  | G5          | N4            |     |               |       |      |
| POLYGONACEAE        | <i>Coccoloba sp.</i>               |                       | *  |             |               |     |               |       |      |
|                     | <i>Triplaris cumingiana</i>        | guayabo hormiguero    | *  | G4          | N3            |     |               |       |      |
| PROTEACEAE          | <i>Roupala montana</i>             | came asado            | *  | G5          | N4            |     |               |       |      |
| RHAMNACEAE          | <i>Colubrina heteroneura</i>       | carbonero             | *  |             |               |     |               |       |      |
| RUBIACEAE           | <i>Alibertia edulis</i>            | madroño - trompito    | *  | G5          | N4            |     |               |       |      |
|                     | <i>Alseis blackiana</i>            | mamecillo             | *  | G3          | N3            |     |               |       |      |
|                     | <i>Antirhea trichantha</i>         | mazanuco              | *  | G2          | N2            |     |               |       |      |
|                     | <i>Calycophyllum candidissimum</i> | alazano - quayabo     | *  | G4          | N3            |     |               |       |      |
|                     | <i>Coussarea curvicaemia</i>       | huesito               | *  | G3          | N3            |     |               |       |      |
|                     | <i>Faramea occidentalis</i>        | benjamín - garrotillo | *  | G5          | N3            |     |               |       |      |
|                     | <i>Genipa americana</i>            | jaqua                 | *  | G5          | N4            |     |               |       |      |
|                     | <i>Posoqueria latifolia</i>        | boca de vieja         | *  | G5          | N5            |     |               |       |      |
|                     | <i>Psychotria sp.</i>              | cafecillo             | *  |             |               |     |               |       |      |
|                     | <i>Randia sp.</i>                  | rosetillo             | *  |             |               |     |               |       |      |
| RUTACEAE            | <i>Rosenbergiodendron formosum</i> |                       | *  | G4          | N3            |     |               |       |      |
| SAPINDACEAE         | <i>Zanthoxylum panamense</i>       | cicadro - tachuelo    | *  | G3          | N3            |     |               |       |      |
|                     | <i>Cupania rufescens</i>           | gorrojero colorao     | *  | G5          | N3            |     |               |       |      |
|                     | <i>Cupania sylvatica</i>           | gorrojero             | *  | G3          | N3            |     |               |       |      |
|                     | <i>Matayba glaberrima</i>          | matillo               | *  | G3          | N3            |     |               |       |      |
|                     | <i>Serjania sp.</i>                |                       | *  |             |               |     |               |       |      |

| CLASS MAGNOLIOPSIDA |                                  |                  | T7 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|---------------------|----------------------------------|------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                          | COMMON NAME      |    |             |               |     |               |       |      |
| SAPOTACEAE          | <i>Chrysophyllum cainito</i> (c) | caimito          | *  | G5          | N5            |     |               |       |      |
| SIMAROUBACEAE       | <i>Quasia amara</i>              | amargo           | *  |             |               |     |               |       |      |
| SOLANACEAE          | <i>Solanum sp.</i>               |                  | *  | G5          | N5            |     |               |       |      |
| STERCULIACEAE       | <i>Guazuma ulmifolia</i>         | negrito          | *  | G5          | N5            |     |               |       |      |
|                     | <i>Helicteres guazumaefolia</i>  | torcidillo       | *  | G4          | N3            |     |               |       |      |
|                     | <i>Sterculia apetala</i>         | árbol panamá     | *  | G5          | N4            |     |               |       |      |
| THEOPHRASTACEAE     | <i>Clavija mezii</i>             |                  | *  |             |               |     |               |       |      |
| TILIACEAE           | <i>Apeiba libourbou</i>          | peine de mono    | *  | G5          | N5            |     |               |       |      |
|                     | <i>Luehea seemannii</i>          | guácimo colorado | *  | G5          | N4            |     |               |       |      |
|                     | <i>Luehea speciosa</i>           | guácimo          | *  | G5          | N4            |     |               |       |      |
| VERBENACEAE         | <i>Lantana camara</i>            | siete negritos   | *  | G5          | N5            |     |               |       |      |

| CLASS LILIOPSIDA |                                      |                  | T1 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|------------------|--------------------------------------|------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY           | SPECIES                              | COMMON NAME      |    |             |               |     |               |       |      |
| ARACEAE          | <i>Montrichardia arborescens</i> (a) | castaño          | *  | G4          | N4            |     |               |       |      |
| ARECACEAE        | <i>Attalea butyracea</i>             | palma real       | *  | G3          | N3            |     |               |       |      |
|                  | <i>Bactris major</i>                 | caña brava       | *  | G5          | N3            |     |               |       |      |
|                  | <i>Desmoncus isthmus</i>             | matamba          | *  | G3          | N3            |     |               |       |      |
|                  | <i>Elaeis oleifera</i>               | palma acelitera  | *  | G5          | N3            |     |               |       |      |
|                  | <i>Oenocarpus mapora</i>             | maquenque        | *  | G4          | N3            |     |               |       |      |
|                  | <i>Roystonea regia</i> (c)           | palma real       | *  | G4          | NE            |     |               |       |      |
| BROMELIACEAE     | <i>Aechmea magdalenae</i>            | pita             | *  | G5          | N3            |     |               |       |      |
| CYCLANTHACEAE    | <i>Carludovica palmata</i>           | sombrero panamá  | *  | G5          | N3            |     |               |       |      |
|                  | <i>Cyclanthus bipartitus</i>         |                  | *  | G5          | N5            |     |               |       |      |
| HELICONIACEAE    | <i>Heliconia latispatha</i>          | chichica         | *  | G5          | N4            |     |               |       |      |
| MARANTACEAE      | <i>Calathea latifolia</i>            | bijao            | *  | G5          | N5            |     |               |       |      |
| ORCHIDACEAE      | <i>Brassavola nodosa</i>             | dama de la noche | *  | G4          | N3            |     |               | All   |      |
|                  | <i>Notylia pentachne</i>             | orquidea         | *  | G2          | N2            |     |               | All   |      |
|                  | <i>Oeceoclades maculata</i>          | orquidea         | *  | G3          | N3            |     |               | All   |      |
|                  | <i>Oncidium stipitatum</i>           | orquidea         | *  | G3          | N3            |     |               | All   |      |
| POACEAE          | <i>Chusquea sp.</i>                  | caricillo        | *  |             |               |     |               |       |      |
|                  | <i>Hyparrhenia rufa</i>              | paja faragua     | *  | G5          | NE            |     |               |       |      |
|                  | <i>Saccharum spontaneum</i> (n)      | paja canalera    | *  | G5          | NE            |     |               |       |      |
|                  | <i>Scleria sp.</i>                   |                  | *  |             |               |     |               |       |      |
| ZINGIBERACEAE    | <i>Costus sp.</i>                    | gengibre         | *  |             |               |     |               |       |      |

**Nota:** RG: Global Rank; RN: Nacional Rank, END: Endémic Species; N: National; EPL: Protected by National Wildlife Laws, CITES: Apéndice I (AI), Apéndice II (AII); IUCN: CR: Critically in Danger, E: In Danger, I: Indetermined, R: Rare, V: Vulnerable. Cultivated Species (c), Naturalized Species (n), Aquatic (a).

UNAUTHORIZED USE OR DUPLICATION IS PROHIBITED  
PROHIBIDA LA REPRODUCCION SIN AUTORIZACION  
DEL AUTOR

**Table EA-31: Birds Identified at Site T7**

| GAME BIRDS     |                  |                                     |                               | T7              | Global | National | END | EPL    | CITES | UICN |
|----------------|------------------|-------------------------------------|-------------------------------|-----------------|--------|----------|-----|--------|-------|------|
| ORDER          | FAMILY           | SPECIES                             | COMMON NAME                   |                 | Rank   | Rank     |     | Panamá |       |      |
| COLUMBIFORMES  | COLUMBIDAE       | <i>Leptotila v. verreauxi</i>       | paloma rabiblanca             | *               | G5     | N5       |     |        |       |      |
| GALLIFORMES    | CRACIDAE         | <i>Ortalis cinereiceps</i>          | chachalaca cabecigris         | *               | G5     | N3       |     | x      |       |      |
| PICIFORMES     | RAMPHASTIDAE     | <i>Pteroglossus t. torquatus</i>    | lucancillo collarajo          | *               |        |          |     |        |       |      |
|                |                  | <i>Ramphastos sulfuratus</i>        | tucán pico iris               | *               | G4     | N4       |     |        |       | All  |
| PSITTACIFORMES | PSITTACIDAE      | <i>Amazona ochrocephala</i>         | amazona coroniamarillo        | *               | G4     | N4       |     | x      | All   |      |
| FOREST BIRDS   |                  |                                     |                               | T7              | Global | National | END | EPL    | CITES | UICN |
| ORDER          | FAMILY           | SPECIES                             | COMMON NAME                   |                 | Rank   | Rank     |     | Panamá |       |      |
| FALCONIFORMES  | ACCIPITRIDAE     | <i>Buteo brachyurus</i>             | gavilán colicorto             | *               | G4     | N4       |     |        |       | All  |
|                | FALCONIDAE       | <i>Milvago chimachima</i>           | caracara cabeciamarilla       | *               | G5     | N5       |     |        |       | All  |
| APODIFORMES    | TROCHILIDAE      | <i>Leptodon cayanensis</i>          | elanio cabecigris             | *               |        |          |     |        |       |      |
|                |                  | <i>Amazilia t. tzacatl</i>          | amazilia colirufa             | *               | G5     | N5       |     |        |       | All  |
|                |                  | <i>Chlorostilbon assimilis</i>      | esmeralda jardinera           | *               | G4     | N4       | B2  |        |       |      |
|                |                  | <i>Phaethornis superciliosus</i>    | ermitaño collargo             | *               | G5     | N5       |     |        |       |      |
| TROGONIFORMES  | TROGONIDAE       | <i>Phaethornis longuemareus</i>     | ermitaño chico                | *               | G5     | N5       |     |        |       |      |
| CORACIIFORMES  | TROGONIDAE       | <i>Trogon massena hoffmanni</i>     | trogon colipizarra            | *               | G4     | N4       |     |        |       |      |
|                | ALCEDINIDAE      | <i>Chloroceryle americana</i>       | martín pescador verde         | *               | G5     | N5       |     |        |       |      |
| PICIFORMES     | MOMOTIDAE        | <i>Momotus momota conexus</i>       | momoto coroniazulado          | *               | G4G5   | N4       |     |        |       |      |
|                | PICIDAE          | <i>Melanerpes rubricapillus</i>     | carpintero coronirrojo        | *               | G5     | N5       |     |        |       |      |
| PASSERIFORMES  | DENDROCOLAPTIDAE | <i>Deconychura longicauda</i>       | trepatroncos collargo         | *               |        |          |     |        |       |      |
|                | EMBERIZIDAE      | <i>Xiphorhynchus guttatus nanus</i> | trepatroncos gorgianteado     | *               | G5     | N5       |     |        |       |      |
|                |                  | <i>Ramphocelus d. dimidiatus</i>    | sangre de toro                | *               | G5     | N5       |     |        |       |      |
|                |                  | <i>Sporophila americana hicksii</i> | espiguero variable            | *               | G4     | N4       |     |        |       |      |
|                |                  | <i>Thraupis episcopus cana</i>      | tangara azulera               | *               | G5     | N5       |     |        |       |      |
|                |                  | <i>Thraupis palmarum atripennis</i> | tangara palmera               | *               | G5     | N5       |     |        |       |      |
|                |                  | <i>Volatinia jacarina splendens</i> | semillero negrizulado         | *               | G5     | N5       |     |        |       |      |
|                | FORMICARIDAE     | <i>Hylophylax n. naevioides</i>     | hormiguero collarajo          | *               | G4     | N4       |     |        |       |      |
|                | HIRUNDINIDAE     | <i>Hirundo rustica</i>              | golondrina tjereta            | *               | G5     | NN       |     |        |       |      |
|                |                  | <i>Progne chalybea</i>              | martín pechigris              | *               | G5     | N5       |     |        |       |      |
|                | ICTERIDAE        | <i>Riparia riparia</i>              | martín arenero                | *               | G5     | NN/BBS   |     |        |       |      |
|                |                  | <i>Cacicus cela vitellinus</i>      | cacique lomiamarillo          | *               |        |          |     |        |       |      |
|                | MUSCICAPIDAE     | <i>Cassidix mexicanus</i>           | talingo                       | *               | G5     | N5       |     |        |       |      |
|                | PIPRIDAE         | <i>Turdus grayi casius</i>          | mirlo pardo                   | *               | G5     | N5       |     |        |       |      |
|                |                  | <i>Chiroxiphia lanceolata</i>       | saltafín coludo               | *               | G4     | N4       |     |        |       |      |
|                | TROGLODYTIDAE    | <i>Pipra mentalis ignifera</i>      | saltafín cabecirrojo          | *               | G4     | N4       |     |        |       |      |
|                | TYRANNIDAE       | <i>Henicorhina leucophrys</i>       | soterey-selvático pechigris   | *               | G5     | N4       |     |        |       |      |
|                |                  | <i>Elaenia flavogaster</i>          | elania panachuda              | *               | G5     | N5       |     |        |       |      |
|                |                  |                                     | <i>Tyrannus melancholicus</i> | tirano tropical | *      | G5       | N5  |        |       |      |

Note:  
 RG: Global Rank; RN: National Rank; BBS: Migratory species in decline (Breeding Bird Survey)  
 END: Endémic; N: National; B: Binational, Costa Rica and Panamá; B2: Southern Pacific portion of Central America; EPL: Protected by National Wildlife Laws  
 CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In Danger, VU: Vulnerable.

**Table EA-32: Mammals Identified at Site T7**

| CLASS MAMMALIA |                |                                |                           | T7 | Global | National | END | EPL    | CITES | UICN |
|----------------|----------------|--------------------------------|---------------------------|----|--------|----------|-----|--------|-------|------|
| ORDER          | FAMILY         | SPECIES                        | COMMON NAME               |    | Rank   | Rank     |     | Panamá |       |      |
| XENARTHRA      | DASYPODIDAE    | <i>Dasyops novemcinctus</i>    | armadillo de nueve bandas | *  | G5     | N5       |     | x      |       |      |
| CHIROPTERA     | PHYLLOSTOMIDAE | <i>Corallia castanea</i>       | murciélago frugívoro      | *  | G5     | N5       |     |        |       |      |
|                |                | <i>Carollia perspicillata</i>  | murciélago frugívoro      | *  | G5     | N5       |     |        |       |      |
|                |                | <i>Artibeus jamaicensis</i>    | murciélago frugívoro      | *  | G5     | N5       |     |        |       |      |
|                |                | <i>Artibeus lituratus</i>      | murciélago frugívoro      | *  | G5     | N5       |     |        |       |      |
| RODENTIA       | DASYPROCTIDAE  | <i>Dasyprocta punctata</i>     | ñeque                     | *  | G5     | N5       |     | x      |       |      |
|                | ECHIMYIDAE     | <i>Proechimys semispinosus</i> | rata espinosa - mocangué  | *  | G5     | N5       |     |        |       |      |
| LAGOMORPHA     | LEPORIDAE      | <i>Sylvilagus brasiliensis</i> | muleto                    | *  | G5     | G5       |     |        |       |      |
| CARNIVORA      | PROCYONIDAE    | <i>Nasua narica</i>            | gato solo                 | *  | G5     | N5       |     | x      |       |      |
|                |                | <i>Procyon lotor</i>           | mapache - gato manglatero | *  | G5     | N5       |     | x      |       |      |

Note:  
 END: Endémic; N: National; B: Binational, Costa Rica and Panamá; B2: Southern Pacific Side of Central  
 EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In danger, VU: Vulnerable.

Table EA-33: Amphibian and Reptile Species Identified at Site T7

| CLASS REPTILIA        |                       |                              |                      | T7 | Global | National | END | EPL    | CITES    | UICN |
|-----------------------|-----------------------|------------------------------|----------------------|----|--------|----------|-----|--------|----------|------|
| ORDER                 | FAMILY                | SPECIES                      | COMMON NAME          |    | Rank   | Rank     |     | Panama |          |      |
| CROCODYLIA            | CROCODYLIDAE          | <i>Crocodylus acutus</i>     | lagarto aguja        | *  | G2     | N2       |     | X      | AI       | VU   |
| SQUAMATA              | BOIDAE                | <i>Boa constrictor</i>       | boa                  | *  | G5     | N4       |     | X      | AI - All |      |
|                       | COLUBRIDAE            | <i>Oxybelis brevirostris</i> | bejuquilla verde     | *  | G5     | N5       |     |        |          |      |
|                       |                       | <i>Oxybelis aeneus</i>       | bejuquilla chocolate | *  | G5     | N4       |     |        |          |      |
|                       | GEKKONIDAE            | <i>Spilotes pullatus</i>     | cazadora             | *  | G5     | N4       |     |        |          |      |
|                       |                       | <i>Gonatodes albogularis</i> | cabeza naranja       | *  | G5     | N4       |     |        |          |      |
|                       | POLYCHROTIDAE         | <i>Iguana iguana</i>         | iguana verde         | *  | G4     | N3       |     | X      | All      |      |
|                       |                       | <i>Anolis auratus</i>        |                      | *  | G4G5   | N4       |     |        |          |      |
|                       | TEIIDAE               | <i>Ameiva ameiva</i>         | borriquero           | *  | G5     | N5       |     |        |          |      |
| <i>Ameiva festiva</i> |                       | borriquero                   | *                    | G5 | N4     |          |     |        |          |      |
| VIPERIDAE             | <i>Bothrops asper</i> | serpiente equis              | *                    | G5 | N5     |          |     |        |          |      |
| TESTUDINES            | EMYDIDAE              | <i>Trachemys scripta</i>     | tortuga              | *  | G5     | N4       |     |        |          |      |

| CLASS AMPHIBIANS |                 |                                     |             | T7 | Global | National | END | EPL    | CITES | UICN |
|------------------|-----------------|-------------------------------------|-------------|----|--------|----------|-----|--------|-------|------|
| ORDER            | FAMILY          | SPECIES                             | COMMON NAME |    | Rank   | Rank     |     | Panama |       |      |
| ANURA            | BUFONIDAE       | <i>Bufo marinus</i>                 | sapo        | *  | G5     | N5       |     |        |       |      |
|                  |                 | <i>Bufo typhonius</i>               | sapo        | *  | G5     | N4       |     |        |       |      |
|                  | DENDROBATIDAE   | <i>Colostethus iniquinalis</i>      |             | *  | G3G4   | N3       |     |        |       |      |
|                  | LEPTODACTYLIDAE | <i>Eleutherodactylus fitzingeri</i> |             | *  | G5     | N4       |     |        |       |      |

Note:

END: Endémico; N: National; B: Binational, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In danger, VU: Vulnerable.

Table EA-34: Flora Species Identified at Site T8

| CLASS MAGNOLIOPSIDA  |                                 |                       | T8 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|----------------------|---------------------------------|-----------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY               | SPECIES                         | COMMON NAME           |    |             |               |     |               |       |      |
| ANACARDIACEAE        | <i>Anacardium excelsum</i>      | espavé                | *  | G5          | N5            |     |               |       |      |
|                      | <i>Spondias mombin</i>          | jobo                  | *  | G5          | N5            |     |               |       |      |
| ASTERACEAE           | <i>Vernonanthura patens</i>     |                       | *  | G5          | N5            |     |               |       |      |
| BOMBACACEAE          | <i>Ochroma pyramidale</i> (c)   | balso                 | *  | G5          | N5            |     |               |       |      |
|                      | <i>Pseudobombax septenatum</i>  | barrigón              | *  | G5          | N4            |     |               |       |      |
| BORAGINACEAE         | <i>Cordia alliodora</i>         | laurel                | *  | G5          | N5            |     |               |       |      |
| BURSERACEAE          | <i>Bursera simaruba</i>         | almácigo - carate     | *  | G5          | N5            |     |               |       |      |
| CECROPIACEAE         | <i>Cecropia peltata</i>         | guarumo               | *  | G5          | N5            |     |               |       |      |
| COCHLOSPERMACEAE     | <i>Cochlospermum vitifolium</i> | poro - poro           | *  | G5          | N5            |     |               |       |      |
| DILLENIACEAE         | <i>Curatela americana</i>       | chumico               | *  | G5          | N5            |     |               |       |      |
| ELAEOCARPACEAE       | <i>Muntingia calabura</i>       | periquito -majaguillo | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Cassia moschata</i>          | caña fistula          | *  | G4          | N3            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Erythrina fusca</i>          | palo santo            | *  | G5          | N5            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Enterolobium cyclocarpum</i> | corotú                | *  | G5          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Pseudosamanea gauchapele</i> | guachapalí            | *  | G4          | N2            |     |               |       |      |
| EUPHORBIACEAE        | <i>Persea americana</i> (c)     | aguacate              | *  | G5          | N5            |     |               |       |      |
| MELIACEAE            | <i>Cedrela odorata</i>          | cedro amargo          | *  | G4          | N4            |     | X             |       | VU   |
| MORACEAE             | <i>Ficus sp.</i>                | higuerón              | *  |             |               |     |               |       |      |
|                      | <i>Ficus trigonata</i>          |                       | *  |             |               |     |               |       |      |
| STERCULIACEAE        | <i>Guazuma ulmifolia</i>        | negrito               | *  | G5          | N5            |     |               |       |      |
|                      | <i>Helicteres quazumaefolia</i> | torcidillo            | *  | G4          | N3            |     |               |       |      |
|                      | <i>Sterculia apetala</i>        | árbol panamá          | *  | G5          | N4            |     |               |       |      |
| TILIACEAE            | <i>Apeiba tibourbou</i>         | peine de mono         | *  | G5          | N5            |     |               |       |      |
|                      | <i>Luehea seemannii</i>         | guácimo colorado      | *  | G5          | N4            |     |               |       |      |

| CLASS LILIOPSIDA |                                 |                | T8 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|------------------|---------------------------------|----------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY           | SPECIES                         | COMMON NAME    |    |             |               |     |               |       |      |
| POACEAE          | <i>Bambusa sp.</i>              | bambú          | *  |             |               |     |               |       |      |
|                  | <i>Hyparrhenia rufa</i>         | paja faragua   | *  | G5          | NE            |     |               |       |      |
|                  | <i>Panicum maximum</i>          | paja de guinea | *  | G5          | NE            |     |               |       |      |
|                  | <i>Saccharum spontaneum</i> (n) | paja canalera  | *  | G5          | NE            |     |               |       |      |

Nota: RG: Global Rank; RN: Nacional Rank, END: Endémic Species; N: Nacional; EPL: Protected by National Wildlife Laws, CITES: Apéndice I (AI), Apéndice II (AII); IUCN: CR: Critically in Danger; E: In Danger; I: Indetermined, R: Rare, V: Vulnerable. Cultivated Species (c), Naturalized Species (n), Aquatic (a).

Table EA-35: Bird Species Identified at Site T8

| COASTAL BIRDS  |                               |  |                                 | T8                  | Global | National | END | EPL | CITES | IUCN |  |
|----------------|-------------------------------|--|---------------------------------|---------------------|--------|----------|-----|-----|-------|------|--|
| ORDER          | FAMILY                        | SPECIES                                    | COMMON NAME                     |                     | Rank   | Rank     |     |     |       |      |  |
| PELICANIFORMES | FREGATIDAE                    | <i>Fregata magnificens</i>                 | fragata magnífica               | *                   | G5     | N5       |     |     |       |      |  |
|                | PELICANIDAE                   | <i>Pelecanus occidentalis carolinensis</i> | pelicano marrón                 | *                   | G4     | N4       |     |     |       |      |  |
|                | PHALACROCORACIDAE             | <i>Phalacrocorax o. olivaceus</i>          | cormorán neotropical            | *                   |        |          |     |     |       |      |  |
| GAME BIRDS     |                               |  |                                 | T8                  | Global | National | END | EPL | CITES | IUCN |  |
| ORDER          | FAMILY                        | SPECIES                                    | COMMON NAME                     |                     | Rank   | Rank     |     |     |       |      |  |
| COLUMBIFORMES  | COLUMBIDAE                    | <i>Leptotila v. verreauxi</i>              | paloma rabiblanca               | *                   | G5     | N5       |     |     |       |      |  |
| PICIFORMES     | RAMPHASTIDAE                  | <i>Ramphastos sulfuratus</i>               | tucán pico iris                 | *                   | G4     | N4       |     |     | All   |      |  |
| FOREST BIRDS   |                               |  |                                 | T8                  | Global | National | END | EPL | CITES | IUCN |  |
| ORDER          | FAMILY                        | SPECIES                                    | COMMON NAME                     |                     | Rank   | Rank     |     |     |       |      |  |
| FALCONIFORMES  | ACCIPITRIDAE                  | <i>Pandion haliaetus</i>                   | águila pescadora                | *                   | G5     | NN       |     |     |       |      |  |
| PASSERIFORMES  | EMBERIZIDAE                   | <i>Sporophila americana hicksii</i>        | espiguero variable              | *                   | G4     | N4       |     |     |       |      |  |
|                |                               | <i>Volatinia jacarina splendens</i>        | semillero negrizulado           | *                   | G5     | N5       |     |     |       |      |  |
|                | HIRUNDINIDAE                  | <i>Hirundo rustica</i>                     | golondrina tijereta             | *                   | G5     | NN       |     |     |       |      |  |
|                |                               | <i>Progne chalybea</i>                     | martín pechigris                | *                   | G5     | N5       |     |     |       |      |  |
|                |                               | <i>Riparia riparia</i>                     | martín arenero                  | *                   | G5     | NN/BBS   |     |     |       |      |  |
|                |                               | <i>Stelgidopteryx ruficollis</i>           | golondrina-alirrasposa sureña   | *                   | G5     | N5       |     |     |       |      |  |
|                |                               | <i>Stelgidopteryx s. serripennis</i>       | golondrina-alirrasposa norteña  | *                   | G5     | NN       |     |     |       |      |  |
|                |                               |  | <i>Tachycineta a. albilinea</i> | golondrina manglera | *      | G3       | N3  |     |       |      |  |
|                |                               | ICTERIDAE                                  | <i>Cassidix mexicanus</i>       | talingo             | *      | G5       | N5  |     |       |      |  |
|                |                               | MIMIDAE                                    | <i>Mimus gilvus</i>             | sinsonete tropical  | *      | G5       | NE  |     |       |      |  |
|                |                               | MUSCICAPIDAE                               | <i>Turdus grayi casius</i>      | mirlo pardo         | *      | G5       | N5  |     |       |      |  |
|                |                               | TYRANNIDAE                                 | <i>Elaenia flavogaster</i>      | elania penachuda    | *      | G5       | N5  |     |       |      |  |
|                | <i>Myiozetetes similis</i>    |  | mosquero social                 | *                   | G5     | N5       |     |     |       |      |  |
|                | <i>Tyrannus melancholicus</i> |  | tirano tropical                 | *                   | G5     | N5       |     |     |       |      |  |
|                |                               | <i>Tyrannus savana monacha</i>             | tijereta sabanera               | *                   | G5     | N5       |     |     |       |      |  |

Note:

RG: Global Rank; RN: National Rank; BBS: Migratory species in decline (Breeding Bird Survey)

END: Endémico; N: National; B: Binacional, Costa Rica and Panamá; B2: Southern Pacific portion of Central America; EPL: Protected by National Wildlife Laws

CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In Danger; VU: Vulnerable.

Table EA-36: Mammal Species Identified at Site T8

| CLASS MAMMALIA  |                |                               |                           | T8 | Global | National | END | EPL | CITES | IUCN |
|-----------------|----------------|-------------------------------|---------------------------|----|--------|----------|-----|-----|-------|------|
| ORDER           | FAMILY         | SPECIES                       | COMMON NAME               |    | Rank   | Rank     |     |     |       |      |
| DIDELPHIMORPHIA | DIDELPHIDAE    | <i>Didelphis marsupialis</i>  | zorra común               | *  | G5     | N5       |     |     |       |      |
| XENARTHRA       | BRADYPODIDAE   | <i>Bradypus variegatus</i>    | perezoso de tres dedos    | *  | G5     | N5       |     |     |       |      |
|                 | DASYPODIDAE    | <i>Dasyops novemcinctus</i>   | armadillo de nueve bandas | *  | G5     | N5       |     | X   |       |      |
| CHIROPTERA      | PHYLLOSTOMIDAE | <i>Carollia perspicillata</i> | murciélago frugívoro      | *  | G5     | N5       |     |     |       |      |
|                 |                | <i>Artibeus jamaicensis</i>   | murciélago frugívoro      | *  | G5     | N5       |     |     |       |      |
|                 |                | <i>Artibeus lituratus</i>     | murciélago frugívoro      | *  | G5     | N5       |     |     |       |      |
| RODENTIA        | DASYPROCTIDAE  | <i>Dasyprocta punctata</i>    | ñeque                     | *  | G5     | N5       |     | X   |       |      |
| CARNIVORA       | MURIDAE        | <i>Oecomys trinitatis</i>     | gran rata arocera arborea | *  |        |          |     |     |       |      |
|                 | PROCYONIDAE    | <i>Nasua narica</i>           | gato solo                 | *  | G5     | N5       |     | X   |       |      |

Note:

END: Endémico; N: National; B: Binacional, Costa Rica y Panamá; B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In danger; VU: Vulnerable.

**Table EA-37: Amphibian and Reptile Species Identified at Site T8**

| CLASS REPTILIA    |                |                               |                      | T8 | Global | National | END | EPL    | CITES | UICN |
|-------------------|----------------|-------------------------------|----------------------|----|--------|----------|-----|--------|-------|------|
| ORDER             | FAMILY         | SPECIES                       | COMMON NAME          |    | Rank   | Rank     |     | Panamá |       |      |
| <b>CROCODYLIA</b> | CROCODYLIDAE   | <i>Crocodylus acutus</i>      | lagarto aguja        | *  | G2     | N2       |     | X      | AI    | VU   |
| <b>SQUAMATA</b>   | COLUBRIDAE     | <i>Oxybelis brevirostris</i>  | bejuquilla verde     | *  | G5     | N5       |     |        |       |      |
|                   |                | <i>Oxybelis aeneus</i>        | bejuquilla chocolate | *  | G5     | N4       |     |        |       |      |
|                   | CORYTOPHANIDAE | <i>Basiliscus basiliscus</i>  | meracho              | *  | G4     | N4       |     |        |       |      |
|                   | GEKKONIDAE     | <i>Gonatodes alboquilaris</i> | cabeza naranja       | *  | G5     | N4       |     |        |       |      |
|                   | IGUANIDAE      | <i>Iguana iguana</i>          | iguana verde         | *  | G4     | N3       |     | X      | AI    |      |
| <b>TESTUDINES</b> | TEIIDAE        | <i>Ameiva ameiva</i>          | borriquero           | *  | G5     | N5       |     |        |       |      |
|                   | EMYDIDAE       | <i>Trachemys scripta</i>      | tortuga              | *  | G5     | N4       |     |        |       |      |

| CLASS AMPHIBIANS |           |                     |             | T8 | Global | National | END | EPL    | CITES | UICN |
|------------------|-----------|---------------------|-------------|----|--------|----------|-----|--------|-------|------|
| ORDER            | FAMILY    | SPECIES             | COMMON NAME |    | Rank   | Rank     |     | Panamá |       |      |
| <b>ANURA</b>     | BUFONIDAE | <i>Bufo marinus</i> | sapo        | *  | G5     | N5       |     |        |       |      |

Note:

END: Endémico; N: National; B: Binational, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN-CR: Critically in Danger; EN: In danger, VU: Vulnerable.

Table EA-38: Flora Species Identified at Site T9

| CLASS MAGNOLIOPSIDA  |                                |                       | T9 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|----------------------|--------------------------------|-----------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY               | SPECIES                        | COMMON NAME           |    |             |               |     |               |       |      |
| ANACARDIACEAE        | <i>Anacardium excelsum</i>     | espavé                | *  | G5          | N5            |     |               |       |      |
|                      | <i>Astronium graveolens</i>    | zorro                 | *  | G4          | N3            |     |               |       |      |
|                      | <i>Spondias mombin</i>         | jobo                  | *  | G5          | N5            |     |               |       |      |
| ANNONACEAE           | <i>Annona hayesii</i>          | chirimoya             | *  | G3          | N3            |     |               |       |      |
|                      | <i>Annona spraguei</i>         | chirimoya             | *  | G3          | N3            |     |               |       |      |
|                      | <i>Xylopia frutescens</i>      | malegueto macho       | *  | G5          | N4            |     |               |       |      |
| BIGNONIACEAE         | <i>Tabebuia rosea</i>          | roble                 | *  | G5          | N5            |     |               |       |      |
| BOMBACACEAE          | <i>Pachira sessilis</i>        | yucu de monte         | *  | G5          | N4            |     |               |       |      |
|                      | <i>Pseudobombax septenatum</i> | barrigón              | *  | G5          | N4            |     |               |       |      |
| BORAGINACEAE         | <i>Cordia alliodora</i>        | laurel                | *  | G5          | N5            |     |               |       |      |
|                      | <i>Cordia collococo</i>        | laurel blanco         | *  |             |               |     |               |       |      |
| BURSERACEAE          | <i>Protium tenuifolium</i>     | chutra - cicuadro     | *  | G3          | N3            |     |               |       |      |
| CAPPARIDACEAE        | <i>Capparis frondosa</i>       |                       | *  | G5          | N3            |     |               |       |      |
| CECROPIACEAE         | <i>Cecropia peltata</i>        | guarumo               | *  | G5          | N5            |     |               |       |      |
| CHRYSOBALANACEAE     | <i>Hirtella racemosa</i>       | camaroncillo          | *  | G5          | N5            |     |               |       |      |
| CLUSIACEAE           | <i>Vismia baccifera</i>        | pinta moso            | *  |             |               |     |               |       |      |
| COMBRETACEAE         | <i>Terminalia amazonia</i>     | amarillo              | *  | G5          | N4            |     |               |       |      |
| ELAEOCARPACEAE       | <i>Muntingia calabura</i>      | periquito -majaguillo | *  |             |               |     |               |       |      |
| ERYTHROXYLACEAE      | <i>Erythroxylum sp.</i>        |                       | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Cassia moschata</i>         | caña fistula          | *  | G4          | N3            |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Hymenaea courbaril</i>      | algarrobo             | *  | G5          | N4            |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Swartzia simplex</i>        | naranjillo            | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Andira inermis</i>          | harino                | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Erythrina fusca</i>         | palo santo            | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Lonchocarpus latifolius</i> | peronil               | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Acacia melanoceras</i>      | cachito               | *  | G4          | N2            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Cojoba rufescens</i>        | coralillo             | *  | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga hayesii</i>            | guabo                 | *  | G3          | N3            |     |               |       | LR   |
| FAB-MIMOSOIDEAE      | <i>Inga laurina</i>            | guabito cansa boca    | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga sp.</i>                | guabo de monte        | *  |             |               |     |               |       |      |
| FLACOURTIACEAE       | <i>Casearia commersoniana</i>  | corta lengua - mauro  | *  | G5          | N5            |     |               |       |      |
|                      | <i>Casearia sylvestris</i>     |                       | *  | G5          | N5            |     |               |       |      |
|                      | <i>Lacistema aggregatum</i>    | huesito               | *  | G5          | N5            |     |               |       |      |
|                      | <i>Lindackeria laurina</i>     | carbonero             | *  | G5          | N4            |     |               |       |      |
|                      | <i>Zuelania guidonea</i>       | árbol caspa           | *  | G5          | N3            |     |               |       |      |
| LECYTHIDACEAE        | <i>Gustavia superba</i>        | membrillo             | *  | G5          | N4            |     |               |       |      |
| MELASTOMATACEAE      | <i>Miconia argentea</i>        | papelillo             | *  | G5          | N5            |     |               |       |      |
|                      | <i>Miconia minutiflora</i>     | copo de nieve         | *  | G4          | N4            |     |               |       |      |
| MELIACEAE            | <i>Guarea glabra</i>           | cedro macho           | *  | G5          | N5            |     |               |       |      |
|                      | <i>Guarea guidonea</i>         | cedro                 | *  | G4          | N4            |     |               |       |      |
|                      | <i>Trichilia hirta</i>         | conejo colorado       | *  | G5          | N4            |     |               |       |      |
| MONIMIACEAE          | <i>Siparuna pauciflora</i>     | pasmo                 | *  | G5          | N4            |     |               |       |      |
| MORACEAE             | <i>Ficus insipida</i>          | higuerón              | *  | G5          | N4            |     |               |       |      |
|                      | <i>Ficus sp.</i>               | higuerón              | *  |             |               |     |               |       |      |
|                      | <i>Maclura tinctoria</i>       | palo mora             | *  | G5          | N4            |     |               |       |      |
|                      | <i>Trophis racemosa</i>        | lechosa               | *  | G5          | N4            |     |               |       |      |
| MYRSINACEAE          | <i>Ardisia sp.</i>             | raspa lengua          | *  |             |               |     |               |       |      |
| MYRTACEAE            | <i>Myrcia gatunensis</i>       | pimiento              | *  | G2          | N2            |     |               |       |      |
| PASSIFLORACEAE       | <i>Passiflora ambigua</i>      | pasionaria            | *  | G3          | N3            |     |               |       |      |
|                      | <i>Passiflora foetida</i>      | calzoncillo           | *  | G5          | N5            |     |               |       |      |
|                      | <i>Passiflora vitifolia</i>    | pasionaria            | *  | G5          | N5            |     |               |       |      |
| PIPERACEAE           | <i>Piper aequale</i>           | hinojo                | *  | G5          | N5            |     |               |       |      |
|                      | <i>Piper marginatum</i>        | hinojo                | *  | G5          | N5            |     |               |       |      |
| POLYGONACEAE         | <i>Coccoloba sp.</i>           |                       | *  |             |               |     |               |       |      |
|                      | <i>Triplaris cumingiana</i>    | guayabo hormiguero    | *  | G4          | N3            |     |               |       |      |
| PROTEACEAE           | <i>Roupala montana</i>         | carne asado           | *  | G5          | N4            |     |               |       |      |
| RUBIACEAE            | <i>Alibertia edulis</i>        | madroño - trompito    | *  | G5          | N4            |     |               |       |      |
|                      | <i>Antirhea trichantha</i>     | mazanuco              | *  | G2          | N2            |     |               |       |      |
|                      | <i>Coussarea sp.</i>           |                       | *  |             |               |     |               |       |      |
|                      | <i>Fareamea occidentalis</i>   | benjamín - garrotillo | *  | G5          | N3            |     |               |       |      |

| CLASS MAGNOLIOPSIDA |                                  |                     | T9 | Global Rank | National Rank | END | EPL panameñas | CITES | IUCN |
|---------------------|----------------------------------|---------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                          | COMMON NAME         |    |             |               |     |               |       |      |
| RUTACEAE            | <i>Zanthoxylum panamense</i>     | cicandro - tachuelo | *  | G3          | N3            |     |               |       |      |
| SAPINDACEAE         | <i>Cupania rufescens</i>         | gorgojero colorao   | *  | G5          | N3            |     |               |       |      |
|                     | <i>Cupania scrobiculata</i>      | gorgojero           | *  |             |               |     |               |       |      |
|                     | <i>Matayba glaberrima</i>        | matillo             | *  | G3          | N3            |     |               |       |      |
|                     | <i>Sapindus saponaria</i>        | jaboncillo          | *  | G5          | N3            |     |               |       |      |
| SAPOTACEAE          | <i>Chrysophyllum cainito</i> (c) | caimito             | *  | G5          | N5            |     |               |       |      |
| STERCULIACEAE       | <i>Guazuma ulmifolia</i>         | negrito             | *  | G5          | N5            |     |               |       |      |
| TILIACEAE           | <i>Apeiba tibourbou</i>          | peine de mono       | *  | G5          | N5            |     |               |       |      |
|                     | <i>Luehea seemannii</i>          | guácimo colorado    | *  | G5          | N4            |     |               |       |      |
|                     | <i>Luehea speciosa</i>           | guácimo             | *  | G5          | N4            |     |               |       |      |
| VERBENACEAE         | <i>Aegiphila</i> sp.             |                     | *  |             |               |     |               |       |      |

| CLASS LILIOPSIDA |                                 |                 | T9 | Global Rank | National Rank | END | EPL panameñas | CITES | IUCN |
|------------------|---------------------------------|-----------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY           | SPECIES                         | COMMON NAME     |    |             |               |     |               |       |      |
| ARECACEAE        | <i>Astrocaryum standleyanum</i> | chunga          | *  | G4          | N2            |     |               |       |      |
|                  | <i>Attalea butyracea</i>        | palma real      | *  | G3          | N3            |     |               |       |      |
|                  | <i>Bactris maior</i>            | caña brava      | *  | G5          | N3            |     |               |       |      |
|                  | <i>Cryosophila warszewiczii</i> | palma guagara   | *  | G3          | N3            |     |               |       |      |
|                  | <i>Desmoncus isthmus</i>        | matamba         | *  | G3          | N3            |     |               |       |      |
|                  | <i>Elaeis oleifera</i>          | palma aceitera  | *  | G5          | N3            |     |               |       |      |
|                  | <i>Oenocarpus mapora</i>        | maquenque       | *  | G4          | N3            |     |               |       |      |
| CYCLANTHACEAE    | <i>Carludovica palmata</i>      | sombrero panamá | *  | G5          | N3            |     |               |       |      |
| ORCHIDIACEAE     | <i>Notylia pentachne</i>        | orquidea        | *  | G2          | N2            |     |               | All   |      |
|                  | <i>Oeceoclades maculata</i>     | orquidea        | *  | G3          | N3            |     |               | All   |      |
|                  | <i>Oncidium stipitatum</i>      | orquidea        | *  | G3          | N3            |     |               | All   |      |
| POACEAE          | <i>Chusquea</i> sp.             | caricillo       | *  |             |               |     |               |       |      |

**Nota:** RG: Global Rank; RN: Nacional Rank, END: Endémic Species; N: National; EPL: Protected by National Wildlife Laws, CITES: Apéndice I (AI), Apéndice II (AII); IUCN: CR: Critically in Danger; E: In Danger; I: Indetermined, R: Rare, V: Vulnerable. Cultivated Species (c), Naturalized Species (n), Aquatic (a).

Table EA-39: Bird Species Identified at Site T9

| GAME BIRDS                    |                             |                                     |                                | T9                   | Global | National | END | EPL<br>Panama | CITES | IUCN |
|-------------------------------|-----------------------------|-------------------------------------|--------------------------------|----------------------|--------|----------|-----|---------------|-------|------|
| ORDER                         | FAMILY                      | SPECIES                             | COMMON NAME                    |                      | Rank   | Rank     |     |               |       |      |
| COLUMBIFORMES                 | COLUMBIDAE                  | <i>Columba cayennensis</i>          | paloma colorada                | *                    | G5     | N5       |     | X             |       |      |
|                               |                             | <i>Leptotila v. verreauxi</i>       | paloma rabiblanca              | *                    | G5     | N5       |     |               |       |      |
| PSITTACIFORMES                | PSITTACIDAE                 | <i>Amazona ochrocephala</i>         | amazona coroniamarillo         | *                    | G4     | N4       |     | X             | All   |      |
| FOREST BIRDS                  |                             |                                     |                                | T9                   | Global | National | END | EPL<br>Panama | CITES | IUCN |
| ORDER                         | FAMILY                      | SPECIES                             | COMMON NAME                    |                      | Rank   | Rank     |     |               |       |      |
| FALCONIFORMES                 | FALCONIDAE                  | <i>Chondrohierax u. uncinatus</i>   | elanio piquiganchudo           | *                    | G5     | N3       |     |               |       | All  |
| APODIFORMES                   | TROCHILIDAE                 | <i>Amazilia t. tzacali</i>          | amazilia colirrufa             | *                    | G5     | N5       |     |               |       | All  |
|                               |                             | <i>Chlorostilbon assimilis</i>      | esmeralda jardinera            | *                    | G4     | N4       | B2  |               |       |      |
| CORACIFORMES                  | MOMOTIDAE                   | <i>Momotus momota conexus</i>       | momoto coroniazulado           | *                    | G4G5   | N4       |     |               |       |      |
| PICIFORMES                    | PICIDAE                     | <i>Campephilus guatemalensis</i>    | carpintero pico plata          | *                    | G4     | N4       |     |               |       |      |
|                               |                             | <i>Melanerpes rubricapillus</i>     | carpintero coronirrojo         | *                    | G5     | N5       |     |               |       |      |
| PASSERIFORMES                 | DENDROCOLAPTIDAE            | <i>Xiphorhynchus guttatus nanus</i> | trepatroncos gorgiateado       | *                    | G5     | N5       |     |               |       |      |
|                               |                             | <i>Ramphocelus d. dimidiatus</i>    | sangre de toro                 | *                    | G5     | N5       |     |               |       |      |
|                               | EMBERIZIDAE                 | <i>Sporophila americana hicksii</i> | espiguero variable             | *                    | G4     | N4       |     |               |       |      |
|                               |                             | <i>Thraupis episcopus cana</i>      | tangara azuleja                | *                    | G5     | N5       |     |               |       |      |
|                               |                             | <i>Thraupis palmarum atripennis</i> | tangara palmera                | *                    | G5     | N5       |     |               |       |      |
|                               | FORMICARIDAE                | <i>Hylophylax n. naevioides</i>     | hormiguero colliarejo          | *                    | G4     | N4       |     |               |       |      |
|                               |                             | ICTERIDAE                           | <i>Cacicus cela vitellinus</i> | cacique lomiamarillo | *      |          |     |               |       |      |
|                               | <i>Psarocolius wagleri</i>  |                                     | oropéndola cabecicastaña       | *                    |        |          |     |               |       |      |
|                               | <i>Cassidix mexicanus</i>   |                                     | talingo                        | *                    | G5     | N5       |     |               |       |      |
|                               | <i>Scaphidura oryzivora</i> |                                     | vaquero gigante                | *                    |        |          |     |               |       |      |
|                               | MIMIDAE                     | <i>Mimus gilvus</i>                 | sinsonte tropical              | *                    | G5     | NE       |     |               |       |      |
|                               | MUSCICAPIDAE                | <i>Turdus grayi casius</i>          | mirlo pardo                    | *                    | G5     | N5       |     |               |       |      |
|                               | PIPRIDAE                    | <i>Pipra mentalis ignifera</i>      | saltarin cabecirrojo           | *                    | G4     | N4       |     |               |       |      |
|                               | TYRANNIDAE                  | <i>Elaenia flavogaster</i>          | elania penachuda               | *                    | G5     | N5       |     |               |       |      |
| <i>Myiozetetes similis</i>    |                             | mosquero social                     | *                              | G5                   | N5     |          |     |               |       |      |
| <i>Tyrannus melancholicus</i> |                             | tirano tropical                     | *                              | G5                   | N5     |          |     |               |       |      |
|                               |                             | <i>Tyrannus savana monacha</i>      | tijereta sabanera              | *                    | G5     | N5       |     |               |       |      |

Note:

RG: Global Rank; RN: National Rank, BBS: Migratory species in decline (Breeding Bird Survey)  
 END: Endémic; N: National; B: Binacional, Costa Rica and Panamá, B2: Southern Pacific portion of Central America; EPL: Protected by National Wildlife Laws  
 CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger; EN: In Danger, VU: Vulnerable.

**Table EA-40: Mammal Species Identified at Site T9**

| CLASS MAMMALIA  |                |                                 |                             | T9 | Global | National | END | EPL<br>Panama | CITES     | IUCN |
|-----------------|----------------|---------------------------------|-----------------------------|----|--------|----------|-----|---------------|-----------|------|
| ORDER           | FAMILY         | SPECIES                         | COMMON NAME                 |    | Rank   | Rank     |     |               |           |      |
| DIDELPHIMORPHIA | DIDELPHIDAE    | <i>Didelphis marsupialis</i>    | zorra común                 | *  | G5     | N5       |     |               |           |      |
| XENARTHRA       | DASYPODIDAE    | <i>Dasyops novemcinctus</i>     | armadillo de nueve bandas   | *  | G5     | N5       |     | X             |           |      |
| CHIROPTERA      | PHYLLOSTOMIDAE | <i>Carollia perspicillata</i>   | murciélago frugívoro        | *  | G5     | N5       |     |               |           |      |
|                 |                | <i>Artibeus jamaicensis</i>     | murciélago frugívoro        | *  | G5     | N5       |     |               |           |      |
|                 |                | <i>Artibeus lituratus</i>       | murciélago frugívoro        | *  | G5     | N5       |     |               |           |      |
| RODENTIA        | DASYPROCTIDAE  | <i>Dasyprocta punctata</i>      | ñeque                       | *  | G5     | N5       |     | X             |           |      |
|                 | SCIURIDAE      | <i>Sciurus granatensis</i>      | ardilla colorada            | *  | G5     | N5       |     |               |           |      |
| LAGOMORPHA      | LEPORIDAE      | <i>Sylvilagus brasiliensis</i>  | muleto                      | *  | G5     | G5       |     |               |           |      |
| CARNIVORA       | FELIDAE        | <i>Herpailurus yagouaroundi</i> | jaguarundi - tigrillo congo | *  | G4     | N4       |     | X             | AI - AIII |      |
|                 | PROCYONIDAE    | <i>Nasua narica</i>             | gato solo                   | *  | G5     | N5       |     | X             |           |      |
|                 |                | <i>Procyon lotor</i>            | mapache - gato manglatero   | *  | G5     | N5       |     | X             |           |      |
| ARTIODACTYLA    | TAYASSUIDAE    | <i>Tayassu tajacu</i>           | saino                       | *  | G5     | N5       |     | X             | AI        |      |
|                 |                | <i>Odocoileus virginianus</i>   | venado cola blanca          | *  | G5     | N5       |     | X             |           |      |

Note:

END: Endémico; N: National; B: Binational, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger, EN: In danger, VU: Vulnerable.

**Table EA-41: Amphibian and Reptile Species Identified at Site T9**

| CLASS REPTILIA |                      |                              |                | T9 | Global | National | END | EPL<br>Panama | CITES     | IUCN |
|----------------|----------------------|------------------------------|----------------|----|--------|----------|-----|---------------|-----------|------|
| ORDER          | FAMILY               | SPECIES                      | COMMON NAME    |    | Rank   | Rank     |     |               |           |      |
| CROCODYLIA     | CROCODYLIDAE         | <i>Crocodylus acutus</i>     | lagarto acuja  | *  | G2     | N2       |     | X             | AI        | VU   |
| SQUAMATA       | BOIDAE               | <i>Boa constrictor</i>       | boa            | *  | G5     | N4       |     | X             | AI - AIII |      |
|                | COLUBRIDAE           | <i>Spilotes pullatus</i>     | cazadora       | *  | G5     | N4       |     |               |           |      |
|                | CORYTOPHANIDAE       | <i>Basiliscus basiliscus</i> | meracho        | *  | G4     | N4       |     |               |           |      |
|                | ELAPIDAE             | <i>Micrurus nigrocinctus</i> | coral          | *  | G5     | N4       |     |               |           |      |
|                | GEKKONIDAE           | <i>Gonatodes albobularis</i> | cabeza naranja | *  | G5     | N4       |     |               |           |      |
|                | IGUANIDAE            | <i>Iguana iguana</i>         | iguana verde   | *  | G4     | N3       |     | X             | AI        |      |
|                | POLYCHROTIDAE        | <i>Anolis aeneus</i>         | saino          | *  | G4G5   | N4       |     |               |           |      |
| TEIIDAE        | <i>Ameiva ameiva</i> | borriquero                   | *              | G5 | N5     |          |     |               |           |      |

CLASS AMPHIBIANS

| ORDER | FAMILY          | SPECIES                             | COMMON NAME      | T9 | Global Rank | National Rank | END | EPL<br>Panama | CITES | IUCN |
|-------|-----------------|-------------------------------------|------------------|----|-------------|---------------|-----|---------------|-------|------|
| ANURA | BUFONIDAE       | <i>Bufo marinus</i>                 | sapo             | *  | G5          | N5            |     |               |       |      |
|       |                 | <i>Bufo typhonius</i>               | sapo             | *  | G5          | N4            |     |               |       |      |
|       | DENDROBATIDAE   | <i>Colostethus inguinalis</i>       |                  | *  | G3G4        | N3            |     |               |       |      |
|       |                 | <i>Dendrobates auratus</i>          | rana verdi-negra | *  | G4G5        | N3N4          |     |               |       |      |
|       | LEPTODACTYLIDAE | <i>Eleutherodactylus fitzingeri</i> |                  | *  | G5          | N4            |     |               |       |      |

Note:

END: Endémico; N: National; B: Binational, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger, EN: In danger, VU: Vulnerable.

Table EA-42: Flora Species Identified at Site T10

| CLASS MAGNOLIOPSIDA |                                |                      | T10 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|---------------------|--------------------------------|----------------------|-----|-------------|---------------|-----|---------------|-------|------|
| FAMILY              | SPECIES                        | COMMON NAME          |     |             |               |     |               |       |      |
| ANACARDIACEAE       | <i>Anacardium excelsum</i>     | esnavé               | *   | G5          | N5            |     |               |       |      |
|                     | <i>Spondias mombin</i>         | jobo                 | *   | G5          | N5            |     |               |       |      |
| ANNONACEAE          | <i>Annona spraguei</i>         | chirimoya            | *   | G3          | N3            |     |               |       |      |
|                     | <i>Xylopia frutescens</i>      | malegueto macho      | *   | G5          | N4            |     |               |       |      |
| APOCYNACEAE         | <i>Stemmadenia grandiflora</i> |                      | *   | G5          | N5            |     |               |       |      |
| ARALIACEAE          | <i>Dendropanax arboreus</i>    | mufequito            | *   | G5          | N5            |     |               |       |      |
|                     | <i>Schefflera morototoni</i>   | guarumo de pava      | *   | G5          | N4            |     |               |       |      |
| BIGNONIACEAE        | <i>Godmania aesculifolia</i>   | cacho del diablo     | *   |             |               |     |               |       |      |
| BOMBACACEAE         | <i>Ochroma pyramidale (c)</i>  | balso                | *   | G5          | N5            |     |               |       |      |
|                     | <i>Pachira sessilis</i>        | yuco de monte        | *   | G5          | N4            |     |               |       |      |
| BURSERACEAE         | <i>Bursera simaruba</i>        | almácigo - carate    | *   | G5          | N5            |     |               |       |      |
|                     | <i>Protium tenuifolium</i>     | chutra - cicuadro    | *   | G3          | N3            |     |               |       |      |
| CECROPIACEAE        | <i>Cecropia peltata</i>        | guarumo              | *   | G5          | N5            |     |               |       |      |
|                     | <i>Licania platypus</i>        | sapote - sangre      | *   | G5          | N5            |     |               |       |      |
| COMBRETACEAE        | <i>Terminalia amazonia</i>     | amarillo             | *   | G5          | N4            |     |               |       |      |
| CONNARACEAE         | <i>Connarus panamensis</i>     |                      | *   | G5          | N5            |     |               |       |      |
| DILLENIACEAE        | <i>Davilla kunthii</i>         | chumico pedorro      | *   | G5          | N5            |     |               |       |      |
| EUPHORBIACEAE       | <i>Acalypha diversifolia</i>   |                      | *   | G5          | N5            |     |               |       |      |
|                     | <i>Croton draco</i>            | sangrillo            | *   | G5          | N4            |     |               |       |      |
|                     | <i>Mabea occidentales</i>      |                      | *   | G5          | N4            |     |               |       |      |
| FAB-FABOIDEAE       | <i>Andira inermis</i>          | harino               | *   | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE       | <i>Machaerium kegelii</i>      | falsa uña de gato    | *   | G3          | N3            |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Inga sapindoides</i>        | quabo de monte       | *   | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE     | <i>Inga spectabilis</i>        | guaba machete        | *   | G5          | N5            |     |               |       |      |
| FLACOURTIACEAE      | <i>Hasseltia floribunda</i>    | parimontón           | *   | G5          | N5            |     |               |       |      |
|                     | <i>Lacistema aggregatum</i>    | huesito              | *   | G5          | N5            |     |               |       |      |
| LAURACEAE           | <i>Ocotea puberula</i>         | sigua                | *   | G3          | N3            |     |               |       |      |
|                     | <i>Phoebe cinnamomifolia</i>   | sigua blanca         | *   | G5          | N5            |     |               |       |      |
| MELASTOMATACEAE     | <i>Miconia argentea</i>        | papelillo            | *   | G5          | N5            |     |               |       |      |
|                     | <i>Miconia minutiflora</i>     | copo de nieve        | *   | G4          | N4            |     |               |       |      |
| MELIACEAE           | <i>Guarea glabra</i>           | cedro macho          | *   | G5          | N5            |     |               |       |      |
|                     | <i>Guarea guidonea</i>         | cedro                | *   | G4          | N4            |     |               |       |      |
| MYRTACEAE           | <i>Eugenia oerstediana</i>     |                      | *   |             |               |     |               |       |      |
| PIPERACEAE          | <i>Piper sp.</i>               | hinojo               | *   |             |               |     |               |       |      |
| POLYGONACEAE        | <i>Coccoloba parimensis</i>    | uvero                | *   | G5          | N1            |     |               |       |      |
| RUBIACEAE           | <i>Cephaelis tomentosa</i>     | labios ardientes     | *   | G4          | N4            |     |               |       |      |
|                     | <i>Coutarea hexandra</i>       |                      | *   |             |               |     |               |       |      |
| SAPINDACEAE         | <i>Cupania cinerea</i>         | gorgojero            | *   | G5          | N3            |     |               |       |      |
|                     | <i>Cupania rufescens</i>       | gorgojero colorao    | *   | G5          | N3            |     |               |       |      |
|                     | <i>Matayba glaberrima</i>      | matillo              | *   | G3          | N3            |     |               |       |      |
| SAPOTACEAE          | <i>Chrysophyllum argenteum</i> | caimito de monte     | *   | G2T4        | N3            |     |               |       |      |
| STERCULIACEAE       | <i>Guazuma ulmifolia</i>       | negrito              | *   | G5          | N5            |     |               |       |      |
| TILIACEAE           | <i>Apeiba aspera</i>           | peine de mono        | *   | G5          | N4            |     |               |       |      |
|                     | <i>Apeiba tibourbou</i>        | peine de mono        | *   | G5          | N5            |     |               |       |      |
|                     | <i>Luehea seemannii</i>        | quácimo colorado     | *   | G5          | N4            |     |               |       |      |
|                     | <i>Trichospermum galeottii</i> | capulín - majaguillo | *   | G5          | N4            |     |               |       |      |
| VOCHYSIACEAE        | <i>Vochysia ferruginea</i>     | flor de mayo         | *   | G5          | N4            |     |               |       |      |

| CLASS LILIOPSIDA |                              |                 | T10 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|------------------|------------------------------|-----------------|-----|-------------|---------------|-----|---------------|-------|------|
| FAMILY           | SPECIES                      | COMMON NAME     |     |             |               |     |               |       |      |
| ARECACEAE        | <i>Attalea butyracea</i>     | palma real      | *   | G3          | N3            |     |               |       |      |
|                  | <i>Desmoncus isthmus</i>     | matamba         | *   | G3          | N3            |     |               |       |      |
|                  | <i>Elaeis oleifera</i>       | palma aceitera  | *   | G5          | N3            |     |               |       |      |
| BROMELIACEAE     | <i>Aechmea magdalenae</i>    | pita            | *   | G5          | N3            |     |               |       |      |
| CYCLANTHACEAE    | <i>Carludovica palmata</i>   | sombrero panamá | *   | G5          | N3            |     |               |       |      |
|                  | <i>Cyclanthus bipartitus</i> |                 | *   | G5          | N5            |     |               |       |      |
|                  | <i>Scleria sp.</i>           | cortadera       | *   |             |               |     |               |       |      |
| HELICONIACEAE    | <i>Heliconia latispata</i>   | chichica        | *   | G5          | N4            |     |               |       |      |
| MARANTACEAE      | <i>Calathea latifolia</i>    | bijao           | *   | G5          | N5            |     |               |       |      |
| POACEAE          | <i>Chusquea sp.</i>          | caricillo       | *   |             |               |     |               |       |      |
| ZINGIBERACEAE    | <i>Costus sp.</i>            | gengibre        | *   |             |               |     |               |       |      |

Nota: RG: Global Rank; RN: Nacional Rank; END: Endémic Species; N: National; EPL: Protected by National Wildlife Laws; CITES: Apéndice I (AI), Apéndice II (AII); IUCN: CR: Critically in Danger; E: In Danger; I: Indetermined, R: Rare, V: Vulnerable. Cultivated Species (c), Naturalized Species (n), Aquatic (a).

Table EA-43: Bird Species Identified at Site T10

| GAME BIRDS       |               |                                       |                          | T10 | Global | National | END | EPL<br>Panama | CITES | IUCN |
|------------------|---------------|---------------------------------------|--------------------------|-----|--------|----------|-----|---------------|-------|------|
| ORDER            | FAMILY        | SPECIES                               | COMMON NAME              |     | Rank   | Rank     |     |               |       |      |
| COLUMBIFORMES    | COLUMBIDAE    | <i>Columba cayennensis</i>            | paloma colorada          | *   | G5     | N5       |     | X             |       |      |
|                  |               | <i>Leptotilia v. verreauxi</i>        | paloma rabiblanca        | *   | G5     | N5       |     |               |       |      |
| FOREST BIRDS     |               |                                       |                          | T10 | Global | National | END | EPL<br>Panama | CITES | IUCN |
| ORDER            | FAMILY        | SPECIES                               | COMMON NAME              |     | Rank   | Rank     |     |               |       |      |
| COLUMBIFORMES    | COLUMBIDAE    | <i>Columbina talpacoti rufipennis</i> | tortolita rojiza         | *   | G5     | N5       |     |               |       |      |
| CUCULIFORMES     | CUCULIDAE     | <i>Crotophaga ani</i>                 | garrapatero piquilloso   | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Playa cayana thermophila</i>       | cuco ardilla             | *   | G5     | N5       |     |               |       |      |
| CAPRIMULGIFORMES | NYCTIBIDAE    | <i>Nyctibius griseus</i>              | nictibio común           | *   | G5     | N4       |     |               |       |      |
| APODIFORMES      | TROCHILIDAE   | <i>Amazilia t. tzacatl</i>            | amazilia colirrufa       | *   | G5     | N5       |     |               |       | All  |
| PICIFORMES       | PICIDAE       | <i>Melanerpes rubricapillus</i>       | carpintero coronirrojo   | *   | G5     | N5       |     |               |       |      |
| PASSERIFORMES    | EMBERIZIDAE   | <i>Ramphocelus d. dimidiatus</i>      | sangre de toro           | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Sporophila americana hicksii</i>   | espiquero variable       | *   | G4     | N4       |     |               |       |      |
|                  |               | <i>Thraupis episcopus cana</i>        | tangara azuleja          | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Thraupis palmarum atripennis</i>   | tangara palmera          | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Volatinia jacarina splendens</i>   | semillero negrizulado    | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Cassidix mexicanus</i>             | talingo                  | *   | G5     | N5       |     |               |       |      |
|                  | MUSCICAPIDAE  | <i>Turdus grayi casius</i>            | mirlo pardo              | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Microcerculus marginatus</i>       | soterrey-ruiseñor sureño | *   | G5     | N4       |     |               |       |      |
|                  | TROGLODYTIDAE | <i>Elaenia flavogaster</i>            | elania penachuda         | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Myiarchus panamensis</i>           | copetón panameño         | *   | G4     | N4       |     |               |       |      |
|                  | TYRANNIDAE    | <i>Myiozetetes similis</i>            | mosquero social          | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Tyrannus melancholicus</i>         | tirano tropical          | *   | G5     | N5       |     |               |       |      |
|                  |               | <i>Tyrannus savana monacha</i>        | tijereta sabanera        | *   | G5     | N5       |     |               |       |      |

Note:  
 RG: Global Rank; RN: National Rank; BBS: Migratory species in decline (Breeding Bird Survey)  
 END: Endémic; N: National; B: Binational, Costa Rica and Panamá; B2: Southern Pacific portion of Central America; EPL: Protected by National Wildlife Laws  
 CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In Danger; VU: Vulnerable.

Table EA- 44: Mammal Species Identified at Site T10

| CLASS MAMMALIA  |                |                                |                           | T10 | Global | National | END | EPL<br>Panama | CITES | IUCN |
|-----------------|----------------|--------------------------------|---------------------------|-----|--------|----------|-----|---------------|-------|------|
| ORDER           | FAMILY         | SPECIES                        | COMMON NAME               |     | Rank   | Rank     |     |               |       |      |
| DIDELPHIMORPHIA | DIDELPHIDAE    | <i>Didelphis marsupialis</i>   | zorra común               | *   | G5     | N5       |     |               |       |      |
| XENARTHRA       | BRADYPODIDAE   | <i>Bradypus variegatus</i>     | perezoso de tres dedos    | *   | G5     | N5       |     |               |       |      |
| CHIROPTERA      | PHYLLOSTOMIDAE | <i>Corallia castanea</i>       | murciélago frugívoro      | *   | G5     | N5       |     |               |       |      |
|                 |                | <i>Carollia perspicillata</i>  | murciélago frugívoro      | *   | G5     | N5       |     |               |       |      |
|                 |                | <i>Artibeus jamaicensis</i>    | murciélago frugívoro      | *   | G5     | N5       |     |               |       |      |
|                 |                | <i>Artibeus lituratus</i>      | murciélago frugívoro      | *   | G5     | N5       |     |               |       |      |
| RODENTIA        | DASYPROCTIDAE  | <i>Dasyprocta punctata</i>     | ñeque                     | *   | G5     | N5       |     | X             |       |      |
|                 | MURIDAE        | <i>Oecomys trinitatis</i>      | gran rata arocera arborea | *   |        |          |     |               |       |      |
| LAGOMORPHA      | LEPORIDAE      | <i>Sylvilagus brasiliensis</i> | muleto                    | *   | G5     | G5       |     |               |       |      |

Note:  
 END: Endémic; N: National; B: Binational, Costa Rica y Panamá; B2: Southern Pacific Side of Central  
 EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In danger; VU: Vulnerable.

Table EA-45: Amphibian and Reptile Species Identified at Site T10

| CLASS REPTILIA   |                       |                               |                      | T10 | Global | National | END | EPL<br>Panama | CITES | IUCN |
|------------------|-----------------------|-------------------------------|----------------------|-----|--------|----------|-----|---------------|-------|------|
| FAMILY           | FAMILIA               | SPECIES                       | COMMON NAME          |     | Rank   | Rank     |     |               |       |      |
| SQUAMATA         | COLUBRIDAE            | <i>Oxybelis brevirostris</i>  | hejuquilla verde     | *   | G5     | N5       |     |               |       |      |
|                  |                       | <i>Oxybelis aeneus</i>        | hejuquilla chocolate | *   | G5     | N4       |     |               |       |      |
|                  |                       | <i>Spilotes pullatus</i>      | cazadora             | *   | G5     | N4       |     |               |       |      |
|                  | GEKKONIDAE            | <i>Gonatodes alboquilaris</i> | cabeza naranja       | *   | G5     | N4       |     |               |       |      |
|                  | IGUANIDAE             | <i>Iguana iguana</i>          | iguana verde         | *   | G4     | N3       |     | X             | All   |      |
|                  | TEIIDAE               | <i>Ameiva festiva</i>         | borriquero           | *   | G5     | N4       |     |               |       |      |
| VIPERIDAE        | <i>Bothrops asper</i> | serpiente equis               | *                    | G5  | N5     |          |     |               |       |      |
| CLASS AMPHIBIANS |                       |                               |                      | T10 | Global | National | END | EPL<br>Panama | CITES | IUCN |
| FAMILY           | FAMILIA               | SPECIES                       | COMMON NAME          |     | Rank   | Rank     |     |               |       |      |
| ANURA            | BUFONIDAE             | <i>Bufo marinus</i>           | sapo                 | *   | G5     | N5       |     |               |       |      |

Note:  
 END: Endémic; N: National; B: Binational, Costa Rica y Panamá; B2: Southern Pacific Side of Central  
 EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN:CR: Critically in Danger; EN: In danger; VU: Vulnerable.

Table EA-46 Flora Species Identified at Site M4

| CLASS MAGNOLIOPSIDA  |                                 |                    | M4 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|----------------------|---------------------------------|--------------------|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY               | SPECIES                         | COMMON NAME        |    |             |               |     |               |       |      |
| ACANTHACEAE          | <i>Aphelandra scabra</i>        |                    | *  | G5          | N5            |     |               |       |      |
| ANACARDIACEAE        | <i>Astronium graveolens</i>     | zorro              | *  | G4          | N3            |     |               |       |      |
|                      | <i>Mangifera indica</i> (c)     | mango              | *  | G5          | NE            |     |               |       |      |
|                      | <i>Spondias mombin</i>          | jobo               | *  | G5          | N5            |     |               |       |      |
|                      | <i>Tapirira gulanensis</i>      | palo gusano        | *  | G3          | N2            |     |               |       |      |
| ANNONACEAE           | <i>Annona hayesii</i>           | chirimoya          | *  | G3          | N3            |     |               |       |      |
|                      | <i>Annona spraguei</i>          | chirimoya          | *  | G3          | N3            |     |               |       |      |
|                      | <i>Xylopa frutescens</i>        | malequeto macho    | *  | G5          | N4            |     |               |       |      |
| APOCYNACEAE          | <i>Stemmadenia grandiflora</i>  |                    | *  | G5          | N5            |     |               |       |      |
|                      | <i>Thevetia ahouai</i>          | huevo de gato      | *  | G5          | N5            |     |               |       |      |
| ARALIACEAE           | <i>Dendropanax arboreus</i>     | muñequito          | *  | G5          | N5            |     |               |       |      |
|                      | <i>Schefflera morototoni</i>    | quarumo de pava    | *  | G5          | N4            |     |               |       |      |
|                      | <i>Sciadodendron excelsum</i>   | jobo lagarto       | *  | G4          | N3            |     |               |       |      |
| ARISTOLOCHIACEAE     | <i>Aristolochia sp.</i>         | farolito           | *  |             |               |     |               |       |      |
| BIGNONIACEAE         | <i>Godmania aesculifolia</i>    | cacho del diablo   | *  |             |               |     |               |       |      |
| BOMBACACEAE          | <i>Ochroma pyramidale</i> (c)   | balso              | *  | G5          | N5            |     |               |       |      |
|                      | <i>Pachira quinata</i>          | cedro espino       | *  | G5          | N2            |     |               |       | VU   |
|                      | <i>Pachira sessilis</i>         | yuco de monte      | *  | G5          | N4            |     |               |       |      |
|                      | <i>Pseudobombax septenatum</i>  | barrigón           | *  | G5          | N4            |     |               |       |      |
| BORAGINACEAE         | <i>Cordia alliodora</i>         | laurel             | *  | G5          | N5            |     |               |       |      |
|                      | <i>Cordia collococo</i>         | laurel blanco      | *  |             |               |     |               |       |      |
| BURSERACEAE          | <i>Bursera simaruba</i>         | almáquio - carate  | *  | G5          | N5            |     |               |       |      |
|                      | <i>Protium tenuifolium</i>      | chutra - cicuadro  | *  | G3          | N3            |     |               |       |      |
| CAPPARIDACEAE        | <i>Capparis sp.</i>             | olivo              | *  |             |               |     |               |       |      |
| CARICACEAE           | <i>Carica papaya</i> (c)        | papaya             | *  | G5          | N5            |     |               |       |      |
|                      | <i>Carica sp.</i>               | papaya de monte    | *  |             |               |     |               |       |      |
| CECROPIACEAE         | <i>Cecropia obtusifolia</i>     | guarumo            | *  | G5          | N5            |     |               |       |      |
|                      | <i>Cecropia peltata</i>         | guarumo            | *  | G5          | N5            |     |               |       |      |
| CHRYSOBALANACEAE     | <i>Hirtella racemosa</i>        | camaroncillo       | *  | G5          | N5            |     |               |       |      |
| COCHLOSPERMACEAE     | <i>Cochlospermum vitifolium</i> | poro - poro        | *  | G5          | N5            |     |               |       |      |
| CONNARACEAE          | <i>Connarus panamensis</i>      |                    | *  | G5          | N5            |     |               |       |      |
| DILLENACEAE          | <i>Davilla kunthii</i>          | chumico pedorro    | *  | G5          | N5            |     |               |       |      |
|                      | <i>Dillenia sp.</i>             |                    | *  |             |               |     |               |       |      |
| EUPHORBIACEAE        | <i>Croton billbergianus</i>     | sangrillo          | *  | G5          | N5            |     |               |       |      |
|                      | <i>Hura crepitans</i>           | tronador           | *  | G5          | N4            |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Bauhinia sp.</i>             | escalera de mono   | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Senna sp.</i>                |                    | *  |             |               |     |               |       |      |
| FAB-CAESALPINIOIDEAE | <i>Swartzia simplex</i>         | naraniillo         | *  | G5          | N5            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Machaerium kegelii</i>       | falsa uña de gato  | *  | G3          | N3            |     |               |       |      |
| FAB-FABOIDEAE        | <i>Ormosia macrocalyx</i>       | coralillo          | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Acacia hayesii</i>           |                    | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Acacia melanoceras</i>       | cachito            | *  | G4          | N2            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Adenopodia polystachya</i>   |                    | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Albizia adinocephala</i>     |                    | *  | G4          | N2            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Cojoba rufescens</i>         | coralillo          | *  | G4          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Enterolobium cyclocarpum</i> | corotú             | *  | G5          | N4            |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Inga hayesii</i>             | guabo              | *  | G3          | N3            |     |               |       | LR   |
| FAB-MIMOSOIDEAE      | <i>Inga laurina</i>             | guabito cansa boca | *  |             |               |     |               |       |      |
| FAB-MIMOSOIDEAE      | <i>Leucaena leucocephala</i>    | leucaena           | *  |             |               |     |               |       |      |
| FLACOURTIACEAE       | <i>Casearia aculeata</i>        | pica lengua        | *  | G5          | N5            |     |               |       |      |
| CLASS MAGNOLIOPSIDA  |                                 |                    | M4 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
| FAMILY               | SPECIES                         | COMMON NAME        |    |             |               |     |               |       |      |
| FLACOURTIACEAE       | <i>Hasseltia floribunda</i>     | parimontón         | *  | G5          | N5            |     |               |       |      |
|                      | <i>Lacistema aggregatum</i>     | huesito            | *  | G5          | N5            |     |               |       |      |
|                      | <i>Xylosma sp.</i>              | roseto - cachito   | *  |             |               |     |               |       |      |
|                      | <i>Zuelania guidonea</i>        | árbol caspa        | *  | G5          | N3            |     |               |       |      |
| LAURACEAE            | <i>Ocotea puberula</i>          | sigua              | *  | G3          | N3            |     |               |       |      |
|                      | <i>Phoebe cinnamomifolia</i>    | sigua blanca       | *  | G5          | N5            |     |               |       |      |
| LECYTHIDACEAE        | <i>Gustavia superba</i>         | membrillo          | *  | G5          | N4            |     |               |       |      |

| CLASS LILIOPSIDA |                                 |                  |   | M4 | Global Rank | National Rank | END | EPL panameñas | CITES | UICN |
|------------------|---------------------------------|------------------|---|----|-------------|---------------|-----|---------------|-------|------|
| FAMILY           | SPECIES                         | COMMON NAME      |   |    |             |               |     |               |       |      |
| ARECACEAE        | <i>Acrocomia aculeata</i>       | palma de vino    | * | G3 | N3          | N             |     |               |       |      |
|                  | <i>Attalea butyracea</i>        | palma real       | * | G3 | N3          |               |     |               |       |      |
|                  | <i>Bactris barronis</i>         |                  | * | G2 | N2          | N             |     |               |       |      |
|                  | <i>Bactris coloradonis</i>      |                  | * | G2 | N2          |               |     |               |       |      |
|                  | <i>Bactris guineensis</i>       | palma uva        | * |    |             |               |     |               |       |      |
|                  | <i>Bactris major</i>            | caña brava       | * | G5 | N3          |               |     |               |       |      |
|                  | <i>Cryosophila warszewiczii</i> | palma quagara    | * | G3 | N3          |               |     |               |       |      |
|                  | <i>Desmoncus isthmus</i>        | matamba          | * | G3 | N3          |               |     |               |       |      |
| BROMELIACEAE     | <i>Elaeis oleifera</i>          | palma aceitera   | * | G5 | N3          |               |     |               |       |      |
|                  | <i>Aechmea magdalenae</i>       | pita             | * | G5 | N3          |               |     |               |       |      |
|                  | <i>Tillandsia flexuosa</i>      | barba de chivo   | * | G4 | N3          |               |     |               |       |      |
| CYCLANTHACEAE    | <i>Carludovica palmata</i>      | sombrero panamá  | * | G5 | N3          |               |     |               |       |      |
| HELICONIACEAE    | <i>Heliconia latispatha</i>     | chichica         | * | G5 | N4          |               |     |               |       |      |
|                  | <i>Heliconia platystachys</i>   | platanillo       | * | G4 | N4          |               |     |               |       |      |
| ORCHIDACEAE      | <i>Brassavola nodosa</i>        | dama de la noche | * | G4 | N3          |               |     |               | AI    |      |
|                  | <i>Catasetum viridiflavum</i>   | orquidea         | * | G3 | N3          |               |     |               | AI    |      |
|                  | <i>Vanilla planifolia</i>       | vainilla         | * | G5 | N2          |               |     |               | AI    |      |
| POACEAE          | <i>Chusquea sp.</i>             | caricillo        | * |    |             |               |     |               |       |      |
|                  | <i>Saccharum spontaneum (n)</i> | paja canalera    | * | G5 | NE          |               |     |               |       |      |
| ZINGIBERACEAE    | <i>Costus sp.</i>               | gengibre         | * |    |             |               |     |               |       |      |

Nota: RG: Global Rank; RN: Nacional Rank, END: Endémic Species; N: National; EPL: Protected by National Wildlife Laws, CITES: Apéndice I (AI), Apéndice II (AII); IUCN: CR: Critically in Danger; E: In Danger; I: Indetermined, R: Rare, V: Vulnerable. Cultivated Species (c), Naturalized Species (n), Aquatic (a).

Table EA-47: Bird Species Identified at Site M4

| COASTAL BIRDS                 |                   |  |                                | M4 | Global Rank | National Rank | END | EPL Panama | CITES | UICN |
|-------------------------------|-------------------|--|--------------------------------|----|-------------|---------------|-----|------------|-------|------|
| ORDER                         | FAMILY            | SPECIES                                    | COMMON NAME                    |    |             |               |     |            |       |      |
| CHARADRIIFORMES               | SCOLOPACIDAE      | <i>Actitis macularia</i>                   | playero colector               | *  | G5          | NN/BBS        |     |            |       |      |
|                               |                   | <i>Catoptrophorus semipalmatus</i>         | playero albiblanco             | *  | G5          | NN            |     |            |       |      |
|                               |                   | <i>Numenius phaeopus</i>                   | zarapito trinador              | *  | G5          | NN            |     |            |       |      |
|                               |                   | <i>Calidris pusilla</i>                    | playero semipalmado            | *  |             |               |     |            |       |      |
| CICONIIFORMES                 | THRESKIORNITHIDAE | <i>Eudocimus albus</i>                     | ibis blanco                    | *  | G5          | N4            |     |            |       |      |
| PELICANIFORMES                | FREGATIDAE        | <i>Fregata magnificens</i>                 | fragata magnífica              | *  | G5          | N5            |     |            |       |      |
|                               | PELICANIDAE       | <i>Pelecanus occidentalis carolinensis</i> | pelicano marrón                | *  | G4          | N4            |     |            |       |      |
|                               | PHALACROCORACIDAE | <i>Phalacrocorax o. olivaceus</i>          | comorán neotropical            | *  |             |               |     |            |       |      |
| GAME BIRDS                    |                   |  |                                | M4 | Global Rank | National Rank | END | EPL Panama | CITES | UICN |
| ORDER                         | FAMILY            | SPECIES                                    | COMMON NAME                    |    |             |               |     |            |       |      |
| COLUMBIFORMES                 | COLUMBIDAE        | <i>Leptotila v. verreauxi</i>              | paloma rabiblanca              | *  | G5          | N5            |     |            |       |      |
| GALLIFORMES                   | CRACIDAE          | <i>Ortalis cinereiceps</i>                 | chachalaca cabecigris          | *  | G5          | N3            |     | X          |       |      |
| FOREST BIRDS                  |                   |  |                                | M4 | Global Rank | National Rank | END | EPL Panama | CITES | UICN |
| ORDER                         | FAMILY            | SPECIES                                    | COMMON NAME                    |    |             |               |     |            |       |      |
| CICONIIFORMES                 | ARDEIDAE          | <i>Ardea h. herodias</i>                   | garza azul mayor               | *  | G5          | NN            |     |            |       |      |
|                               |                   | <i>Casmerodius albus egretta</i>           | garceta grande                 | *  | G5          | N5            |     |            |       |      |
|                               |                   | <i>Egretta t. thula</i>                    | garceta nivea                  | *  | G5          | N5            |     |            |       |      |
| FALCONIFORMES                 | ACCIPITRIDAE      | <i>Pandion halliastus</i>                  | águila pescadora               | *  | G5          | NN            |     |            |       |      |
|                               | FALCONIDAE        | <i>Milvago chimachima</i>                  | caracara cabeciamarilla        | *  | G5          | N5            |     |            | AI    |      |
| APODIFORMES                   | TROCHILIDAE       | <i>Amazilia t. tzacatl</i>                 | amazilia colirrufa             | *  | G5          | N5            |     |            | AI    |      |
|                               |                   | <i>Chlorostilbon assimilis</i>             | esmeralda jardinera            | *  | G4          | N4            | B2  |            |       |      |
| CORACIIFORMES                 | ALCEDINIDAE       | <i>Chloroceryle americana</i>              | martín pescador verde          | *  | G5          | N5            |     |            |       |      |
| PASSERIFORMES                 | HIRUNDINIDAE      | <i>Sporophila americana hicksii</i>        | espiquero variable             | *  | G4          | N4            |     |            |       |      |
|                               |                   | <i>Hirundo rustica</i>                     | golondrina tijereta            | *  | G5          | NN            |     |            |       |      |
|                               |                   | <i>Progne chalybea</i>                     | martín pechigris               | *  | G5          | N5            |     |            |       |      |
|                               |                   | <i>Riparia riparia</i>                     | martín arenoso                 | *  | G5          | NN/BBS        |     |            |       |      |
|                               |                   | <i>Stelgidopteryx ruficollis</i>           | golondrina-alirrasposa sureña  | *  | G5          | N5            |     |            |       |      |
|                               |                   | <i>Stelgidopteryx s. serripennis</i>       | golondrina-alirrasposa norteña | *  | G5          | NN            |     |            |       |      |
|                               | ICTERIDAE         | <i>Cacicus cela vitellinus</i>             | cacique lomiamarillo           | *  |             |               |     |            |       |      |
|                               |                   | <i>Psarocolius wagleri</i>                 | oropéndola cabecicastaña       | *  |             |               |     |            |       |      |
|                               |                   | <i>Cassidix mexicanus</i>                  | tailingo                       | *  | G5          | N5            |     |            |       |      |
|                               | MUSCIPIDAE        | <i>Scaphidura oryzivora</i>                | vaquero gigante                | *  |             |               |     |            |       |      |
|                               | TROGLODYTIDAE     | <i>Turdus grayi casius</i>                 | mirlo pardo                    | *  | G5          | N5            |     |            |       |      |
|                               | TYRANNIDAE        | <i>Microcerculus marginatus</i>            | soterrey-ruseñor sureño        | *  | G5          | N4            |     |            |       |      |
|                               |                   | <i>Elaenia flavogaster</i>                 | elania penachuda               | *  | G5          | N5            |     |            |       |      |
|                               |                   | <i>Myiarchus panamensis</i>                | copetón panameño               | *  | G4          | N4            |     |            |       |      |
|                               |                   | <i>Myiodynastes maculatus</i>              | mosquero rayado                | *  | G5          | N5            |     |            |       |      |
| <i>Myiozetetes similis</i>    |                   | mosquero social                            | *                              | G5 | N5          |               |     |            |       |      |
| <i>Tyrannus melancholicus</i> | tirano tropical   | *  | G5                             | N5 |             |               |     |            |       |      |

Note: RG: Global Rank; RN: National Rank, BBS: Migratory species in decline (Breeding Bird Survey) END: Endémic; N: National; B: Binacional, Costa Rica and Panamá, B2: Southern Pacific portion of Central America; EPL: Protected by National Wildlife Laws CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger; EN: In Danger, VU: Vulnerable.

**Table EA-48: Mammal Species Identified at Site M4**

| CLASS MAMMALIA  |                |                                |                           | M4 | Global | National | END | EPL<br>Panama | CITES | UICN |
|-----------------|----------------|--------------------------------|---------------------------|----|--------|----------|-----|---------------|-------|------|
| ORDER           | FAMILY         | SPECIES                        | COMMON NAME               |    | Rank   | Rank     |     |               |       |      |
| DIDELPHIMORPHIA | DIDELPHIDAE    | <i>Didelphis marsupialis</i>   | zorra común               | *  | G5     | N5       |     |               |       |      |
|                 | DASYPODIDAE    | <i>Dasybus novemcinctus</i>    | armadillo de nueve bandas | *  | G5     | N5       |     | X             |       |      |
| CHIROPTERA      | PHYLLOSTOMIDAE | <i>Corallia castanea</i>       | murciélago frugívoro      | *  | G5     | N5       |     |               |       |      |
|                 |                | <i>Carollia perspicillata</i>  | murciélago frugívoro      | *  | G5     | N5       |     |               |       |      |
|                 |                | <i>Artibeus jamaicensis</i>    | murciélago frugívoro      | *  | G5     | N5       |     |               |       |      |
|                 |                | <i>Artibeus lituratus</i>      | murciélago frugívoro      | *  | G5     | N5       |     |               |       |      |
| RODENTIA        | AGOUTIDAE      | <i>Agouti paca</i>             | conejo pintado            | *  | G5     | N5       |     | X             |       |      |
|                 | DASYPROCTIDAE  | <i>Dasyprocta punctata</i>     | ñeque                     | *  | G5     | N5       |     | X             |       |      |
| LAGOMORPHA      | LEPORIDAE      | <i>Sylvilagus brasiliensis</i> | muleto                    | *  | G5     | G5       |     |               |       |      |
| CARNIVORA       | PROCYONIDAE    | <i>Nasua narica</i>            | gato solo                 | *  | G5     | N5       |     | X             |       |      |
|                 |                | <i>Procyon lotor</i>           | mapache - gato manglatero | *  | G5     | N5       |     | X             |       |      |

Note:

END: Endémic; N: National; B: Binational, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger; EN: In danger, VU: Vulnerable.

**Table EA-49: Amphibian and Reptile Species Identified at Site M4**

| CLASS REPTILIA |                       |                              |                      | M4 | Global | National | END | EPL<br>Panama | CITES    | UICN |  |
|----------------|-----------------------|------------------------------|----------------------|----|--------|----------|-----|---------------|----------|------|--|
| FAMILY         | FAMILIA               | SPECIES                      | COMMON NAME          |    | Rank   | Rank     |     |               |          |      |  |
| CROCODYLIA     | CROCODYLIDAE          | <i>Crocodylus acutus</i>     | lagarto aguia        | *  | G2     | N2       |     | X             | AI       | VU   |  |
|                | BOIDAE                | <i>Boa constrictor</i>       | boa                  | *  | G5     | N4       |     | X             | AI - AII |      |  |
| SQUAMATA       | COLUBRIDAE            | <i>Oxybelis aeneus</i>       | bejuquilla chocolate | *  | G5     | N4       |     |               |          |      |  |
|                | ELAPIDAE              | <i>Micrurus nigrocinctus</i> | coral                | *  | G5     | N4       |     |               |          |      |  |
|                | GEKKONIDAE            | <i>Gonatodes albobularis</i> | cabeza naranja       | *  | G5     | N4       |     |               |          |      |  |
|                | IGUANIDAE             | <i>Ctenosaura similis</i>    | iguana negra         |    | *      | G4       | N4  |               |          |      |  |
|                |                       | <i>Iguana iguana</i>         | iguana verde         |    | *      | G4       | N3  |               | X        | AII  |  |
|                | TEIIDAE               | <i>Ameiva ameiva</i>         | borriquero           |    | *      | G5       | N5  |               |          |      |  |
|                | <i>Ameiva festiva</i> | borriquero                   |                      | *  | G5     | N4       |     |               |          |      |  |

| CLASS AMPHIBIANS |               |                               |                  | M4 | Global | National | END  | EPL<br>Panama | CITES | UICN |
|------------------|---------------|-------------------------------|------------------|----|--------|----------|------|---------------|-------|------|
| FAMILY           | FAMILIA       | SPECIES                       | COMMON NAME      |    | Rank   | Rank     |      |               |       |      |
| ANURA            | BUFONIDAE     | <i>Bufo marinus</i>           | sapo             | *  | G5     | N5       |      |               |       |      |
|                  | DENDROBATIDAE | <i>Colostethus inguinalis</i> |                  | *  | G3G4   | N3       |      |               |       |      |
|                  |               | <i>Dendrobates auratus</i>    | rana verdi-negra |    | *      | G4G5     | N3N4 |               |       |      |

Note:

END: Endémic; N: National; B: Binational, Costa Rica y Panamá, B2: Southern Pacific Side of Central

EPL: Protected nationally; CITES: Apéndice 1 (1), Apéndice 2 (2); IUCN: CR: Critically in Danger; EN: In danger, VU: Vulnerable.

**APPENDIX E - SOCIO ECONOMIC STUDY FOR MARINE SITES**

## **INTRODUCTION**

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This report discusses the socioeconomic evaluation of potential sites for the disposal of earth from excavations in the Panama Canal. An in-depth socioeconomic evaluation has been conducted for three sites that are important due to their location near residential neighborhoods or because they include institutions with public services (Palo Seco Hospital). These are sites **T10 - El Arado, M4 - Palo Seco and M2 - El Chorrillo.**

For the rest of the multi-sites, a professional opinion was issued by experts, with an estimate of possible effects and recommendations. For the case of site M5- Artificial Island, the recommendations made during the 1<sup>st</sup> phase of the project were used.

The evaluation of the area of El Arado, as a site for the disposal of dirt, has important advantages, such as its proximity to the area of the Panama Canal, undulated irregular topography, and road accessibility. However, there are some constraints. First, most of the surface area of this site is dedicated to livestock pasture activities and production of chicken on the industrial level. The community of Rio Congo, the most important of El Arado, maintains important relations with the cities of La Chorrera, Arraiján and Panama, at the commercial and labor force levels.

With respect to Palo Seco, two field visits were conducted and a statistics official was interviewed. It is important to mention that there may be inconveniences encountered with this site, mainly due to the officials who work at the hospital.

At El Chorrillo, the most important variable is that a fishing cooperative is located in the site, which could be a main obstacle for its use by the Project.

## **1. METHODOLOGY**

### **1.1. Site of "El Arado"**

#### **a) Field information.**

Direct observations and consultations were conducted in the following way:

- Initial field visits to the communities of El Arado: Rio Congo, El Lirio, Santa Cruz.
- Interview with the Mayor of El Arado.
- Visit and consultations to obtain information at the offices of the Ministry of Agricultural Development, Regional Agency of Capira. The Regional Chief of Livestock was consulted; he provided part of the information presented in this report.
- Visit and consultations with the Ministry of Health and Health Center located in Chorrera.
- Visit and consultations with the Health Center, located in Rio Congo.

- Visit and consultation to the Training Center – Rio Congo Farm, a project funded by the Spanish Technical Cooperation Agency. It is located in the Rio Congo, and is being moved to another community outside the town. Its purpose was training small farmers and indigenous people mainly coming from communities located in the area.

**b) Documentation Information.**

Bibliographic Review: the project has worked with statistical information published by the General Statistics Office of the Country, corresponding to the Population and Housing Census and Agricultural Census for the years 1980, 1990 and 2000.

Limitations: lack of statistics for certain variables at the county and township levels, which are not published and are necessary to conduct the comparative analysis of indicators and variables.

**1.2 Site of “Palo Seco”**

**a) Field Information.**

There were two visits conducted to the Palo Seco site, involving the National Hospital of Larga Estancia (HNLE), administered by the Ministry of Health. A hospital official was interviewed.

**b) Documentation information:** there was access to statistical information through the public relations staff at the Center.

**1.3. Site of “El Chorrillo”**

**a) Field information**

There were two visits conducted to El Chorrillo and the Fishermen Cooperative, where two fishermen were interviewed.

During the field visit, professor Balbino Soo was interviewed at the National Institute of Culture (INAC) on themes of patrimony and legislation in Casco Viejo.

**b) Documentation Information**

Information was obtained from the Housing Ministry, Ministry of Health – Metropolitan Region of Health, the National General Accounting Office, Municipality of Panama and Community Board of El Chorrillo.

## **2. SITE OF “EL ARADO”**

The site of “El Arado” has attractive characteristics for the disposal of earth in large quantities. On the other hand, it also has unfavorable factors which could disqualify it for this purpose.

Some of the elements that favor the site include its proximity to the excavation site, topography and accessibility. Some of the elements that disfavor the site, include the fact that it is occupied by mid-sized livestock and chicken farms; both activities provide economic incentives for the area. These activities can directly conflict with the project over the utilization of this site for the disposal of excavated material.

Moreover, the site under evaluation is located very close to the community of Rio Congo, the largest community in the county, which is closely linked to the cities of La Chorrera and Panama. Around 50% of its population is involved in activities that are conducted within the township, such as: raising livestock, chicken, production of pineapples and a few retail and service industries available locally. The rest of the population (50%) works outside the area in commercial and service activities in the cities of La Chorrera and Panama City.

### **2.1 General Aspects**

#### **Location**

The County of El Arado is geographically located in the basin of the Panama Canal, in the district of La Chorrera. It borders on the north with the county of Ancon (district of Panama), to the south with the county of Barrio Colon (district of La Chorrera), to the East with the county of La Represa (district of La Chorrera) and to the West with the county of Santa Clara and Nuevo Emperador (district of Arraiján). It is located about 20 kilometers from Panama City and at least 10 kilometers from the city of La Chorrera and from the center of the district of Arraiján.

#### **Surface**

The surface area of the county is 60.5 squared kilometers (6,049 ha), making it the second largest county in the district, only smaller than the township of Amador, with a surface area of 65.5 squared kilometers.

## 2.2 Administrative and Political Division

The county of El Arado belongs to the district of La Chorrera, province of Panama and is comprised of the following 12 communities within its administrative and political jurisdiction: Cabecera de Bernardino, Cerro Viejo, El Limón, El Lirio, La Celestina, Loma Alta, Moscú, Naranjal, Puente Velásquez, Rio Congo, Rio Congo Abajo (or Los Montero ) and Santa Cruz

## 2.3. Physical Characteristics

**Table 2.1. Surface Area, Population and Population Density. District of La Chorrera and county of El Arado. Census of 1980,1990,2000.**

| Description             | Surface area<br>in km2 | Population |        |         | Density<br>(Inhabitants per Km2) |       |       |
|-------------------------|------------------------|------------|--------|---------|----------------------------------|-------|-------|
|                         |                        | 1980       | 1990   | 2000    | 1980                             | 1990  | 2000  |
| District<br>La Chorrera | 688.10                 | 66,974     | 89,780 | 124,656 | 97.3                             | 130.5 | 181.2 |
| County of<br>El Arado   | 60.5                   | 1,574      | 1,696  | 2,012   | 26.0                             | 28.0  | 33.3  |

Source: General Comptroller of the Republic. Statistics Division and 2000 Census, Populated Areas in Panama. Volume 1. Tome 1. Page 15

The distribution of the population is the result of simultaneous economic, social, demographic and cultural activities. The county of El Arado is comprised of 13 communities, of which 9 have less than 100 people, which shows the low population density and great dispersion of the population. From the year 1980 to 2000, El Arado had a slight increase in population density per kilometer squared, from 26 to 33<sup>1</sup>; this value is lower than the national population density, which is 37.6 people per squared kilometer. In the year 2000, the density of the district of La Chorrera was 181.2 .

The spatial distribution of the population of El Arado shows, in the most important community (Rio Congo), the traditional pattern of the towns in the interior of the country: it concentrates population around the town plaza, which is comprised of a church, park, schools, parish house, stores and some offices such as town hall and

<sup>1</sup> Contraloría General de la República. Censos Nacionales de Población y Vivienda. 2000. Tabla No.3 de Superficie, Población y Densidad. Censos de 1980 a 2000.-Página 4.

public buildings. Based on this zoning, the rest of the houses are located apart. However, other populated areas of El Arado have lower population levels. For instance, 9 communities have less than 100 people, according to Table 2.3 of this document.

The population densities have a close relationship with the development levels of the towns; this phenomenon has already been analyzed at the country level. For example, the United Nations show that only after a population density of 25 people per square kilometer<sup>2</sup> do people develop closer social and cultural ties and more diversified economic activities, which are necessary to achieve a certain level of socioeconomic development.

In the area of El Arado, the places with the lowest population densities do not have efficient infrastructure nor total access to potable water, sewerage, storm drainage, telecommunications, and solid waste management. From this situation, the quality of life of this population can be inferred.

The community of Rio Congo is the most important of El Arado. It contains most of its population, public services and communications network. The community that follows is El Lirio, and both represent communities that are better organized spatially, although at El Lirio the conditions worsen considerably.

## **2.4. Social Aspects**

### **2.4.1. Dynamics of the population and vital indicators**

According to the Population and Housing Census of 2000, El Arado has 2 thousand people, of which 53.5% are men and the rest women.

From the year 1990 to 2000, there was an increase of about 20% in the population, which shows an annual growth rate of around 2.0%. This growth is below the growth rate for the district of La Chorrera.

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<sup>2</sup> Herrera, Ligia. Regiones de Desarrollo Socioeconómico de Panamá. 1994. Panamá, página 15.

**Table 2.2. Population by age group for the area of El Arado. Year: 2000**

| Population  |       |       |       |            |                    |                     |                         |
|-------------|-------|-------|-------|------------|--------------------|---------------------|-------------------------|
| Description | SEX   |       |       | AGE GROUPS |                    |                     |                         |
|             | TOTAL | MEN   | WOMEN | TOTAL      | Less than 15 years | From 15 to 64 years | From 65 years and older |
| Total       | 2,012 | 1,076 | 936   | 2,012      | 655.91             | 1,204.98            | 150.90                  |
| Percentage  | 100.0 | 53.48 | 46.52 | 100.0      | 32.60              | 59.90               | 7.50                    |

**Source:** General Comptroller of the Republic. Division of Statistics and Census. Year 2000. Vol. 1. Tome 3. Page 884-885

Table 2.2 divides the population into three main categories, and shows that nearly 60 percent of the population is between the ages of 15 and 64. The second population group according to age, corresponds to the population under 15 years, which is a cross-section representative of about 33% of the population.

If this data are correlated with the average age of the population of El Arado, which is 26 years, the population of El Arado, can be classified as a young one. This average is the same as those of the District of La Chorrera, and the Panama province and very similar (27 years in age) to that of the Panama District.

The smallest age group of El Arado is made up of the elderly (65 years and older) and represents 7.5 percent of the population.

An analysis of the data presented by the Western Health Region Department of Panama, for the area of El Arado in years 1993, 1995 and 2002, indicates that 60 percent of the population is less than 45 years of age. In contrast to Table 2.2 shows the same percentage for a range of age groups, which includes individuals up to 60 years, for the year 2000. This variation shows an increment of the population for ages under 45 years.

**Table 2.3. Population for the County of El Arado, by sex and community.  
Years: 1980, 1990, 2000**

| DESCRIPTION                    | 1980        |            |            | 1990        |            |            | 2000        |             |            |
|--------------------------------|-------------|------------|------------|-------------|------------|------------|-------------|-------------|------------|
|                                | Total       | H*         | M*         | Total       | H          | M          | Total       | H           | M          |
| <b>County Place Population</b> |             |            |            |             |            |            |             |             |            |
| <b>El Arado</b>                | <b>1574</b> | <b>859</b> | <b>715</b> | <b>1696</b> | <b>902</b> | <b>794</b> | <b>2012</b> | <b>1076</b> | <b>936</b> |
| Cabecera de Bernardino         | 102         | 52         | 50         | 10          | 5          | 5          | 8           | 4           | 4          |
| Cerro Viejo                    | 11          | 8          | 3          | 11          | 4          | 7          | 10          | 5           | 5          |
| El Limón                       | 437         | 248        | 189        | 51          | 29         | 22         | 44          | 27          | 17         |
| El Lirio                       | 22          | 15         | 7          | 415         | 235        | 180        | 423         | 233         | 190        |
| La Celestina                   | 120         | 68         | 52         | 61          | 34         | 27         | 68          | 35          | 33         |
| Loma Alta                      | 21          | 9          | 12         | 242         | 134        | 108        | 261         | 144         | 117        |
| Moscú                          | 6           | 5          | 1          | 34          | 22         | 12         | 32          | 18          | 14         |
| Naranjal                       | 19          | 12         | 7          | 23          | 13         | 10         | 58          | 34          | 24         |
| Puente Velásquez               | 626         | 336        | 290        | 599         | 296        | 303        | 51          | 23          | 28         |
| Rio Congo                      | 16          | 7          | 9          | 36          | 18         | 18         | 77          | 395         | 382        |
| Rio Congo Abajo or Los Montero | 10          | 7          | 3          | 15          | 10         | 5          | 35          | 18          | 17         |
| Santa Cruz                     | 184         | 92         | 92         | 199         | 102        | 97         | 245         | 140         | 105        |

**\*Note: H = men, M = women. Source:** From the database of the Population and Housing Census, year 2000, Division of Statistics and Census, General Comptroller of the Republic.

The structure by gender of the population of the county of El Arado, reflects a greater number of men, based on the three decades presented in Table 2.3. The index of men to women for the year 2000 is 115 men for every 100 women; however, in some communities it can be as high as 153.

El Arado shows a slow and natural population growth level over three decades.

**Table 2.4. Population of the District of La Chorrera, by county. Years 1980,1990,2000**

|    | <b>Description</b> | <b>1980</b>   | <b>Description</b> | <b>1990</b>   | <b>Description</b> | <b>2000</b>    |
|----|--------------------|---------------|--------------------|---------------|--------------------|----------------|
| 1  | Barrio Balboa      | 21,106        | Barrio Balboa      | 23,698        | Barrio Balboa      | 29,053         |
| 2  | Barrio Colón       | 16,460        | Barrio Colón       | 20,746        | Guadalupe          | 26,857         |
| 3  | Guadalupe          | 10,905        | Guadalupe          | 18,015        | Barrio Colón       | 26,818         |
| 4  | El Coco            | 2,917         | El Coco            | 7,767         | El Coco            | 14,167         |
| 5  | Playa Leona        | 2,378         | Playa Leona        | 4,279         | Puerto Caimito     | 7,198          |
| 6  | Puerto Caimito     | 2,233         | Puerto Caimito     | 3,623         | Playa Leona        | 6,706          |
| 7  | Amador             | 1,622         | Amador             | 1,925         | Amador             | 2,675          |
| 8  | El Arado           | 1,574         | El Arado           | 1,696         | El Arado           | 2,012          |
| 9  | Mendoza            | 1,120         | Feuillet           | 1,372         | Feuillet           | 1,745          |
| 10 | Santa Rita         | 1,016         | Santa Rita         | 1,191         | Santa Rita         | 1,307          |
| 11 | Feuillet           | 971           | Los Díaz           | 858           | Mendoza            | 1,053          |
| 12 | Los Díaz           | 927           | Mendoza            | 851           | Iturralde          | 927            |
| 13 | Hurtado            | 764           | Iturralde          | 792           | Hurtado            | 893            |
| 14 | La Represa         | 731           | Herrera            | 715           | Los Díaz           | 893            |
| 15 | Herrera            | 686           | Hurtado            | 703           | Herrera            | 812            |
| 16 | Iturralde          | 595           | La Represa         | 650           | La Represa         | 696            |
| 17 | Arosemena          | 498           | Obaldía            | 559           | Obaldía            | 554            |
| 18 | Obaldía            | 471           | Arosemena          | 340           | Arosemena          | 290            |
|    | <b>Total</b>       | <b>66,974</b> | <b>Total</b>       | <b>89,780</b> | <b>Total</b>       | <b>124,656</b> |

**Source:** Based on data from the Population and Housing Census, years 2000, 1990 and 1980, Division of Statistics and Census, General Comptroller of the Republic.

The District of La Chorrera comprises of 18 counties, with a population of 124,656 inhabitants. The county of El Arado, with a population of 2,012, represents 1.6% of the population of La Chorrera, and occupies the eighth position with respect to number of people. Table 2.4 shows populations rankings in descending order over the period of 3 decades for the district of La Chorrera. El Arado remains in the same place. The following counties change their position as a result of an increase in population in the year 2000: Guadalupe, Puerto Caimito and Mendoza.

In the District of La Chorrera it is important to distinguish between urban vs rural counties. Rural counties are located in areas of the Canal Zone. Among these counties, El Arado occupies the second place due to its population and housing. However, its community is even more important since Rio Congo is a semi-urban area.

▪ **Birth Rate**

The birth rate has been stable over the years 1998, 1999 and 2000, with a rate of around 20 births for every one thousand people. This rate reflects a decrease with

respect to those figures recorded in previous years, as can be seen for the years 1996 and 1997, where the rate was 29.5 and 25.4, respectively. Likewise, the county of El Arado, according to the 2000 Census, presents an average number of live births per woman of 3.1.

**Table 2.5. Birth Rate for El Arado. Census 1980, 1990, 2000**

| District<br>County      | BIRTH RATE |      |        |      |        |      |
|-------------------------|------------|------|--------|------|--------|------|
|                         | 1980       |      | 1990   |      | 2000   |      |
| Description             | Number     | Rate | Number | Rate | Number | Rate |
| District of La Chorrera | 1852       | 26.7 | 2352   | 25.6 | 2786   | 24.6 |
| County of El Arado      | 46         | 28.2 | 49     | 28.4 | 41     | 20.6 |

Table 2.5. shows a decrease of the birth rate both in the District of La Chorrera and in the county of El Arado. However, in both places, during the same period, the population showed an increase; this increase is probably not the result of natural growth, but linked to other factors, such as a sustained migration experienced by the district of La Chorrera and Arraiján for several decades now. According to the analyses of the General Accounting Office of the Republic, the Regional Health Plan for Western Panama and the Urban Development Plan for the Areas of the Pacific and Atlantic, there will be a sustained increase in the next few decades in the two districts mentioned, as a consequence of migrations towards these sites.

At the same time, the following rates have experienced a sustained decrease: global fertility rate (number of children born per woman), total birth rate (per one thousand inhabitants). The Total Global Fertility Rate has decreased from 5.4 to 2.5 in 2001 and the total birth rate has decreased from 36.3 to 21.3, both for the period 1960 to 2001<sup>3</sup>.

In the year 2002, there were 31 live births recorded in the county of El Arado (13 boys and 18 girls) from mothers whose ages ranged from 15 to 39 years, all born in Health facilities in the Western Health Region of Panama. This figure is evidence of the natural decrease trend in the population of the area.

<sup>3</sup> Contraloría General de la República. Nivel de Fecundidad en la República. Censo 2000. Tabla 221-12 Pagina 43.

- **Life Expectancy**

In 1992, life expectancy was 75.80 for the Western Sector of the Metropolitan Health Region, with an average life expectancy of 78.16 for women and 73.56 for men.

Life expectancy<sup>4</sup> for the Metropolitan Health Region, Western Sector (in which El Arado is included), is 74.9 for the year 2003, 77.3 for women and 72.6 for men. This figure indicates that in this area life expectancy has decreased with respect to the year 1992.

Estimations for the current five year period of 2000-2005 give a value of 74.9<sup>5</sup>, a figure which is lower than that for 1992.

- **Mortality**

**Table 2.6. Mortality in the District of La Chorrera and the County of El Arado. Years: 1993, 1995 and 2002**

| District<br>County         | MORTALITY |      |      |
|----------------------------|-----------|------|------|
|                            | 1993      | 1995 | 2002 |
| District of<br>La Chorrera | 302       | 659  | 399  |
| County of<br>El Arado      | 6         | 7    | 8    |

The mortality rate for the country in general, for the years 1980, 1990<sup>6</sup> and 2000, is of 4.1, equivalent to 7,959, 9,799 and 11,841 deaths, respectively.

For the year 2001 the general mortality rate increased to 4.2 in the country.

With respect to the Infant Mortality Rate in the country, it was of 21.7 in 1980 18.9 in 1990. In the year 2002, the infant mortality rate decreased to 16.5.

In the Health Region for Western Panama (RMS), there is a rate of 14.6 for the year 1992 and 12.9 for the year 2002.

<sup>4</sup> Ministerio de Salud. Región Metropolitana de Salud. Panamá Oeste. Boletín Estadístico. 2002. Tabla No.2

<sup>5</sup> Contraloría General de la República. Situación Demográfica. Tabla 1. Estimaciones de la Esperanza de Vida. Años 1980, 1990, 2005, 2010.

<sup>6</sup> Contraloría General de la República. Censo 1990. Estadísticas Vitales. Sección 221. Tabla 221-01 Natalidad y Mortalidad. De 195 2-91 pag. 16.

Based on the data for the Health Region for Western Panama , for the year 1992, there were 631 deaths in La Chorrera and 6 in El Arado, of which 50% occurred in the group of 60 or older.

In the year 2002, the regional health authority recorded 8 deaths in El Arado, mainly in the age group of 60 and older. The same report of the regional health authority indicates that for the year 2002, the main causes of death in the district of La Chorrera, were the following: Malign Tumors (67); Cerebral vascular illness (40); Accidents, suicides, homicides and other violence (35); heart attack (16) and Mellitus Diabetes (15).

The chronological series of deaths due to illness in the RMS, indicates that the deaths due to infarction and cerebral/ vascular diseases, increased since 1993 to 2003 from 102 cases to 204. The diarrhea cases increased from 7132 to 22,032 and tuberculosis increased from 38 to 141.

With respect to the level or morbidity, medical consultations (2002) in the Health Center of the El Arado, totaled approximately 593.

At the level of the Western Panama RMS, the five main causes of morbidity are colds, diarrhea, rhino-pharyngitis, bronchitis, malnutrition and other forms of anemia. Given that these are not congenital diseases, these type of illnesses can be associated with the lack of resources due to the socioeconomic situation of the population in Western Panama.

## 2.4.2. Housing

The county of El Arado, according to Census-2000, has around 500 houses, distributed in 12 communities, of which 85% are found in the communities of Rio Congo, El Lirio, Loma Alta and Santa Cruz. The average number of inhabitants per house is of 4.2 persons, above the average for the District of Panama (4.0), Panama City (3.7) and the province of Panama (3.9).

Despite being located 20 kilometers from Panama City, and less than 10 kilometers from the City of La Chorrera and the center of Arraijan, El Arado has a high level of marginality in most of its communities (2000 Census). For example, 30% of the houses do not have potable water, 40% do not have electricity, 23% of the houses have dirt floors and 29% do not have a bathroom.

Twenty four percent of the community uses firewood for cooking. The level of access to certain communication services and household goods, reveal that 32% do not have a television set and 88% does not have a residential phone.

**Table 2.7. Important characteristics of homes in the county of El Arado. 2000 Census.**

| CHARACTERISTICS          | COUNTY | RIO CONGO | EL LIRIO | LOMA ALTA | Sta. CRUZ |
|--------------------------|--------|-----------|----------|-----------|-----------|
| Total                    | 489    | 200       | 98       | 68        | 51        |
| With dirt floor          | 114    | 12        | 60       | 14        | 8         |
| Without potable water    | 141    | 9         | 46       | 26        | 14        |
| Without bathroom         | 16     | 0         | 8        | 4         | 0         |
| Without electrical light | 199    | 20        | 96       | 28        | 13        |
| Cook with firewood       | 119    | 8         | 50       | 23        | 12        |
| Cook with carbon         | 1      | 0         | 0        | 0         | 0         |
| No television            | 156    | 26        | 65       | 26        | 11        |
| No radio                 | 107    | 40        | 28       | 10        | 11        |
| No residential telephone | 431    | 155       | 98       | 62        | 49        |

Note: The communities of El Arado, Rio Congo, El Lirio, Loma Alta and Santa Cruz, represent 85.27% of the total number of houses.

**Source:** Based on the data from the Population and Housing Census for the year 2000, 1990 and 1980, Division of Statistics and Census, General Comptroller of the Republic.

Based on the data of the Regional Health Authority for the Western Sector, there are 80,639 houses in this sector, of which 10% do not have potable water, 5% do not have sewage services, and only 61.4% have service for the collection of solid waste.

It is important to underline that the community of El Lirio, the second in importance in terms of number of houses (20%) and population (25%), presents the worse condition in terms of quality of life. This community does not have electricity nor to other important services such as television and residential telephone.

Near the community of El Lirio (at 7 kilometers), there are facilities for the provision of water in Laguna Alta, which takes water from the Gatun Lake. This water is conducted to Nuevo Emperador, where there is a processing plant (at a distance of 4 kilometers from the community of Rio Congo) and distributed to certain communities in the district of Arraiján.

### **2.4.3. Infrastructure and services**

#### **▪ Road infrastructure for transportation and communication**

The Inter-American Highway, by way of one of its arteries, connects the county of El Arado with the rest of the country, through an asphalt regional roadway that reaches up to the community of Rio Congo. The other communities are accessible using other local dirt roads, accessible during the dry months of the year.

Some communities, like El Lirio, are very close to Lake Gatun, which allows for transportation by boat in addition to the road.

The surface of the El Arado county presents an irregular topography made of small undulations and slopes, and widely covered with pastures in large areas for extensive livestock raising. In addition, there are some isolated areas with forest coverage.

Spatially, the area is mainly used for raising livestock and agriculture (mainly subsistence), which are the two most important activities.

There are farms for commercial crops (pineapple) and areas with improved pastures, live barriers and commercial tree species.

With respect to communication infrastructure, it has four public telephones, three located in Rio Congo and one in El Lirio. The radio is the main means of communication used in these areas.

#### **▪ Education Infrastructure**

El Arado includes three schools:

- In Rio Congo, there is a Basic or Primary School. This school has 11 rooms, 200 students and 16 teachers.
- The school of El Arado had 85 students matriculated in the year 2000 and 3 teachers.
- The school of Santa Cruz had 42 students matriculated in the year 2000, and one teacher.

In El Arado, the population with less than a third grade of education is 141 people, and the illiterate population was of 143 people in the year 2000.

- **Health Infrastructure**

El Arado has two health facilities, including the Health Center at Rio Congo and a Health Post in El Jobo.

The Health Center provides service for General Medicine once per week (Wednesday), and has one doctor and one nurse in staff. Pregnant women receive attention and other activities include general vaccinations, and medical attention for common illnesses. In the year 2002, there were 571 medical consultations attended at the Health Center.

There are several technical consultations, including Nutrition, Psychology, Social Work, Listening tests, which are provided at the Magally Ruiz Health Center, located in La Chorrera, where the population goes to receive these services.

- **Public Services**

The county of El Arado has basic public services: in the area of public security, it has two police posts, both located along the asphalt road that connects the community of Rio Congo with the city of La Chorrera and the community of Nuevo Emperador. One of these police posts is located in Rio Congo.

## **2.5. Economic Aspects**

### **2.5.1. Employment**

El Arado, based on figures from Census 2000, had a population of 2,012 people. There is a satisfactory level of employment, with an unemployment rate of 8.3% for that year, very similar to the rate for 1990, which was 8.0%.

More than one third of the population (37%) is employed and dedicated to agricultural activities. El Arado is a rural county located in the Panama Canal Basin. Its communities are connected to industrial poultry farming that take place in the area and to important livestock activities. In the last 2 years, the industrial cultivation of pineapples has also been introduced; this activity requires a significant amount of labor, for preparation, planting, harvest and post-harvest.

### **2.5.2. Agricultural activities**

For an analysis of agricultural activities, they are divided into annual crops and permanent or semi-annual crops.

- **Annual crops**

El Arado includes a wide variety of annual crops (see Table 2.9); they are oriented to a market demand for rice, corn, beans, yucca, and cucumber (see Table 2.8). Other

crops include onion, tomatoes, watermelon, melon and pumpkins. The rest of the crops satisfy the self consumption of the producers and their families, such as ñame, guandú and otoe.

**Table 2.8. Number of crops, surface planted and harvest of agricultural products**

| CROP     | Number of Cultivations | SURFACE PLANTED | HARVEST            |          |
|----------|------------------------|-----------------|--------------------|----------|
|          |                        |                 | UNIT OF MEASURE    | QUANTITY |
| Rice     | 24                     | 13              | Quintal (unpeeled) | 265      |
| Corn     | 75                     | 38              | Quintal (grain)    | 718      |
| Bean     | 38                     | 9               | Quintal (dry)      | 76       |
| Yucca    | 130                    | 5               | Quintal            | 300      |
| Cucumber | 22                     | 1.5             | Quintal            | 263      |

**Source:** Agricultural Census for the Year 2000, Statistics and Census Division, General Comptroller of the Republic.

- Permanent Crops

On the other hand, permanent crops include: pineapple, lemon, plantain, orange and avocado, which are sold in the market. Among these crops, pineapple is highly marketed. Other fruits are cultivated, for the self consumption of the farmer and his family such as: coffee, bananas, papaya, cacao, coconut, grapefruit, mango and guanabana (custard apple).

Of all the crops mentioned, pineapple shows a potential for expansion during the next few years. Pineapple is an export crop, classified as a "non-traditional export crop" and promoted by the Ministry of Agricultural Development (MIDA) as part of its policy for non traditional exports.

Traditional exports include crops such as sugar and coffee, that have been exported for many decades and their markets are saturated or have contracted (such as the sugar market) with the introduction of substitute products.

Pine is traditionally cultivated in the district of La Chorrera, especially in the county of Herrera, in the area known as Sanguenga. This is an excellent pine producing area and has dedicated to pineapple production for export mainly to the United States.

The rest of the permanent crops listed have sporadic links to market.

**Table 2.9. Number of agricultural parcels, crops and sales of permanent crops in the county of El Arado.**

| <b>CROPS</b>  | <b>NUMBER OF PARCELS</b> | <b>UNIT OF MEASURE</b> | <b>HARVEST</b> | <b>SALES</b> |
|---------------|--------------------------|------------------------|----------------|--------------|
| Coffee        | 40                       | QQ                     | 15             | -            |
| Bananas       | 116                      | Raceme                 | 940            | 13           |
| Plantains     | 200                      | 100                    | 1558           | 169          |
| Papaya        | 65                       | Unit                   | 2337           | 94           |
| Orange        | 155                      | 100                    | 753            | 98           |
| Cacao         | 11                       | Pound                  | 89             | -            |
| Pineapple     | 18                       | Unit                   | 287429         | 287000       |
| Coconut       | 189                      | Unit                   | 13920          | 220          |
| Annatto       | 76                       | Quintal                | 11             | 1            |
| Avocado       | 107                      | 100                    | 97             | 14           |
| Lemon         | 151                      | 100                    | 1126           | 279          |
| Grapefruit    | 62                       | 100                    | 135            | 11           |
| Mango         | 233                      | 100                    | 960            | 15           |
| Guanábana     | 111                      | Unit                   | 691            | 3            |
| Passion fruit | 39                       | Pound                  | 227            | -            |
| Pixbae        | 71                       | Raceme                 | 592            | 4            |
| Guava         | 37                       | -                      | -              | -            |
| Cashew        | 166                      | -                      | -              | -            |

**Source:** Data from the 2000 Agricultural Census, Division of Statistics and Census, General Comptroller of the Republic.

### **2.5.3. Livestock activities**

Approximately half of the land in El Arado is used for extensive livestock activities. According to the 2000 Agricultural Census, the existence of livestock was of 2,797 heads, which is equivalent to around 3 thousand hectares, or 50% of the county lands. There are also activities related to milk production.

In addition to livestock activities, there are also important pig raising and chicken farming activities. There were 583 pigs and 208,791 chicken recorded in the area. The production of chicken companies represents an important economic motor for growth and employment at the county level and specifically for the community of Rio Congo. It

is estimated that there are 100 facilities for production with a capacity of 23,000 chickens per area.

In addition to farming of livestock, pigs and chickens, there are other activities of lesser economic importance, such as raising of goats, horses, ducks, geese and turkeys.

**TABLE 2.10. Number of agricultural animal farms, by class in the county of El Arado.**

| DESCRIPTION     | Number of Activities | EXISTENCE (HEADS) |
|-----------------|----------------------|-------------------|
| Bovine          | 76                   | 2,797             |
| Porcine         | 36                   | 582               |
| Horses          | 89                   | 192               |
| Hens (chickens) | 260                  | 208,791           |
| Ducks and geese | 38                   | 750               |
| Turkeys         | 13                   | 109               |

Source: Based on data from the 2000 Agricultural Census, Division of Statistics and Census, General Comptroller of the Republic.

#### **2.5.4. Land tenure**

About 75 % of the lands in El Arado have a property title. Approximately 44% of these properties are owned by producers. It is estimated that each hectare in this area has a market value of 2,000 B/..

#### **2.5.5. Land use**

According to the 2000 Census, 70% of lands are used for pastures (natural and improved), and 10% for agricultural activities.

Not only the lands with pastures are used for bovine livestock (a total of 2,700 hectares); lands classified as "permanent crops" are also used for these activities (these are lands with dispersed fruit trees).

**Table 2.11. Agricultural operations and surface, by activity, in the county of El Arado.**

| DESCRIPTION          | NUMBER OF ACTIVITIES | SURFACE (HA) |
|----------------------|----------------------|--------------|
| Total                | 361                  | 3913         |
| Annual crops         | 177                  | 173          |
| Permanent crops      | 295                  | 190          |
| Fallow               | 61                   | 306          |
| Traditional pastures | 43                   | 1028         |
| Improved pastures    | 44                   | 1131         |
| Natural pastures     | 162                  | 540          |
| Forest               | 101                  | 231          |
| Other lands          | 275                  | 312          |

Source: 2000 Agricultural Census, Division of Statistics and Census, General Comptroller of the Republic.

## 2.6. Planning and Development Strategies of the State

The Urban Development Plan of the Housing Ministry, on the theme of Residential Uses up to the Year 2020, Metropolitan Area of Panama, Western Sector, indicates that in the "sub-zone of La Chorrera, nearly 70 to 100 percent of the territorial increase, will take place in the urban locality of La Chorrera (Barrio Balboa, Barrio Colón) with emphasis towards the east (up to the Juan D. Arosemena county) with other counties, El Coco, Guadalupe and part of Puerto Caimito, with the percentage increasing to 96%. This means that the residential growth will occur in fragmented expansions in comparison to the current residential pattern; in other words, it will occur in each one of the counties mentioned."<sup>7</sup>

El Arado is one of the counties of the District of La Chorrera which is partially included in the study and plan. These also include Herrera, Hu rtado, Los Díaz, and Santa Rita. They distinguish themselves by being separated from the Pan-American Highway and due to their low population level. In 1990, the average number of inhabitants per county did not reach one thousand 1000 in the year 2000 and the situation has slight variations in the present.

The Plan recommends for these counties a policy of containment that allows for the provision of basic services for these populated areas, with the objective of reaching a level of self-sufficiency that limits the prevalent linear level of expansion. The increase in population by the year 2020 is expected to increase the average from 1000 to 1600 per county.

<sup>7</sup> Ministerio de Vivienda. Plan de Desarrollo Urbano, de las Areas Metropolitanas del Pacífico y Atlántico. Página 15-26.

## **2.7. Conclusions**

The site of "El Arado" presents some limitations for its use as a disposal site, which are presented below:

- Its proximity to Rio Congo, the most important community of the county, with 40% of the population; this community is the county capital.
- It does not contribute an aggregate value unless investment is made in the modified land.
- There is bovine cattle activity in the hands of mid-sized livestock produces, that would have to be financially compensated.
- There is a strong chicken production activity, at the commercial levels, that might be directly affected .

### **3. SITE OF “PALO SECO”**

The site of “Palo Seco”, in contrast to “El Arado”, which is a county with several communities, is a singular site: it includes a facility that serves as a health center for the elderly. The property destined for this activity has an extension of approximately three hectares and the structure consists of seven two-story buildings.

#### **3.1 Location**

The site of “Palo Seco”, is located in the County of Ancón, district and province of Panama. (area of the former Canal Zone, known as the Reverted Areas). Specifically, it is located in the Pacific Coast, on the sea coast, and western side of the Panama Canal, in a peninsula between Farfan and Kobee Beaches, surrounded by the sea and tropical vegetation.

The only infrastructure found in this site is the National Hospital of Larga Estancia, which was established through Resolution No. 276, of July 9, 1998, located in front of Amador Causeway, three kilometers far from the Bridge of the Americas.

#### **3.2 Technical Program of the Hospital**

Services provided at the hospital include:

- Attention for patients with Hansen Disease.
- Attention for terminally ill cases.
- Attention for elderly adults with Chronic Incapacitating Illnesses
- Attention for young people with disabilities (social cases).
- Geriatric Center: integral attention for independent elderly adults.

Other multiple activities are conducted: training, social, cultural and recreational activities. The Hospital provides services for hospitalized residents, with the following characteristics: gerontocracy, senile dementia, genetic deformations, abandoned patients. Most of the residents are very elderly (more than 80 years).

Currently, it is the only hospital in Panama which admits persons who suffer from Hansen's Disease<sup>8</sup> (leprosy) both nationals and foreigners.

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<sup>8</sup> People can become infected by Hansen's Disease when they breathe the dust or dirt where the armadillo has deposited its feces. During the construction of the canal, certain deformations were observed in workers' skins, and they were transported to Miraflores, where they were isolated. Then the United States Senate designated twenty five thousand Balboas for the construction of this Hospital.

The Hospital began operations at the current site, with patients who were workers of the Panama Canal, in 1907.

### 3.3. Administration of the hospital

In the year 1979, the hospital was returned to Panama, in fulfillment of the Torrijos-Carter agreement, and began to be administered by the Ministry of Health.

In 1996, it was incorporated to the structure of the Ministry of Health, pursuant to Resolution No. 024 of September 18 1996, under the category of Third Level Hospital for specialized attention for the elderly; currently, it is administered by the Ministry of Health.

In 1998, pursuant to Resolution No. 276 of July 8, 1998, its name was changed to Larga Estancia National Hospital.

**Table 3-1. Staff and residents in the Hospital**

| DESCRIPTION                                | QUANTITY                 |                        | TOTAL     |
|--|--------------------------|------------------------|-----------|
|  | MINISTRY OF HEALTH STAFF | RESIDENTS AND PATIENTS |           |
| Physicians                                 | 3                        |                        | 3         |
| Nurses                                     | 4                        |                        | 4         |
| Auxiliary staff                            | 6                        |                        | 6         |
| Technicians                                | 4                        |                        | 4         |
| Residents with Hansen (controlled leprosy) |                          | 8*                     | 8*        |
| Other patients                             |                          | 46                     | 46        |
| <b>TOTAL</b>                               | <b>17</b>                | <b>54</b>              | <b>71</b> |

Source: Palo Seco Hospital

\*Note: These residents do not wish to leave the Hospital ; they perform certain tasks in the Hospital and receive payment. Ambulatory Hansen patients also receive a stipend.

### 3.4. Financing and self-management

This Hospital is financed by a budget assigned by the Government of Panama, through the Ministry of Health, and through self-management. It receives income from the monthly payments of ten residents in the amount of B/.300.00 for each. Residents receive the following services: daily medical evaluation, food, recreation, individual room with bed, television, clothing and a place to store the clothing.

### **3.5. Hospital outreach**

Currently there is a project known as Living Museum Project for the Larga Estancia National Hospital, through which an outreach campaign is conducted at the national level.

#### **a) General objectives**

Communicate to the general community the beneficial services provided by the hospital and to promote an end to the myth of rejection towards those people suffering from Hansen Disease, the elderly, and people with disabilities.

Strengthen the outreach strategy for promotion of health and better quality of life, responsibility and citizen participation; motivate independent family integration for those with disabilities to avoid hospitalization.

#### **b) Specific objectives**

- Establish clear communication channels between the staff that works in the facility and other units of the Ministry of Health and related organizations.
- Compile, develop and disseminate information about the facility.
- Establish a common workplace relationship with potential patients.
- Develop linkages with people, companies, universities and other organizations tied to the Hospital to assure the success of established goals and the continuity of the Hospital in future years.

### **3.6. Support organizations**

For certain activities such as training, the Hospital receives the support and/or maintains cooperation agreements with the Office of the First Lady, the National Beneficence Lottery, the Committee of Wives and Ladies of Health, In the near future the Hospital will sign an agreement with the University of Panama, so that experienced personnel can perform their professional duties at the Hospital.

### **3.7. Infrastructure**

The Palo Seco Hospital has the same infrastructure of its original construction (1904-1907); it is made of wood and has seven areas dedicated to: dining room, laundry, special attention areas for the elderly, and hospital. In addition, the site has a Chapel and a parking lot. The area currently assigned by the Inter-Oceanic Regional Authority to the hospital is of 3 hectares.

### **3.8. Property Status of the Hospital**

The Larga Estancia National Hospital is located in a lot administered by the Inter-Oceanic Regional Authority (ARI) pursuant to Law 105 of 1973, which indicates that the goods that returned to Panama as a result of the Torrijos Carter Treaty, are administered by the ARI until they are assigned definitively to a specific agency.

According to the Regional Plan for the Development of the Inter-Oceanic Region, the areas where the Palo Seco Hospital facilities are located are considered as areas of "mixed use". The Plan foresees the establishment of urban and suburban centers, such as hotels and other related tourism activities, museums and other cultural facilities, recreational and residential facilities, non-manufacturing activities, government offices, retail and large sales, etc.

The Inter-Oceanic Regional Authority, designated the three hectares for temporary Hospital use and has given a timeline of one year, beginning on January 2003, to vacate the Hospital and move it to another place, for which purpose other sites are being evaluated (including Pedro Miguel, among others).

### **3.9. Cultural Values**

The Larga Estancia National Hospital (HNLA) has the unique cultural value of being the only hospital whose construction dates back the construction of the Panama Canal, in current operation with the original construction structure built between 1904-1907.

It was perceived that there are professionals linked to the Hospital, who assign a National Historical Heritage value to the site, since many Panamanian and foreign workers of the Panama Canal lived, died and were treated there. These persons were involved in excavation activities.

### **3.10. Preliminary evaluation of the site**

The following can be observed with respect to the request of ARI to vacate the Hospital, in order to identify resistance points at the request:

- With respect to the resistance of the relatives of the residents and patients, the resistance of this group could be limited given that there is neither linkage nor communication with a significant number of relatives. With respect to the staff that works at the Hospital, the resistance to relocation of the Hospital would be limited because of their condition as officials.
- We would expect that the only resistance that could be encountered is the national community, through certain civil society organizations, such as the Social Security Society of Retired and Pensioned Workers and the Association of the Elderly. In this case, it would be important to learn their point of view through interviews.

- The site has an optional value since it is an adequate and organized place and it is valued as a National Heritage site. It is important for both those who can give it a usage value and for those who can give it a usage option value.
- The current proposal from the National Government through the Inter-Oceanic Regional Authority is to transform this site into an area of high economic return assigning it a tourism and commercial value.

## 4. SITE OF “EL CHORRILLO”

### 4.1. General Aspects

#### 4.1.1. Location

The site of El Chorrillo is located in the County of El Chorrillo, located in the southwest sector of Panama City.

Its inhabitants are spatially distributed in an area crossed by Streets 25, 26 and 27 West, framed by Mártires Avenue, Poetas Avenue and “B” Street.

The County of El Chorrillo borders to the north with the Santa Ana County, to the South with the Pacific Ocean, to the East with the San Felipe County and to the West with the County of Ancon.

#### 4.1.2. Surface and spatial distribution

| Description               | *Surface in<br>in Km2. | Population |         |         | Inhabitants per<br>Km2. |       |       |
|---------------------------|------------------------|------------|---------|---------|-------------------------|-------|-------|
|                           |                        | 1980       | 1990    | 2000    | 1980                    | 1990  | 2000  |
| District of<br>Panama     | 2,560.8                | 477,107    | 584,803 | 708,438 | 186.3                   | 228.4 | 276.6 |
| County of El<br>Chorrillo | 0.4                    | 25,145     | 20,488  | 22,632  | 62.86                   | 51.22 | 56.58 |

Source: Table developed with data from the General Comptroller of the Republic. Housing and Population Census. Years 1980,1990,2000.

\*Note: Figures revised in 1988 by the National Institute of Geography using existing cartographic information, on a scale of 1:50,000 and LANDSAT satellite images, geometrically corrected.

The County of El Chorrillo, has an area of 0.4 squared kilometers; it is the smallest of the counties in the District of Panama and has the highest population density in the district. The population density is of 62.86 and 51.22 according to the Census for 1980 and 1990, respectively. The second larges county in terms of area is San Felipe with 0.5 km2; it occupies the third position in terms of population density, and only the Santa Ana county area is larger.

Spatially, the County of El Chorrillo has stagnated, with the establishment of the former Canal Zone limit, to its west, which contributed to a great extent to the city expanding in a different direction.

#### **4.1.3. Political and Administrative Division**

The County of Chorrillo belongs to the district and province of Panama.

The County of Chorrillo, in one of thirteen (13) counties, located within Panama City. The rest of the counties (six) of the district of Panama, are outside the perimeter of the capital city, such as Pacora, Chilibre, Las Cumbres, San Martín, Tocumen, and Pedregal.

The District of Panama, includes 19 counties, namely:

San Felipe, La Exposición or Calidonia, Santa Ana, Bella Vista, Parque Lefevre, Pedregal, Tocumen, San Martín, El Chorrillo, Curundú, Betania, San Francisco, Rio Abajo, Juan Díaz, Las Cumbres, Ancón, Chilibre, Pacora.

The counties of the District of Panama, are administratively divided into 182 communities. In the case of the County of El Chorrillo, its territory is defined by streets and avenues; it includes an administrative subdivision for a locality (lugar poblado), which is Barraza.

The counties present different characteristics based on their quality of life standards, their infrastructure and public services. The urban counties include Chorrillo, Santa Ana, San Felipe, Curundú, Betania, Bella Vista, San Francisco, Parque Lefevre, Rio Abajo. The rural counties include Pacora and San Martín. The rest of the counties have both rural and urban communities, such as Chilibre, Tocumen, Ancón, Las Cumbres, Juan Díaz and Pedregal.

## **4.2. Social aspects**

### **4.2.1. Demographic dynamics.**

#### **▪ Growth**

The natural growth rate of the national population in the last three decades evolved according to the following pattern: the growth rate for 1970 was 30.0, it was 28.0 for 1975, and 22.0 for 1980. This decrease continues in 1990, with a rate of 20.7.

The population of Panama experienced an increase of 509,848 people during the last decade. In other words, it increased from 2,329,329 to 2,839,177 people according to

the 2000 Census, which represents a decrease in the growth rate when compared to the preceding decade.

This tendency can also be observed for the decade of 1970-1980, where the population grew 28%. The rate of increase is considered lower than the previous decade, when the population of the country increased by 32.8%.<sup>9</sup>

The figures presented show a sustained decrease in the natural growth of the population, linked to fertility and mortality, as evidenced in the following sections of this document.

The District of Panama, has experienced population changes since the decade of the 1960s, that can be analyzed through its growth rates, using the following table:

**Table 4.2.**  
**Population growth rates for the District of Panama and County of El Chorrillo.**  
**Census : 1980,1990,2000.<sup>10</sup>**

| CENSUS    | District of Panama              | County of El Chorrillo          |
|-----------|---------------------------------|---------------------------------|
|           | GROWTH RATE<br>(Per 100 people) | GROWTH RATE<br>(Per 100 people) |
| 1970-1980 | 2.13                            | -1.88                           |
| 1980-1990 | 2.01                            | -1.28                           |
| 1990-2000 | 2.00                            | 1.0                             |

The forecasts developed by the General Comptroller of the Republic, foresee that this decreasing trend will continue for the next 25 years as shown in Table 4.2.

Table 4.2. shows a decrease in population for the county of El Chorrillo for the periods of 1970 to 1990.

The global growth rates (TCG) for the country, also show a decrease based on the following: from 1970 to 1975, the TCG is 2.73, from 1980-1985 it is 2.22, from 1995-2000 it is 2.0, and 1.80 in 2002.

With the objective of characterizing the internal population growth of the District of Panama, and to identify the condition of the County of El Chorrillo, based on data from the General Comptroller, three large groups of counties can be highlighted<sup>11</sup>:

<sup>9</sup> Contraloría General de la República de Panamá. Censos Nacionales de Población and Vivienda. 1980. Volumen 1. Lugares Poblados. Página 7.

<sup>10</sup> Contraloría General de la República. Censos Nacionales de Población and Vivienda. 1991 Resultados Finales Básicos. Distrito de Panamá. Página 7.

<sup>11</sup> Contraloría General de la República. Censos Nacionales de Población and Vivienda. 1991 Resultados Finales Básicos. Distrito de Panamá. Página 7

In the first place are those counties with a negative growth rate; in other words, those counties that are losing population, which is mainly a product of migration from the population towards new areas of expansion. This is the case for San Felipe, **El Chorrillo**, Santa Ana, Calidonia, San Francisco and Bella Vista.

In the second place we can find the counties which have a moderately positive growth rate, including Curundú, Betania, Pueblo Nuevo, Rio Abajo, Juan Díaz and Pedregal.

In the third place, we can find the counties with the largest growth, including: Pacora, Chilibre, San Martín, Parque Lefevre, Tocumen, Las Cumbres. Of this group, in 1980 Tocumen reached a growth rate of 13.43, the highest recorded. In 1990, the highest figure corresponds to Pacora, with 12.50.

At the same time, there are also factors that lead to increases in the cities of Panama, San Miguelito, Arraiján and Chorrera, linked to internal migration movements that concentrate the population in the province of Panama<sup>12</sup>. The Ministry of Health, indicates that from 1990 to 2010, the estimated population of the province of Panama will increase by as much as 48.4%.

| <b>Table 4.3.<br/>Evolution of the population of the County of El Chorrillo<br/>Census for 1980, 1990, 2000.</b> |         |           |           |
|--|---------|-----------|-----------|
| Years  | 1980    | 1990      | 2000      |
| Description  | Total   | Total     | Total     |
| Prov. of Panama  | 615,429 | 1,072,127 | 1,388,357 |
| District of Panama   | 407,827 | 584,803   | 708,438   |
| County El Chorrillo  | 25,145  | 20,488    | 22,632    |

Source: General Comptroller of the Republic de Panama. Census of 1980, 1990, 2000. Volume I. Populated Places.

The population for the year 2000 in the County of El Chorrillo increased to 22,632 inhabitants, which reveals that it has 2,144 more people than in 1990 and 2,513 less than in the year 1980. This means that the population has increased by 9.5% in the last 10 years and decreased 11% in the last 20 years. In both periods, it is less than

<sup>12</sup> Contraloría General de la República de Panamá. Censos Nacionales de Población and Vivienda. 1980. Volumen 1. Lugares Poblados. Página 7.

the growth at the national level for Panama, which is 28.2<sup>13</sup> for the period 1970-1980 and 2.00 according to the 2000 Census<sup>14</sup>.

This is in contrast to the forecasts of the Geographer Don Angel Rubio; when in 1940 El Chorrillo had 50,000 people, one fifth<sup>15</sup> of the population of the Capital City, Rubio forecast a tremendous growth; however, in 1980 it only reached 6% of the total population of the District of Panama.

El Chorrillo was bounded spatially by the growth of the city of Panama, when it stopped playing a relevant role in the urban dynamic of the region; it was displaced by new periphery sites, that were the new receivers of migrating communities: the district of San Miguelito and the counties of the district of Panama, expanding towards the western sector, beside the Pan-American Highway, and representing today the most heavily populated sites in the District.

Other counties show similar characteristics to the dynamics of El Chorrillo, including the neighboring counties of San Felipe, Santa Ana, and Calidonia. These counties are located in the old part of Panama City (Casco Viejo), where during the first decades of the republic residents moved to the counties of Bella Vista, San Francisco as the city expanded towards other residential areas; other areas were promoted and invaded such as San Miguelito.

Meanwhile, the old part of the city remained in a commercial area, within Central Avenue, increasing the commercial value of the premises due to its location, in detriment of a residential category. This caused the population that could pay a better rent to leave outside the old city; what remained is a large amount of wooden building in bad disrepair which has caused numerous fires in the last years.

During the years 1930-1940, El Chorrillo concentrated cheap labor for activities related to the transit route that served to link the community with the rest of the country. As the receiver of the rural-urban migration, it was clearly involved in national development as a residence for workers for the construction of the Panama Canal.

According to Dr. R. Lachman, beginning with the Second World War, El Chorrillo, contributed to important changes to the transformation of the economic structure during the years 1950 to 1960, a decade in which other areas such as San Miguelito also expanded.

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<sup>13</sup> Contraloría General de la República. Dirección General de Estadística and Censo. Censo de Población and Vivienda 1980. Página 7.

<sup>14</sup> Contraloría General de la República. Dirección General de Estadística and Censo. Departamento de Estadísticas Vitales. Table 11 1.1. Tasa de Crecimiento intercensal de la población en la república por períodos. 1911-2000. Página No.23.

<sup>15</sup> Idem. Alfredo Figueroa Navarro. Página 14

In the 90s, there is a significant decrease in population growth, of approximately 5,000 people with respect to the previous decade. This was the consequence of the American invasion (December 20, 1989) of Panama City, when the County of El Chorrillo suffered the greatest impact since the former Defense Forces were stationed here.

The American invasion destroyed the structures located in Streets 25, 26 and 27 of El Chorrillo and part of the nearby county of Santa Ana. It is estimated that "12,000 to 15,000 people lost their homes"<sup>16</sup>. This forced many people to leave the county; and since the infrastructure was not immediately rebuilt, many moved out and never returned.

In the 2000 Census a new moderate population increase is recorded for the population of El Chorrillo in contrast to the population decrease observed after the 1940s. In part, the displacement of its previous residents has been replaced by poor people who migrate from poor rural areas to houses in this area, some of which have been condemned due to their poor physical condition. Generally, all these condemned houses are offered to their residents for sale.

**Table 4.4. Structure of the population of El Chorrillo, by gender and age group. Year 2000**

| POPULATION  |        |        |        |            |                    |                |               |
|-------------|--------|--------|--------|------------|--------------------|----------------|---------------|
| Description | SEX    |        |        | AGE GROUPS |                    |                |               |
|             | Total  | Men    | Women  | Total      | Less than 15 years | 15 to 65 years | Over 65 years |
| Number      | 22,632 | 11,217 | 11,415 | 22,630     | 6,447              | 14,794         | 1,389         |
| Percentage  | 100    | 49.56  | 50.43  | 100        | 28.49              | 65.37          | 6.14          |

Source: General Comptroller of the Republic, 2000 Census.

Table 4.4. shows an almost equal distribution of men and women for the year 2000, with a masculinity ration of 98.3 men for every 100 women.

With respect to the distribution of population by age group, most of the population falls between the range of 15 to 64 years, the main age group for productive workers. This

<sup>16</sup> Universidad de Panamá. Instituto de Estudios Nacionales. 1990 El Chorrillo, Situación y Alternativas. Artículo: El Chorrillo Análisis de la Situación Actual. Magela Cabrera A. 109 páginas.

group, comprising of 14,794 people, represents 65.37% of the total population of the county.

The second most important groups is comprised of the youngest population (under 15) and accounts for 30% of the total population of the county, which defines a young population structure, with an average age of 26 years for the whole county. The smallest group is the population older than 65 years, which only accounts for 6.14% of the total population of El Chorrillo.

At the same time, for this period, the masculinity index of El Chorrillo (98.3), was below the national figure of 101.8. With respect to the average number of children born per women, it is 2.2, which is under the national value of 2.4.

#### ▪ **Birth rate**

The level of birth rate (live births per every 1000 inhabitants) from 1954 to 1972 was between 36.0 to 41.10, with a sustained decrease observed after 1964.

The birth rate for the country during the decade 1980-90, resulted in the highest rate of 26.9 during the first two years and the lowest rate of 24.9 when the decade finished.<sup>17</sup> In 1990 the birthrate was of 24.8, and 19.9<sup>8</sup> in 1992.

According to data from the Metropolitan Region of Health (RMS), in the Country of El Chorrill, the birthrate for the year 1996 was of 29.0; for the year 1997 it was 31.0 and 26.9 for the year 1998. The birthrate figure of the RMS includes the District of Panama and the counties of Otoque and Veracruz. The values for the three years were: 21.3, 21.5 and 18.5, respectively. It can be noticed that the birthrates for the County of El Chorrillo are higher than those for the District of Panama and the RMS.

#### ▪ **Fertility**

The global fertility rate<sup>1920</sup> (children per women) for the entire country for the years 1980, 1990 and 2000 are 3.4, 2.9 and 2.7, respectively. The gross fertility rates (per

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<sup>17</sup> Contraloría General de la República. Dirección General de Estadística y Censo. Censo de Población y Vivienda. Estadísticas Vitales. Año 1991. Volumen III Defunciones. Página 16.

<sup>18</sup> Contraloría General de la República. Dirección General de Estadística y Censo. Censo de Población y Vivienda. Estadísticas Vitales. Año 1991. Volumen III Defunciones. Página Comentarios. S/n.

<sup>19</sup> Contraloría General de la República. Dirección de Estadística y Censo. Estadísticas Vitales. Año 2001. Nacimientos vivos y defunciones fetales. Vol. 2. Pag. 43.

<sup>20</sup> Contraloría General de la República. Dirección General de Estadística y Censo. Censo de Población y Vivienda. Estadísticas Vitales. Tabla 221-12. Años 1960-2001. Página 43

1,000 inhabitants) for the same period are 27.0, 25.0 and 22.7. Both rates show clearly the evolution in the decrease in population.

The average age for fertility, for the three reference decades, are 27 for 1980 and 26 for 1990 and 2000, respectively.

In the Regional Health Sector, the rate of fertility is of 2.1 for the year 1996, 2.2 for 1997 and 1.9 for 1998.

The fertility rate for the county of El Chorrillo for the year 2001 is 86.70, higher than that registered for the Health Region, which is 61.60.

The average number of children per women in El Chorrillo is of 2.20 according to the 2000 census, while the national average is of 2.40.

#### ▪ **Life expectancy**

Life expectancy at birth is the most efficient indicator of the living standards and the level of mortality of a population. Panama has one of the highest life expectancies in the Central American region. The life expectancy for women is lower than that for men.

At the province level, there are also important differences in life expectancies. For the five year period 1990-95 there was a higher life expectancy in the provinces of Panama, Los Santos and Herrera<sup>21</sup>; the life expectancy figures ranges from 74 to 75 years, on average. For the five year period, these three provinces have the lowest infant mortality rates.

According to the General Comptroller of the Republic, the estimate for life expectancy at birth, for the five year period 2000-2005, is 74.9, being 77.3 years for women and 72.6 years for men.

#### ▪ **Mortality**

The general mortality rate at the national level in 1980 was of 4.1, and the infant mortality rate for children under one year was 21.7. In 1990, general mortality was 4.1 and infant mortality for children under one year was 18.9. We can see that only the infant mortality figure changes and results in a small decrease.

For the population of the Regional Health Area, the general and infant mortality rates for 1996 are, respectively, 7.8 and 12.9; for the year 1997, 8.8 and 22.1; for 1998, 8.6 and 21.1; for the year 2001, General Mortality is 5.1 and Infant Mortality is 15.1. There is a moderate decrease in the general mortality vs. infant mortality.

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<sup>21</sup> Contraloría General de la República de Panamá. Situación Demográfica. Estadísticas Vitales. Año 1992. Sección 221. Página 7.

Mortality rates for the County of El Chorrillo for the year 2001 are 7.0 for General Mortality and 14.6 for Infant Mortality.

The Regional Health Sector classifies mortality into ten areas, which are shown in Table 4.5.

**Table 4.5. Ten Main Causes of Mortality in the Health Region (R.M.S.) Years 1996 and 1998.**

| AÑO 1996                                |             |            | AÑO 1998                                |             |            |
|---|-------------|------------|---|-------------|------------|
| Cause                                   | Number      | Rate       | Cause                                   | Number      | Rate       |
| Malign Tumors                           | 370         | 66.3       | Malign Tumors                           | 484         | 83.8       |
| Myocardial Acute Infarct                | 331         | 59.3       | Myocardial Acute Infarct                | 426         | 73.8       |
| Accidents, suicides and other violence. | 204         | 36.5       | Cerebral vascular accident              | 257         | 44.5       |
| Septicemia                              | 175         | 31.3       | Accidents, suicides and other violence. | 248         | 43         |
| Bronco-pneumonia                        | 147         | 26.3       | Septicemia                              | 209         | 36.2       |
| Cerebral vascular accident              | 128         | 23         | SIDA                                    | 197         | 34.1       |
| SIDA                                    | 124         | 2          | Bronco-pneumonia                        | 168         | 29.1       |
| Cardio respiratory arrest               | 117         | 21         | Cardiac Insufficiency                   | 138         | 23.9       |
| Pneumonia                               | 88          | 15.8       | Chronic, obstructive lung disease       | 99          | 17.1       |
| Respiratory insufficiency               | 57          | 10.2       | Cardiopathy                             | 87          | 15.1       |
| Other causes                            | 901         | 161.4      | Other causes                            | 544         | 94.2       |
| <b>Total</b>                            | <b>2642</b> | <b>473</b> | <b>Total</b>                            | <b>2956</b> | <b>512</b> |

Source: R.M.S. Data. Proceedings for the year 1996-1998 Department of Planning. Table 11. Page 39.

#### 4.2.2. Housing

**Table 4.6. Important housing characteristics for the county El Chorrillo. 2000 Census**

| Detail                 | Houses  | Dirt floor | No potable water | No electrical light | No radio | No television |
|------------------------|---------|------------|------------------|---------------------|----------|---------------|
| Republic of Panama     | 681,799 | 86,587     | 63,002           | 126,805             | 113,235  | 155,820       |
| District of Panama     | 187,729 | 4,374      | 2,558            | 4,343               | 24,565   | 14,717        |
| County of El Chorrillo | 6,763   | 13         | 1                | 25                  | 1,262    | 467           |

Source: General Comptroller of the Republic de Panama. Census 2000. Volume I. Tomes 2, 3, 4.

According to the 2000 Census figures reported in Table 4.6, the County of El Chorrillo, has a total of 6783 occupied houses. When comparing this figure with the 1990 Census (there were 4667 houses in 1990), there is an increase of 2,116 houses.

With respect to average number of people per household, the County of El Chorrillo (3.3), has a lower average than the District of Panama (3.7) and the national level (4.1). This characteristic in the average number of people per household, lower than the counties for the capital city and the District of Panama,<sup>22</sup> is reflected in the decades since 1970. However, in collective houses, it reaches an average of 104.5 people per house<sup>23</sup>.

Table 4.6. may not be expressing the real level of marginality in the household, for various reasons, including the materials that characterize the house. For instance, although there may not be dirt floors, many households in El Chorrillo have wooden floors in deplorable condition. Another indicator is the number of rooms per house : of the 4,628 existing houses, more than 50% (2678) have one room, 1027 have two rooms, resulting in an average number of 1.7 rooms per house in 1990. The treatment of wastewater is very important in the County since it is related to gastro-intestinal and infectious diseases.

The Urban Development Plan for Metropolitan Areas, stipulates that:

*“In central region of the city, the sewerage system is separated in canals for wastewater and rainwater. Seven collectors discharge wastewaters into the Bay, in the*

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<sup>22</sup> Contraloría General de la República. Censos Nacionales de Población y Vivienda. 1991 Resultados Finales Básicos. Distrito de Panamá. Páginas 24-25.

<sup>23</sup> Contraloría General de la República. Censos Nacionales de Población y Vivienda. 1991 Resultados Finales Básicos. Distrito de Panamá. Página 333.

*area of El Chorrillo, Santa Ana, Calidonia, Bella Vista, San Francisco and Parque Lefevre. The remaining discharge is poured in local rivers.”<sup>24</sup>*

When the data relative to occupied residences is analyzed, it is important to highlight that although the individual permanent residences have increased due to multifamily housing, there are still a number of people who reside in rooms in the area. The housing statistics in 1990, based on the type of house, indicate that there are 658 individual houses (permanent, semi-permanent or improvised), 2107 apartments, 2131 rooms, 6 collective houses and 10 housing units in areas not destined for housing.

With respect to density data, El Chorrillo has the highest population density due to the presence of multifamily units located in this county.

In 1980 there were 2158 individual occupied residences, that did not have electric light; by the year 2000, this situation had decreased to 25 houses without this service.

The Panamanian State, since the middle of the 1940s, has promoted the construction of houses for social purposes, with the first project beginning in 1944, the Renta 1, constructed by the Social Security Bank in El Chorrillo.

El Chorrillo in an urban County, with multifamily buildings, small apartments, that reveal a conceptual deficiency of the housing policy in the county for the districts of Panama, San Miguelito, Colón and the rest of the country. Thus, the population of El Chorrillo can be characterized as a socially, economically and spatially marginalized community.

Within this context, the Panamanian State built in the county of El Chorrillo in 1974 a multifamily residential housing unit known as Barraza (nearly one thousand housing units) and, in 1976, Chorrillo No.1 (approximately 450); during the five year period of 1998-2002, six buildings that house 568 small apartments were built. Gradually these multifamily buildings began to replace the wooden houses that caught on fire throughout the decades and especially during the American invasion in 1989.

At El Chorrillo, housing improvements have been traditionally undertaken by the Panamanian State. Private sector investments in the housing industry have declined. Dr. R. Lachman indicates that the same process will continue: “we do not foresee a qualitative housing development in El Chorrillo as a community”.<sup>25</sup>

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<sup>24</sup> Ministerio de Vivienda. Plan de Desarrollo Urbano de las Areas Metropolitanas del Pacífico y el Atlántico. Informe Borrador. Nov.1997. Página 15-72

<sup>25</sup> Universidad de Panamá. Compilado por el Instituto de Estudios Nacionales. 1990 El Chorrillo, Situación y Alternativas. Artículo: Algunas Consideraciones sobre la Economía de El Chorrillo en la Economía Urbana. Ruben Lachman . 109 páginas.

### 4.2.3. Education

- **Educational Infrastructure**

In the County of El Chorrillo, there are six primary schools, with an annual matriculation, in the year 2002, of 1,327 students. Each one of these schools has six grades corresponding to primary education.

In several of these facilities there is a morning and an afternoon school period.

**Table 4.7. Schools and matriculation for the county of El Chorrillo. Year 2002**

| School Name              | Matriculation |      |       | Teachers |      |        |
|--------------------------|---------------|------|-------|----------|------|--------|
|                          | Total         | Boys | Girls | Total    | Male | Female |
| Infraestructure          |               |      |       |          |      |        |
| José Manuel Hurtado (AM) | 403           | 223  | 180   | NA       | NA   | NA     |
| José Manuel Hurtado (PM) | 269           | 140  | 129   | 11       | 3    | 8      |
| República de Argentina   | 180           | 105  | 75    | 8        | 1    | 7      |
| República de Cuba        | 112           | 64   | 48    | 5        | 0    | 5      |
| República de Perú        | 150           | 76   | 74    | 6        | 0    | 6      |
| República de El Salvador | 207           | 107  | 100   | 8        | 1    | 7      |
| Total                    | 1,327         |      |       |          |      |        |

Source: Ministry of Education, Statistics Department

- **Educational situation**

The net schooling rate is one of the indicators used by the General Comptroller of the Republic for the analysis of educational statistics, and is defined as follows: the proportion of matriculation in adequate ages for each educational level, with respect to the population in adequate age for each level.

The net schooling rate for the year 1999<sup>26</sup> in the country is 94.7 for primary education and 58.9 for middle school education. This primary schooling ratio maintained equivalent levels by gender; this situation varies in middle school as follows: 56% of males, against 61.9% of women, were in middle school.

The rate of desertion is expressed as the proportion of students who, after having begun the year, abandon school without finishing the grade. In 1999, the rate of desertion for primary education at the national level was of 2.0; for middle school education, the official average was of 4.60 and individually it was 1.30

For the year 1990 the General Comptroller of the Republic, indicates that "in the District of Panama, 96% of the population under 6 years of age has some level of

<sup>26</sup> Contraloría General de la República. Dirección de Estadísticas y Censos. Indicadores Sociales. Años 1995-1999. Página 47

instruction, which represents, when compared with figures for 1980, an increase of nearly 2% in the level of instruction in the population<sup>27</sup>.

In the County of El Chorrillo, the population between 6 and 15 years in 1980, that attended primary school or other educational institution<sup>28</sup>, represented 21% of the total population.

In the year 1990, the population of El Chorrillo older than 6 years, which reported a level of instruction, was of 17,997, of which 6,556 attended primary school, 8,600 secondary school, 1273 attended university, 18 a post degree, and nearly 1000 attended vocational school, which represents a positive evolution in relation to the previous decade. The average number of years approved is of 7.8. With respect to other counties of the district, El Chorrillo occupies the lowest levels, comparable to Curundu, Pedregal, Juan Diaz. In this period, the population without education was of 510.

In the year 2000, the population of El Chorrillo of 10 years or older, with less than a third grade education, was of 512 and the illiterate population has decreased from 575 in the year 1980 to 271; in other words, there has been an improvement of 1.49% for the year 2000.

#### **4.2.4. Public and Private Services**

The following services, public and private institutions and organizations can be found in El Chorrillo:

##### Public Services:

- Municipality of El Chorrillo,
- Health Center "Samuel Guillermo Lewis",
- National Police, Area A,
- Fire station "Juan Antonio Guizado",
- National Postal Service,
- Administration for the Amador Cemetery,
- Municipal Library "Nicole Garay"
- Municipal Library "Manuel José Hurtado",
- Library center "Manuel Amador Guerrero", and
- Panamanian Coalition Library.

##### Sports and recreational facilities:

- Basketball court of the Community Board of El Chorrillo

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<sup>27</sup> Contraloría General de la República. Dirección de Estadísticas y Censos. Resultados Finales Básicos del Distrito de Panamá. 1991. página 11.

<sup>28</sup> Contraloría General de la República. Dirección de Estadísticas y Censos. Censos de 1980. Página 99

- Stadium Carlos M. Pretelt (Maracaná)
- Basketball court Calle 27
- Mirador Park,
- Basketball court Carlos A. Mendoza,
- Sports complex Tomasa López
- Gymnasium of Lucha Jesús, “Master Gómez (Barraza)
- Sports Complex “León Cocoliso Tejada (Amador Plaza) and “Los Aburridos” Park.

Private Institutions: Grand Lodge of Panama.

Other Organizations:

- Female Committee of El Chorrillo
- Female Committee of Panama
- Committee of War Refugees of El Chorrillo
- Community Board of El Chorrillo
- Multiple Service Center “Dr. Amadeo Vicente Mastellary”
- National Savings and Credit Cooperative for Retired and Pensioned Workers
- Fisherman Cooperative
- Association of small businessmen of El Chorrillo

With respect to retail establishments, there are more than 100 shops and businesses in the County of El Chorrillo, such as beauty salons, pool halls, bars, supermarkets, stores, workshops, Laundromats, boarding houses, kiosks, pawn shops, tailor shops, libraries, furniture stores, restaurants, bakeries, hardware stores, warehouses, pharmacies, etc.

#### **4.2.5. Cultural Values**

Law No.91 of December 22, 1975, of the National Institute of Culture, which regulates the historic district of the Panama City, stipulates the following in Chapter V:

ARTICLE 37:

“The Historic District of Panama City is enclosed within the following boundaries: from the South to 12<sup>th</sup> Street West, bordering the beach; North up to 12<sup>th</sup> Street West, up the intersection with Eloy Alfaro Avenue; Northeast up to the intersection with the beach, at a distance of approximately 100 meters”.

Law No. 14 of May 5 1982 of the National Institute of Culture, which regulates the custody, conservation and administration of Historic Heritage Sites, stipulates the following in Chapter IV, related to National Historic Monuments and Natural Monuments:

ARTICLE 37:

"Areas or urban spaces such as streets, plazas, neighborhoods, walls, fortresses, ruins or similar landmarks can be qualified or declared national monuments if their history is connected to important events in national history."

ARTICLE 39:

"The National Directorate for Historic Patrimony should approve beforehand all projects or works conducted in areas adjacent to a national or historic monument, with the objective of preventing its deterioration or damage."

The consultation conducted on this theme in the National Institute of Culture (National Directorate for Historic Patrimony),<sup>29</sup> about the limits of the area denominated Historic Monument of the Casco Antiguo, concluded that El Chorrillo borders this area, but does not have historic infrastructure; its Caribbean architecture has nearly disappeared, being the reason why it is not considered a historic heritage site, with the exception of the stone walls of El Chorrillo. These walls were part of fortifications built during the colonial period for the protection of the population against pirates. Two walls were built, one towards the East, Balboa Avenue and Paitilla, and the other towards El Chorrillo and the area of the Bridge of the Americas.

### 4.3. Economic Activity

The economic activities of this county are concentrated, as is natural in retail and services. Of the existing companies, the retail sector represents 40% of all businesses, employs 22%, represents 19% of remunerations and concentrates 46% of income. Businesses such as hotels and restaurants represent 26% of businesses, 20% of employed population, 12% of paid remunerations and concentrates 16% of income (See Table 4.8.).

Fishing is an important economic activity in the county of El Chorrillo, not only because it provides income to the families of fishermen, but because it also contributes to maintaining a traditional activity of sales of fish and fried fish conducted by women. Moreover, fish is bought by residents at a more inexpensive cost among the members of the Fishermen Cooperative.

The sale of fried dishes and fish, in addition to street sales, shoe repair, tailoring and other domestic activities such as cleaning houses, are part of the labor supply of the population of El Chorrillo, which absorbs part of the demand of the capital city.

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<sup>29</sup> Profesor Balbino Soo. Entrevista realizada el 7 de abril de 2003.

**Table 4-8. Number of businesses, staff employed, remunerations and total income in the County of El Chorrillo. August 1999.**

| COUNTY AND CATEGORY OF ECONOMIC ACTIVITIES | No. OF BUSINESSES | STAFF EMPLOYED | REMUNERATIONS (B/.) | TOTAL INCOME (miles de B/.) |
|--|-------------------|----------------|---------------------|-----------------------------|
| DISTRICT OF PANAMA                         | 15,149            | 188,925        | 118,932,615         | 16,394,182                  |
| EL CHORRILLO                               | 221               | 525            | 195,865             | 11,795,502                  |
| Exploitation of mines and quarries         | 1                 | -              | -                   | -                           |
| Manufacturing industries                   | 14                | 78             | 73,955              | 1,789,014                   |
| Retail                                     | 87                | 117            | 37,004              | 5,444,142                   |
| Hotels and restaurants                     | 57                | 107            | 23,482              | 1,980,130                   |
| Transportation, storage and communications | 3                 | 18             | 5,040               | 285,979                     |
| Financial intermediation                   | 1                 | -              | -                   | -                           |
| Real estate and rentals                    | 5                 | 14             | 4,250               | 376,851                     |
| Instruction                                | 5                 | 65             | 20,445              | 555,852                     |
| Social service and health activities       | 5                 | 13             | 3,240               | 74,988                      |
| Other activities and services              | 43                | 55             | 14,300              | 659,226                     |

**Source:** Housing and Population Census, 1999, Division of Statistics and Census, General Comptroller of the Republic.

### Income

Around 21% of the 10 years and older population employed, has incomes up to 174 Balboas per month; 68% of the population has monthly incomes that range between 175 to 599 Balboas; and less than 7% of the employed population has incomes between 600 to 3.000 Balboas per month. In other words, 90% of the population has incomes under 600 Balboas per month.

**Table 4.9. Levels of monthly income for employed population older than 10 years, county of El Chorrillo. Census 1990 and 2000**

| INCOME LEVEL  | NATIONAL TOTAL | 1990  | 2000  | %      |
|---------------|----------------|-------|-------|--------|
| COUNTY        | 200,781        | 6,171 | 8,379 | 100.00 |
| No income     | 7,755          | 254   | 108   | 1.29   |
| Less than 100 | 24,088         | 949   | 710   | 8.47   |
| 100 to 124    | 12,291         | 404   | 486   | 5.80   |
| 125 to 174    | 17,208         | 784   | 535   | 6.39   |
| 175 to 249    | 28,525         | 1,144 | 1,763 | 21.04  |
| 250 to 399    | 39,388         | 1,544 | 2,712 | 32.37  |
| 400 to 599    | 26,089         | 606   | 1,288 | 15.37  |
| 600 to 799    | 12,540         | 178   | 319   | 3.81   |

|                                |       |       |       |      |
|--------------------------------|-------|-------|-------|------|
| 800 to 999                     | 6,958 | 65    | 141   | 1.68 |
| 1000 to 1499                   | 8,268 | 38    | 93    | 1.11 |
| 1500 to 1999                   | 4,172 | 4     | 22    | 0.26 |
| 2000 to 2499                   | 2,613 | 6     | 13    | 0.16 |
| 2500 to 2999                   | 1,105 | -     | 4     | 0.05 |
| 3000 and more                  | 2,729 | 12    | 8     | 0.10 |
| Not declared                   | 7,062 | 183   | 177   | 0.02 |
| Median of monthly income (B/.) | 291.4 | 222.9 | 280.6 |      |

**Source:** Housing and Population Census, 1990 and 2000, Division of Statistics and Census, General Comptroller of the Republic.

#### 4.4. Planning and zoning of the area

##### Policies for Urban Development by the Ministry of Housing

The Urban Development Plan of the Ministry of Housing, classifies El Chorrillo<sup>30</sup> in Sector No.1 of the urban area, and indicates that this sector is comprised of the counties of San Felipe, El Chorrillo, Santa Ana, Calidonia or Exposición and Curundú partially, up to Martín Sosa Street. These counties share a common history with respect to origin and growth of the city and present similar structural characteristics by sub-sector, mainly including low income families.

The following objectives are established for Sector No.1 of the urban area:

- a) Preserve the historic patrimony of the city
- b) Confront urban decay present in the area.

For the historic district, a preservation and rehabilitation strategy has been proposed, to maintain the densities and urban scale present in the area. The urban image of this area requires special attention to preserve these prevailing characteristics, without lessening its historic value.

For the counties of El Chorrillo, Santa Ana, Curundú and part of Calidonia, urban renovation and rehabilitation is proposed, with the purpose of improving areas characterized by a high degree of urban decay.

<sup>30</sup> Ministerio de Vivienda. Plan de Desarrollo Urbano. Informe Borrador. Volumen II. Plan de Desarrollo Urbano. Panamá, noviembre de 1997. Página 16-45

## 5. DEVELOPMENT FORECASTS FOR THE DIFFERENT AREAS

### 5.1. Site of “Palo Seco” and area of influence

In the analysis of this site, it is necessary to integrate an important part of what is known as “Western Panama”, specifically the districts of Arraiján and La Chorrera, in addition to what is denominated “Western Ancon” by the *Urban Development Plan for Metropolitan Areas in the Pacific and Atlantic (MIVI)*; some of the most important areas considered include Howard, a zone which presents great economic potential. According to the Plan, Western Arraijan is an area that can take off economically due to the development of Howard, and in the communities of Vacamonte and Cáceres. In the area of Western Ancon, it is estimated that more than 113,268 jobs will be created by the year 2020, with retail representing 10%, the service sector 63% and the industrial sector 27%.

The development of this area is also favored because it has docks and nearby beaches; in addition, the roadway leading to the Bridge of the Americas will be expanded towards Arraijan, which will increase the possibility to develop areas related to tourism and support services for the Canal activities, as well as retail and industrial activities in Howard”

The region of Western Panama includes the base area of Howard, which is a zone with great potential as an air transport center, which generates a great degree of expectation to create a multimodal transportation system that can connect railroads to the Arraiján-La Chorrera highway and Panama City; in addition, it can connect the North and South Corridors of the Panama-Colón highway.

Focus of growth: in the region of Western Panama, La Chorrera is the area with greatest development potential. One way to contribute to this development would be to provide incentives to tourism, since the district is located very close to some of the most popular beaches in Panama, namely Coronado, Gorgona, Punta Barco and Punta Mala, among others. In other words, the entire Zone 4 as per the Tourism Plan (IPAT). Another form of tourism which can be promoted in this region, due to its access to the Canal Zone, is tourism to the lake, which can be used for fishing, water skiing, eco-tourism, etc. In addition, La Chorrera offers an entry door to the Natural Parks.

Howard is linked to the development of La Chorrera and all the Western Panama Region, which is destined to become an important international airport and export zone. This economic potential for La Chorrera, and Western Panama in general, will allow the area to grow, with greater sources of work and income, which will contribute to shift La Chorrera from being a bedroom community in the future.

Table 5.1. presents forecasts to the year 2020, for number of jobs that are expected to be created. As can be seen, the service sector occupies the first place. For La Chorrera, the sector which can provide most employment is commerce (48%), followed

by the service sector (37), and finally industry (16%). In the case of Arraijan, the most important sector is commerce (57%), followed by industry (25%), and finally services (17%). The area of Western Ancon, including Howard, is estimated to generate 113,268 jobs in which the service sector will contribute 63%, followed by the industry sector with 27%; and finally retail with 10%. (See table 5.1.).

## 5.2. Site of “El Chorrillo”

The County of El Chorrillo, in contrast to the neighboring areas of “Palo Seco”, and according to the Metropolitan Urban Development Plan, presents a low level of growth. As can be seen in Table 5.1., up to the year 2020, it is estimated that it will create around 4,500 jobs, with retail businesses accounting for 42%, the service sector 41% and the industrial sector 17%.

**Table 5.1. Distribution of employment in the metropolitan areas by economic sector, year 2020**

| AREA          | TOTAL   | INDUSTRY |      | RETAIL |      | SERVICES |      |
|---------------|---------|----------|------|--------|------|----------|------|
|               |         | Jobs     | (%)  | Jobs   | (%)  | Jobs     | (%)  |
| Eastern Ancón | 113,268 | 30,367   | 0.27 | 11,846 | 0.10 | 71,055   | 0.63 |
| Western Ancón | 113,268 | 30,367   | 0.27 | 11,846 | 0.10 | 71,055   | 0.63 |
| Arraiján      | 25,628  | 6,484    | 0.25 | 14,672 | 0.57 | 4,472    | 0.17 |
| La Chorrera   | 85,812  | 13,504   | 0.16 | 40,824 | 0.48 | 31,484   | 0.37 |
| El Chorrillo  | 4,543   | 750      | 0.17 | 1,872  | 0.41 | 1,922    | 0.42 |

**Source:** Metropolitan Urban Development Plan. MIVI.

## 5.3. Site T4-Summit Golf

The areas of Paraíso and Pedro Miguel are part of Eastern Ancon according to the Metropolitan Urban Development Plan; it is estimated that they will undergo an important development process, very similar to that of Western Ancon, where the service sector will account for 63% of jobs, industry will account for 2% and retail businesses for 10%.

## **6. CONCLUSIONS**

From the social and economic point of view, sites vary with respect to the interests in play. In this framework, the following conclusions have been made :

### **6.1. Site of "El Arado"**

- "El Arado", is a site very close to the largest community in the county known as Rio Congo, and this could be an important factor in the utilization of this site.
- The most important pressure or resistance for the use of "El Arado" could come from the owners of livestock and chicken farms. It is likely that the community will unite with these farmers, since they are their source of employment.
- Another source of opposition to the project could be the communities of La Chorrera and the District of Arraiján (Nuevo Emperador, Nuevo Chorrillo, etc.); these communities could become important allies of the farmers and actors previously mentioned.
- In order to contribute to the viability of the Project, it would be necessary to implement compensation measures for the actors involved, which could contribute to improving the standard of living through improvements in infrastructure such as roadways, electricity, health facilities, schools, etc.

### **6.2. Site of "Palo Seco"**

- "Palo Seco" can be important for certain national sectors, such as the Association for Retired and Pensioned Workers, and the Association for the Elderly, among others, since it is a site with a tradition of serving the elderly and it is surrounded by optimal environmental conditions to promote good health.
- According to the Regional Plan for Land Use (Law 21 of July 3, 1997) of the Inter-Oceanic Regional Authority (ARI), the area where this site is located was designated for "urban centers" and "community centers". This site, according to the Plan, will be used for urban, tourism and recreational facilities. Therefore, the goals established in the Plan can be an important constraint to this Project.

### 6.3. Site of “El Chorrillo”

- The use of this site would create problems for the fishermen, organized under the *Cooperative of Fishermen of El Chorrillo*, whose members have a fishing tradition of over 30 years. The dredging project would fill up fishing area and force them to leave the area and remove their base of operations.
- Without any doubt, the Cooperative will be the first force to oppose the Project, and the community of El Chorrillo would be its natural ally, since the fisherman are members of this community.
- The project could be viable if the fundamental problem presented is resolved for the fishermen: get within the landfill area, an adequate site with exit to the sea, so the Cooperative can resettle its facilities, and maintain, at a minimum, current conditions.
- As an attractive action to make the Project viable, the landfill can be used for social works for community benefit, such as the development of recreational facilities for children, youth and the elderly, or training facilities (sewing, arts and crafts, or another financial sector that contributes to fill in community needs.) The area can also be developed as a tourist attraction to promote visit to historic forts built during the colonial period.

## **7. EXPERT OPINIONS ON OTHER MULTISITES**

The opinion of experts on the possible impact over the rest of the sites considered as options for the deposit of dredged materials is presented below. The conclusions about site M5 – Artificial Island, use the socioeconomic report developed during Phase I.

### **M1 - MARINA CITY**

This option would affect the entire commercial area located along Balboa Avenue. This is an area of great tourist attraction, and includes a shopping center, restaurants, cinemas and other amenities. The Ciudad Marina option would affect this attractive source of income for entrepreneurs. Sectors and actors involved around this area of Panama City, have a high capacity to generate public opposition to projects that can affect their income through the media, having also strong connections among politics decision-makers.

Existing premises would experience a decrease in the real state value (land and building). The same Boulevard would loose value as a recreational area (during the afternoon tourist circulate through the sector), replaced by another boulevard outside the new perimeter created.

It would be necessary to undertake a complete evaluation of the impact generated, which would include consultations with visitors and locals, including the evaluation of the scenic views.

### **M 3 – AMADOR**

An increase of the Amador Causeway could generate a favorable response from public opinion, since it would satisfy a need felt by the visiting community (national and international).

Some of the benefits expected could include improvements in the waterfront walkway, which would increase the number of visitors to events that may be organized in the future, since visitors currently do not attend events due to complications associated with traffic and parking. In addition, the land from the disposal would be an opportunity to establish other businesses, although the main need would be to improve traffic condition and create parking areas.

Therefore, a positive response is expected both from the population as well as the financial entities affected (retail and tourism), and by the Income Division of the Ministry of Economy and Finance, and the Treasury of the Municipality of Panama, for taxes collected from business growth.

However, structured interviews and consultations are recommended both for visitors and the economic sectors affected (surveys and questionnaires).

#### **T 1 – RIO MANDINGA**

There are eco-tourism activities organized by the Gamboa Resort, which carry visitors through the Mandinga River. The company does not have rights over these waters which are under the jurisdiction of ACP. Therefore, there could be a loss in service resulting from the closure of access used by the boats, but no resistance from the hotel owners, since the river Mandinga is outside the concession area.

#### **T 4 – SUMMIT GOLF**

Given the existing topography in the golf club and the site of disposal, with a large hill in between, the negative effect of disposing of spoil material would have a small impact. The club is an exclusive recreation center, and therefore changes resulting from noise, excess dust, visual impact and other effects caused by the blasting activities could affect this business; there is a topographic barrier, however, that would minimize the negative effects.

The access road to the club would be affected by the transportation of the excavated material, causing inconveniences for the users; it would also impact those people using the roadway as a corridor between Panama and Colon, especially during the morning and afternoon rush hours. The difficulty in the use of this corridor would congest the other two alternative routes between both cities (Transistmica Roadway and North Corridor).

#### **T 9 - RODMAN**

Based on information provided by ARI, the areas of Rodman and Cocoli have been under concession by private international companies for industrial use. Therefore, it is not an area with residents.

With respect to the alteration or changes caused to activities conducted in the Horoko golf field, the same recommendation given for site T4 -- Summit Golf, holds true, with the exception that in the Rodman case, the Inter-American Highway would be affected. This would impact those people using this highway daily to work in the capital (especially those coming from the central provinces of the interior such as La Chorrera and Arraiján). However, it is likely that materials would be transported from the dredging site to Rodman using a shorter route, which would not require the use of the Inter-American Highway.

#### **M 5 –ARTIFICIAL ISLAND**

Certain sectors will see this project as having a negative impact affecting either their economic condition or social status. Other sectors will see it in a positive way:

- In Amador, the modification of the surroundings can change the attractiveness of the site; a decline or increase in real estate value could be expected. This trend cannot be defined without additional studies, such as direct surveys for contingency analyses; these studies could assist in the evaluation of the visitors' perception of the project. Previous sections of this study have shown a significant investment in the tourism development of this peninsula. Any project affecting the landscape of this area will have a dramatic impact on the value of real estate. On the other hand, many projects of this nature have been used to attract tourism and development. Therefore, structured interviews should also be implemented, addressing the different economic sectors implicated (real estate, tourism, commerce).
  
- Of the evaluated coastal communities Bique could be the most affected because the local natural resources (e.g. clams artisan fisheries) are their primary source of income. Therefore, any adverse effects on these resources (e.g. decline in abundance) will directly affect these communities since they base their economy on subsistence fishing activities.
  
- The tourism sector of Taboga might be affected in a similar way that Amador. Further studies are needed with the goal of assessing the perception of the main economic sectors implicated. The information would be collected through application of structured interviews.
  
- Increased employment in areas such as Veracruz and Taboga Island communities could be expected as a consequence of the creation of thousands of new jobs in the island complex, and could lead to urban expansion and improvement in both places.
  
- The economic and urban improvement of the residents of Veracruz and Taboga will produce a secondary labor wave associated with the increased need for new schools, food centers, and recreational activities.

**APPENDIX F - ACP WORKSHOP – SEPTEMBER 2000**

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Workshop 4  
Pacific Area Development Project  
Dredged and Excavated Dry Materials

Panama Canal Authority  
Canal Capacity Projects Office  
Ascanio Arosemena Training Center  
8 a.m. to 12 p.m. - November 21, 2000

## Questions and Scenarios

### Question

How can we take advantage of the 24 to 28 Mm<sup>3</sup> of dredged material and the 45 to 83 Mm<sup>3</sup> of material resulting from the construction of new Post-Panamax-size locks and the deepening and widening of the Pacific entrance to the Panama Canal? State benefits of each option.

Consider or identify the following:

- Existing and potential deposit sites
- Advantageous uses of material for other activities
- Environmental impact
- Impact on present Canal operations
- Costs, including that of equipment, or special requirements
- Innovative ideas (No idea must be ruled out)

## Summary of Ideas

### **The following ideas were gathered in response to this question:**

All groups agreed that ACP could benefit economically from the material resulting from dredging and dry excavation. Selling the reclaimed land or giving it in concession may help ACP effectively recuperate costs.

The dredged and excavated materials may be used to carry out the following projects:

#### **Developing Islands**

- An island south of the Venado Island may complement the multi-modal center in Howard by a causeway or bridge connecting the island to the south of Howard.
- An island east of the Venado Island and north of Tortola Island joined to the mainland by a causeway.
- An island toward the south of Farfan with sufficient draught to accommodate Post-Panamax vessels. It should be taken into account that the geographic location of this island must not interfere with the natural flow of currents originating from the east or from the Bay of Panama.
- An island between Howard and the Canal Anchorage for the following uses: port, eco-tourism, or residential if linked to the mainland by a road built on pilings.
- Material may be transported by a railway, which would subsequently be reused for the trans-shipment center to be located on the new island.

#### **Fills**

- The area south of the Rodman pier to expand pier activities and develop ports. It was also suggested to reserve this area as a disposal site when performing maintenance on the navigation channels. A landfill north of Rodman might obstruct access to Disposal Site W11, and one south of Rodman might affect the drainage of W11 and the Farfan River.
- Area south and next to W11.
- The southern section of Chorrillo, Chorrillo Bay, and east of the Amador Causeway.
- The southeast area of Farfan

- The area along Palo Seco--to develop artificial reefs or tourism activities
- The coast between Casco Viejo and Punta Paitilla would solve vehicular traffic problems, but it would be politically difficult to implement.
- The Bay of Panama; part of the pollution problem of this area would be solved; however, it would affect the Yacht Club and the Miramar Hotel. This fill would require the installation of sewerage drainage.
- The western region of the Paraíso tie-up station.
- Military Firing Range contaminated land areas.

### **Other uses**

- Sell the material for the development of new housing areas in Arraijan, the construction of service roads and bridges for the operation of the Canal.
- Use the area west of W3 as a temporary holding site for dredged material, until it is sold.

### **Environmental Impact**

- All fills may cause problems to the marine fauna and flora

### **Impact on Canal Operations**

- A railway system could be established to transport the material from the fills, depending on its location.
- For some alternatives, the use of conventional equipment such as barges and towboats may be required.
- Preserve some disposal sites such as Victoria and Velásquez to deposit material generated from the maintenance of the Pacific Entrance.

## Results of discussion of the question

The Government of Panama's environmental office (ANAM) and the Interoceanic Region Authority (ARI) have identified protected areas, such as the Farfan and Palo Seco areas, that may not be used as fill sites. The new islands must be at least 3 kilometers from the mainland to avoid impacting the protected areas. The landfill in Gatun Lake where the Canal Dredging Division is now headquartered was mentioned as an example of coexisting with the environment without causing negative impacts.

The importance of consulting the ARI Land-use Plan before undertaking any landfill or Land-use project was mentioned. The Panama government is also making plans for developing the Pacific sector, and ARI will have to be consulted to efficiently coordinate these projects.

Members of the ACP Corporate Planning Department said that three large shipping companies have shown interest in creating islands to the west of the Pacific entrance to the Canal and developing them as container ports. Therefore, there is much potential for dredged and dry excavation material to be used in creating islands.

## Workshop 4 Participants

| <b>Name</b>            | <b>Position</b>              | <b>Floating Equipment or Office</b>                        |
|------------------------|------------------------------|--|
| Adriano Díaz           | Manager                      | <b>Dredging Division</b>                                   |
| Peter Marotta          | Acting Captain               | <b>CHRISTENSEN</b>   |
| Javier Bolívar         | Chief Engineer               |  |
| Jay Gibson             | Acting Captain               | <b>MINDI</b>   |
| Antonio Regist         | Chief Engineer               |  |
| Carlos Reyes           | Manager                      | <b>THOR</b>  |
| Leonidas McClean       | Acting Captain               |  |
| Luis Castellero        | Chief Engineer               |  |
| Ricardo Pérez          | Officer                      |  |
| Marco Collazos         | Manager                      | <b>Support Section</b>                                     |
| Ricardo Sandoval       | Manager                      | <b>Tugboat Operations</b>                                  |
| Eugenio Martínez       | Captain                      | <b>Tugboat</b>   |
|                        | Coordinator for Dredging     |  |
| Luis Santanach         | Projects                     | <b>Dredging Division</b>                                   |
|                        | Technical Engineer, Dredging |  |
| Dinnik Salerno         | Projects                     | <b>Dredging Division</b>                                   |
| Liriola Sandoval       | Manager                      | <b>Engineering Section</b>                                 |
| Gustavo Rivas          | Engineer                     |  |
| Itzel Ulloa            | Civil Engineer               | <b>Budget</b>  |
| Agustín Arias          | Manager                      | <b>Canal Capacity Projects Office</b>                      |
| Yolanda Chin           | Navigation Team Leader       |  |
| Hortensia Broce        | Environmental Team Leader    |  |
| John Gribar            | Consultant                   |  |
| Luis Alfaro            | Manager                      | <b>Engineering Department</b>                              |
| Max De Puy             | Manager                      | <b>Geotechnical Section</b>                                |
| Rolando Rivera         | Civil Engineer               | <b>Division of Research and Projects</b>                   |
| Virgilio Mirones       | Civil Engineer               | <b>Outdoors Maintenance Section</b>                        |
|                        |                              | <b>Environmental Management Division</b>                   |
| Mario Him              | Environmental Specialist     |  |
| Daniel Francis         | Environmental Specialist     |  |
| Chet Lavalas           | Manager                      | <b>Pilots Section</b>                                      |
| Miguel Rodríguez       | Manager                      | <b>Board of Local Inspectors</b>                           |
|                        |                              | <b>Managerial Resources and Investment Program Section</b> |
| Ilya Marotta           | Manager                      |  |
| Velda Blencowe         | Technical Writer/Editor      | <b>Canal Capacity Projects Office</b>                      |
| Susan Harp             | Technical Writer/Editor      |  |
| Kathleen Chung         | Secretary                    |  |
| Gaby Russo             | Secretary                    |  |
| Sandra Ubben           | HR Development Specialist    | <b>Human Resources Department</b>                          |
| Marianela de la Lastra | HR Development Specialist    |  |

## Workshop Groups

### Group A

J. Massot  
L. Sandoval  
R. Sandoval  
B. Moreno  
H. Broce  
D. Broce  
D. Carles

### Group B

A. Díaz  
C. Contreras  
R. Delgado  
C. Reyes  
E. Sánchez  
R. Rivera  
Y. Chin

### Group C

C. Kiamco  
W. Luschinger  
P. Marotta  
R. Pinilla  
G. Saarinen  
J. Gribar

### Group D

A. Arias  
L. Santanach  
M. Collazos  
A. Spadafora  
E. Márquez  
P. Baquero

## Presentations

### Group A

Spokesperson: Ricardo Sandoval

#### **Existing site**

After considering the sites on the west bank that were the military firing ranges, we decided to leave those sites alone for the moment and consider other alternatives. The area just south of the Rodman pier installation could be filled in and used to expand pier operations at Rodman. At the site further south, the existing areas could be expanded and developed as a port.

On the east side of the Canal, we think the areas south of Chorrillo and to the east of the Causeway have potential for filling and reclamation. There would be room for approximately 33 million cubic meters.

If we used the area southeast of Farfan in the bay, we could solve all the transportation problems, because everything could be deposited at just one site. We estimate that a 12,500-hectare surface area, taking the ocean depth into consideration, could receive all the material (110 million cubic meters). As for transportation, it is not cost-effective to use trucks. We could install a railway system to take the material to the area. A large area of land could be filled, reclaiming about 13.75 million square meters.

For recuperating costs, we estimate the reclaimed land value at about \$50 a square meter, so we could recuperate about 40 percent of the costs – that is \$300 million of costs that could be recuperated.

#### **Environmental impact**

What impact would the reclaimed land or an island in the bay have on the surrounding environment? Considering the natural current flow, we would locate it far south to line up with Flamenco Island and the current flow, so sediment deposits would not be a problem. Rather, the sediment would follow the natural current flow.

To the east of the fill, currents would follow their natural course and the material would flow outward (to the south). In terms of development, the site could be developed as a port. We think it could be placed at the southernmost point to coincide with the 10-meter contour (for the ocean bottom) to accommodate ship draft. Ships could come into the port and use a multi-modal system that would have to be developed in the area.

## **Cost**

The costs of the equipment needed to transport the material would have to be taken into consideration. We think the environmental impact would not cause great problems at the deposit site, but a more detailed study would have to be made.

## Presentations

### Group B

Spokesperson: Rolando Rivera

#### **Island development**

- Located south of Venado Island
- Complementary to the Howard multi-modal center
- Would have a causeway or bridge connecting the island with the mainland
- Size – 200 to 400 hectares
- Volume–32 million to 64 million cubic meters of material. The volume could be increased
- Transportation–use a railway system to transport the material, and the same system could be used after construction to benefit the trans-shipment center that would be located on the new island

#### **Deposit site to the west of the Paraiso tie-up station site (note–the tie-up station was recently removed to make room for two-way Panamax traffic)**

- Includes an area containing unexploded ordnance (old military firing range). We might not be able to use it because it is located close to the new locks construction site.
- Benefits–located near the Canal and it would resolve a diplomatic problem with the United States (cleanup of the firing range) by covering the firing range with fill.
- Area–150 hectares
- Volume 37 million cubic meters
- Environmental impact—minimal because there is no forest in that area

#### **Landfill south of Rodman next to the W11 site**

- Since the area will only hold a small volume, perhaps it would be better to not use these areas and keep them for depositing material that results from maintenance of the Canal Pacific entrance. Use of the northern site would obstruct access to site W11, and use of the southern area would affect drainage of W11 and the mouth of the Farfan River

### Expansion of the Amador Causeway

- Volume – 2 million cubic meters
- Location – toward the bay (east of the causeway)
- Includes – filling the inlet by Chorrillo

### Sale of excavated material to develop areas on Canal west bank

- The material could probably be used in the town of Arraijan to develop new residential areas

### Fill in the Panama City Bay (along Balboa Avenue)

- Volume–12 million cubic meters
- Impact–the yacht club and the Miramar Hotel
- Would involve–installation of drainage, high cost of transportation

#### Developing deposit sites east of the Pacific entrance to the Canal:

| Site            | Area (Hectares) | Height of fill (meters) | Volume (Million cubic meters) |
|-----------------|-----------------|-------------------------|-------------------------------|
| W1              | 9.46            | 4                       | .38                           |
| W2              | 10.76           | 2.5                     | .27                           |
| W3              | 67.25           | 4.8                     | 3.23                          |
| W4              | 86.73           | 3                       | 2.6                           |
| W5              | 23.69           | 3                       | .71                           |
| W6              | 85.69           | 3                       | 2.57                          |
| W7              | 30.68           | 3                       | .92                           |
| Island          | 200/200         | 1.6                     | 32M / 64 M                    |
| Bay             | 250             | 6                       | 15                            |
| Campo           | 60              | 5                       | 3                             |
| Rodman South    | 100             | 6                       | 6                             |
| Amador Causeway |                 |                         | 2                             |
| Firing range    | 150             |                         | 37                            |
| Bay             | 200             | 5                       | 12                            |
|                 |                 |                         |                               |

## Presentations

### Group C

Spokesperson: Walter Luchsinger

#### **Potential deposit sites:**

##### **Site south of W7 and the Rodman pier**

- Advantage: Has an economic potential for helping the Mobile company expand its ship bunkering terminal at Rodman
- Disadvantage: Not large enough to handle all the material that will be excavated

##### **Site next to W11 where the Farfan River flows into the ocean**

- This site has economic potential for development of a port on the west bank of the Pacific entrance to the Canal

##### **New island east of Venado Island and north of Tortola Island, connected to the mainland by a causeway**

##### **Amador Causeway**

- Use the filled area for urban development

##### **Contaminated areas to the west of W1 and W2, in the old firing ranges**

- Deposit 285 Mm<sup>3</sup> would cover all of the areas contaminated with unexploded ordnance. Could put an urban development on the site.

##### **Area west of W3**

- Temporary deposit: could be used to store excavated rock until it can be sold and hauled away

##### **Coast between Casco Viejo and Punta Paitilla**

- Disadvantage: politically, any land reclamation there would be very difficult
- Advantage: Land reclamation would solve some existing city traffic congestion
- Environmental Impact
- Areas 1, 2, and 7 (of the sites mentioned above) have marine life that could be impacted
- Impact on Canal operations
- Transportation of excavated material: a railway system would have to be used to access areas 1, 2, and 3
- Barges would be needed to access sites 4 and 7

**DISCUSSION WORKSHOP ON FUTURE DREDGING PROJECTS**

**Compendium of Workshop 4: Project Development in the Pacific Sector**

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- A fill site at Area 1 might have some impact on Canal operations or on the new locks
- Costs
- Area 5 would have low transportation costs because it is near the construction site
- Area 3 and perhaps Area 4 would have a high value for sale or concession of the land

## Presentations

### Group D

Spokesperson: Jorge Solís

|                           | Alignment P1             | Alignment P2         |
|---------------------------|--------------------------|----------------------|
| <b>Depth:</b>             | 9.5 km                   | 9.2 km               |
| <b>Excavation volume:</b> | 70M m <sup>3</sup> + 20% | 37M m <sup>3</sup> + |
| <b>Total Cost:</b>        | \$660M ++                | \$830M +             |

### **Proposed uses of the dredged/excavated material.**

**Make an off-shore island between Howard and the Canal anchorage for the following possible uses:**

- Ports
- Eco-tourism
- Residential (connected to the mainland by a road built on pilings)

**Urban development in the area of the Amador causeway**

**A landfill in the Bay of Panama on which to build a park**

**Sale of the raw material in concession (at Farfan, Velásquez)**

**A coastal landfill along Palo Seco for**

- Artificial reefs
- Tourism development

### **Use as fill for the construction of ACP service roads and bridges in support of Canal operations**

Note: The Victoria and Velásquez sites must be set aside to later receive material dredged during regular maintenance of the Panama Canal entrance.

### **Costs**

Projects located at the Canal entrance would entail transportation expenses, and the transportation expense for filling the area across from Paitilla would be prohibitive.

## Discussions and comments

AGUSTÍN ARIAS, director of the Canal Capacity Projects Office, opened the workshop with introductory comments and stressed the importance of including a plan for using the dredged material to develop the Pacific sector in the Canal expansion dredging plan. He emphasized the importance of using both ARI and ACP information in order to develop reverted areas and the Pacific sector. Members of the Canal Capacity Office and Heritage Lands Administration Division also make short presentations.

### **Presentation by César Kiamco, Locks Studies, Canal Capacity Office**

KIAMCO presented a summary of Canal Capacity Office in-house studies. He presented the proposed alignments for the new locks and a cost estimate for their construction

#### **Question**

ROGELIO PINILLA : How will the retaining wall for the other lane be built? (the dividing wall needed to separate the new locks from the lower-level Miraflores Lake.)

RIGOBERTO DELGADO explained in general how the wall would be constructed.

### **Presentation by Gladys Saarinen, of the Lands Management Office**

SAARINEN explained the difference between (1) patrimonial lands for Canal operation, (2) inalienable areas, and (3) compatible areas. She also commented on the sites on the of the Canal west bank where material may be deposited, on the former military firing ranges and on areas that have already been granted in concession for other uses. SAARINEN also discussed development plans for Corozal West.

#### **Discussion**

AGUSTÍN ARIAS: Explained that there are protected wild areas (in Howard and Farfan) that ARI will turn over to ANAM, as well as another area that ARI is promoting for use as a multi-modal transport center at Farfan, on the west bank of the Canal at Farfan.

PATRICIA BAQUERO: The construction costs for the new locks – does the figure include the value-added benefit? Does it include the cost of a fourth lane for ship traffic?

Answer: The figure includes only construction costs – no benefit from the use or sale of dredged material has been taken into account, and the costs are for building a third lane of locks only (not a fourth).

CÉSAR KIAMCO: Asked for comments on the use of land on the west of the Canal, and on the location of the lands contaminated with unexploded ordnance.

RIGOBERTO DELGADO replied: I checked the W1 – W11 and they do not encompass any of the contaminated areas.

WALTER LUCHSINGER: What is the basis for estimating the quantity of material that may be deposited at these sites?

Discussion, the question was not answered.

CARLOS CONTRERAS: How should we estimate the total cost for dredging to include transportation to the deposit site?

Answer: We estimate dredging and blasting between \$18 and \$20 a cubic meter. Without blasting it should be \$10 a cubic meter. Dry excavation costs between \$3 and \$3.50 a cubic meter. Excavation with the ACP excavator is between \$5 and \$6 a cubic meter, plus blasting which costs \$3 a cubic meter.

**What is the value of the excavated material?**

RIGOBERTO DELGADO: We do not know – it depends on the demand. The ICA construction company is paying \$1 a cubic meter for landfill material for the Punta Pacífica project. The other cost is for transport of the material, which depends on the distance to the deposit site.

CARLOS CONTRERAS: Have you done any study of the projects planned for the next 10 years in order to estimate a market for the material?

AGUSTÍN ARIAS: Arias reviewed a few proposed projects, but said that you cannot be sure that these projects will develop because several large projects have already been cancelled, such as the tourism development project in Amador.

ALIDA SPADAFORA: Are the deposit sites in the bay under water, or would they be higher than sea level?

They are potential deposit sites and they would rise above sea level.

PATRICIA BAQUERO: The Canal has always developed independently of Panama. I think any alternatives for use of the material should be integrated with government plans.

ROGELIO PINILLA: Why is there a distinction between dredged and excavated material?

AGUSTÍN ARIAS: The methods of excavation and their costs are different.

ALIDA SPADAFORA: The areas that still have capacity for material, can they be developed after they are filled?

LUIS ALFARO: If the material is not contaminated, yes, they might be, but it would depend on the cost.

PATRICIA BAQUERO: The ACP should have a long-term land-use plan like ARI's. How do we know whether the areas we are designating as landfills will not obstruct the development of other ARI projects?

GLADYS SAARINEN: The areas designated as compatible with Canal operations, could initially be used for expansion of the Canal, or they could be used for other activities that are already contemplated in the ARI Land-use Plan. The areas are identified in a general manner, and may be zoned for various activities.

LUIS SANTANACH: The dredging deposit sites are located within Canal operation areas.

WALTER LUCHSINGER: If the Canal is planning a development in the areas of compatibility that is not for Canal operations, would the ACP maintain control over those lands?

GLADYS SAARINEN: Only if it is for expansion of Canal operations. Any other development that is not Canal expansion is under the responsibility of ARI. But ARI will only exist for about 4 more years. It is yet to be seen what ministry will take charge of the areas. If we decide to fill the ocean with excavated material from expansion projects, we could say that the area is ours because we excavated the material and paid for it..

CARLOS CONTRERAS: There are already personnel assigned to develop an ACP Land-use Plan.

PATRICIA BAQUERO: The project (to develop a land-use plan) is just getting started.

## Final Comments

PETER MAROTTA: Expressed concern over developing a port right next to an ecological reserve, citing as an example the wild area that is protected by ARI and ANAM in Farfan (Palo Seco).

LUIS SANTANACH: replied that the distance between the new "island" and the mainland would be 3 kilometers, which is far enough to not interfere with the protected areas. He also mentioned as an example the slight impact that the landfill and construction of the Dredging Division complex in Gamboa had on Gatun Lake.

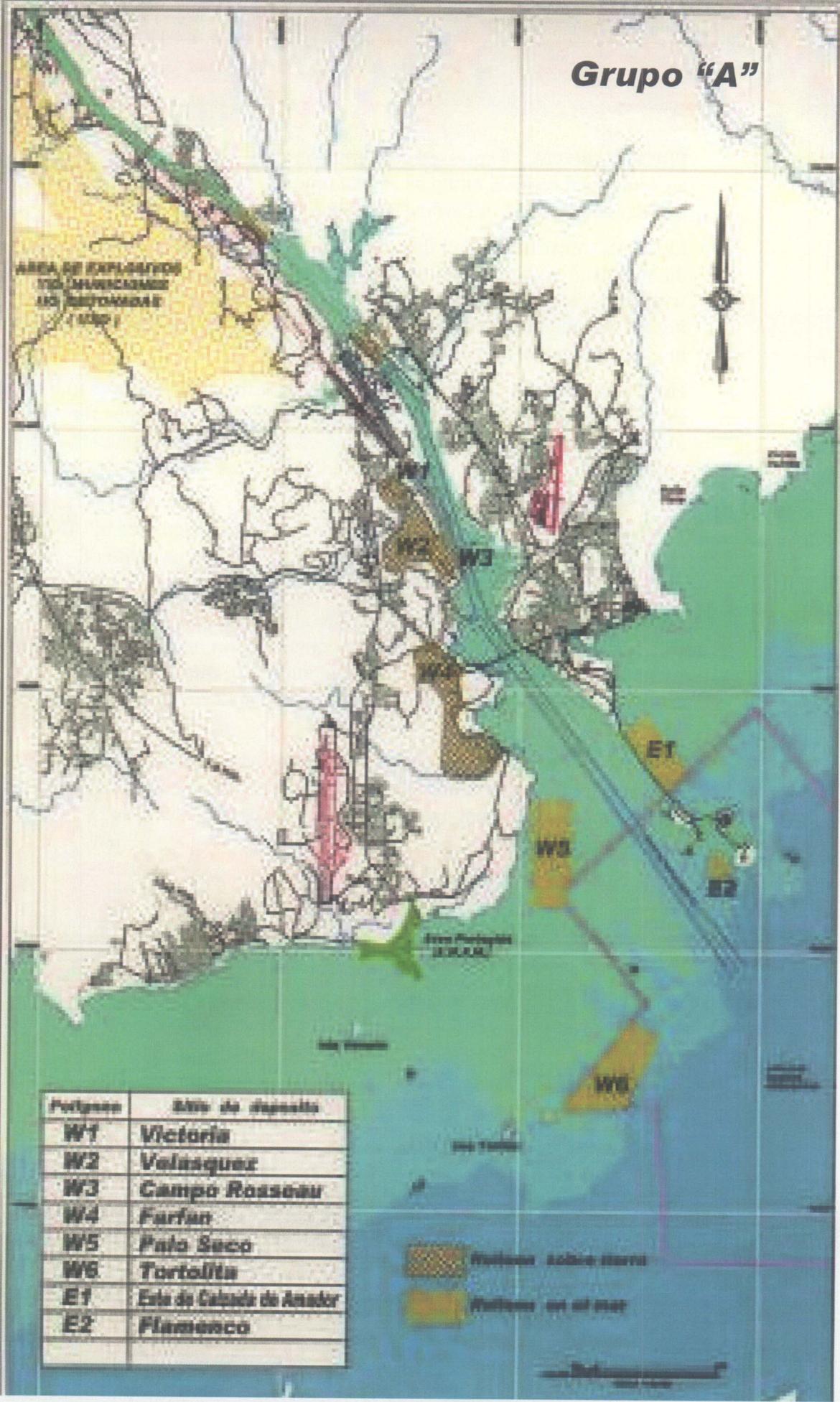
HORTENSIA BROCE: Spoke about the origin of the protected area in Farfan, saying that the Land-Use Plan developed by Nathan Associates for ARI identified the area as one with a unique ecology. She mentioned that any development would have to work with the land-use designations assigned by the plan.

ALIDA SPADAFORA: Confirmed that the Farfan protected area by ANAM and ARI is of a unique ecology because of its location on a site of ecological interest.

PATRICIA BAQUERO: Said that there are already three large shipping companies interested in developing a container port on the west side of the Canal at the Pacific entrance. With this interest in mind, the idea of creating an island and letting a shipping company take over development of the island would be a reasonable idea.

CARLOS CONTRERAS: The Canal and the government could be interested in similar or different areas. The ACP should work in coordination with all the other government agencies to properly coordinate these development projects.

# Grupo "A"



| Portuaria | Sitio de depósito          |
|-----------|----------------------------|
| W1        | Victoria                   |
| W2        | Velasquez                  |
| W3        | Campo Rousseau             |
| W4        | Farfan                     |
| W5        | Palo Seco                  |
| W6        | Tortolita                  |
| E1        | Estre de Caballé de Anador |
| E2        | Flamenco                   |

Residuos sobre tierra  
Residuos en el mar

## Final Comments

PETER MAROTTA: Expressed concern over developing a port right next to an ecological reserve, citing as an example the wild area that is protected by ARI and ANAM in Farfan (Palo Seco).

LUIS SANTANACH: replied that the distance between the new "island" and the mainland would be 3 kilometers, which is far enough to not interfere with the protected areas. He also mentioned as an example the slight impact that the landfill and construction of the Dredging Division complex in Gamboa had on Gatun Lake.

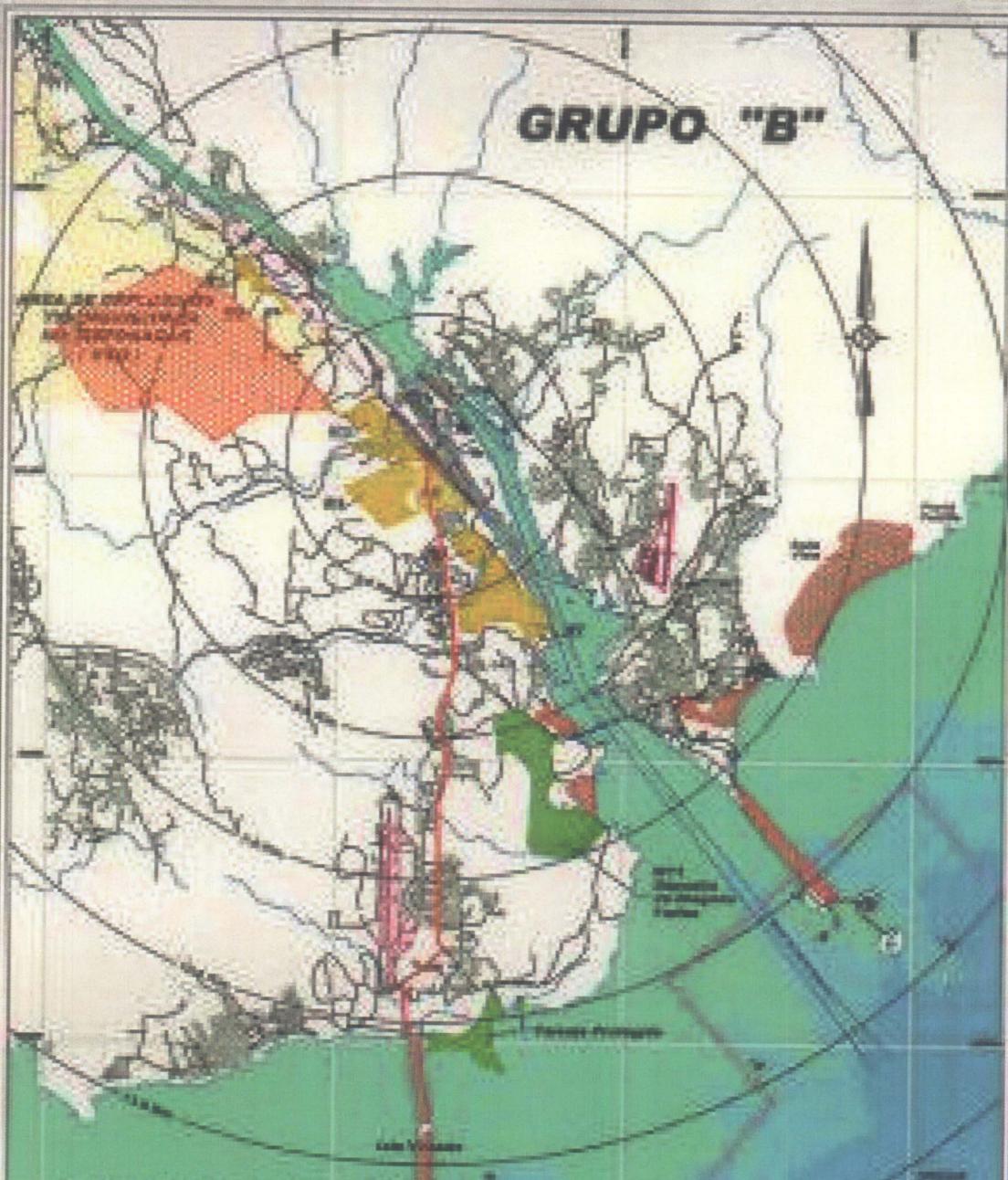
HORTENSIA BROCE: Spoke about the origin of the protected area in Farfan, saying that the Land-Use Plan developed by Nathan Associates for ARI identified the area as one with a unique ecology. She mentioned that any development would have to work with the land-use designations assigned by the plan.

ALIDA SPADAFORA: Confirmed that the Farfan protected area by ANAM and ARI is of a unique ecology because of its location on a site of ecological interest.

PATRICIA BAQUERO: Said that there are already three large shipping companies interested in developing a container port on the west side of the Canal at the Pacific entrance. With this interest in mind, the idea of creating an island and letting a shipping company take over development of the island would be a reasonable idea.

CARLOS CONTRERAS: The Canal and the government could be interested in similar or different areas. The ACP should work in coordination with all the other government agencies to properly coordinate these development projects.

# GRUPO "B"



| Poligono | Area (Hec) | Alto (m) de la Red | Presion (kg/cm <sup>2</sup> ) |
|----------|------------|--------------------|-------------------------------|
| 001      | 1000       | 4                  | 0.05                          |
| 002      | 1000       | 1.2                | 0.01                          |
| 003      | 1000       | 1.2                | 0.01                          |
| 004      | 1000       | 1.2                | 0.01                          |
| 005      | 1000       | 1                  | 0.01                          |
| 006      | 1000       | 1                  | 0.01                          |
| 007      | 1000       | 1                  | 0.01                          |
| 008      | 1000       | 1                  | 0.01                          |
| 009      | 1000       | 1                  | 0.01                          |
| 010      | 1000       | 1                  | 0.01                          |
| 011      | 1000       | 1                  | 0.01                          |
| 012      | 1000       | 1                  | 0.01                          |
| 013      | 1000       | 1                  | 0.01                          |
| 014      | 1000       | 1                  | 0.01                          |
| 015      | 1000       | 1                  | 0.01                          |
| 016      | 1000       | 1                  | 0.01                          |
| 017      | 1000       | 1                  | 0.01                          |
| 018      | 1000       | 1                  | 0.01                          |
| 019      | 1000       | 1                  | 0.01                          |
| 020      | 1000       | 1                  | 0.01                          |
| 021      | 1000       | 1                  | 0.01                          |
| 022      | 1000       | 1                  | 0.01                          |
| 023      | 1000       | 1                  | 0.01                          |
| 024      | 1000       | 1                  | 0.01                          |
| 025      | 1000       | 1                  | 0.01                          |
| 026      | 1000       | 1                  | 0.01                          |
| 027      | 1000       | 1                  | 0.01                          |
| 028      | 1000       | 1                  | 0.01                          |
| 029      | 1000       | 1                  | 0.01                          |
| 030      | 1000       | 1                  | 0.01                          |
| 031      | 1000       | 1                  | 0.01                          |
| 032      | 1000       | 1                  | 0.01                          |
| 033      | 1000       | 1                  | 0.01                          |
| 034      | 1000       | 1                  | 0.01                          |
| 035      | 1000       | 1                  | 0.01                          |
| 036      | 1000       | 1                  | 0.01                          |
| 037      | 1000       | 1                  | 0.01                          |
| 038      | 1000       | 1                  | 0.01                          |
| 039      | 1000       | 1                  | 0.01                          |
| 040      | 1000       | 1                  | 0.01                          |
| 041      | 1000       | 1                  | 0.01                          |
| 042      | 1000       | 1                  | 0.01                          |
| 043      | 1000       | 1                  | 0.01                          |
| 044      | 1000       | 1                  | 0.01                          |
| 045      | 1000       | 1                  | 0.01                          |
| 046      | 1000       | 1                  | 0.01                          |
| 047      | 1000       | 1                  | 0.01                          |
| 048      | 1000       | 1                  | 0.01                          |
| 049      | 1000       | 1                  | 0.01                          |
| 050      | 1000       | 1                  | 0.01                          |
| 051      | 1000       | 1                  | 0.01                          |
| 052      | 1000       | 1                  | 0.01                          |
| 053      | 1000       | 1                  | 0.01                          |
| 054      | 1000       | 1                  | 0.01                          |
| 055      | 1000       | 1                  | 0.01                          |
| 056      | 1000       | 1                  | 0.01                          |
| 057      | 1000       | 1                  | 0.01                          |
| 058      | 1000       | 1                  | 0.01                          |
| 059      | 1000       | 1                  | 0.01                          |
| 060      | 1000       | 1                  | 0.01                          |
| 061      | 1000       | 1                  | 0.01                          |
| 062      | 1000       | 1                  | 0.01                          |
| 063      | 1000       | 1                  | 0.01                          |
| 064      | 1000       | 1                  | 0.01                          |
| 065      | 1000       | 1                  | 0.01                          |
| 066      | 1000       | 1                  | 0.01                          |
| 067      | 1000       | 1                  | 0.01                          |
| 068      | 1000       | 1                  | 0.01                          |
| 069      | 1000       | 1                  | 0.01                          |
| 070      | 1000       | 1                  | 0.01                          |
| 071      | 1000       | 1                  | 0.01                          |
| 072      | 1000       | 1                  | 0.01                          |
| 073      | 1000       | 1                  | 0.01                          |
| 074      | 1000       | 1                  | 0.01                          |
| 075      | 1000       | 1                  | 0.01                          |
| 076      | 1000       | 1                  | 0.01                          |
| 077      | 1000       | 1                  | 0.01                          |
| 078      | 1000       | 1                  | 0.01                          |
| 079      | 1000       | 1                  | 0.01                          |
| 080      | 1000       | 1                  | 0.01                          |
| 081      | 1000       | 1                  | 0.01                          |
| 082      | 1000       | 1                  | 0.01                          |
| 083      | 1000       | 1                  | 0.01                          |
| 084      | 1000       | 1                  | 0.01                          |
| 085      | 1000       | 1                  | 0.01                          |
| 086      | 1000       | 1                  | 0.01                          |
| 087      | 1000       | 1                  | 0.01                          |
| 088      | 1000       | 1                  | 0.01                          |
| 089      | 1000       | 1                  | 0.01                          |
| 090      | 1000       | 1                  | 0.01                          |
| 091      | 1000       | 1                  | 0.01                          |
| 092      | 1000       | 1                  | 0.01                          |
| 093      | 1000       | 1                  | 0.01                          |
| 094      | 1000       | 1                  | 0.01                          |
| 095      | 1000       | 1                  | 0.01                          |
| 096      | 1000       | 1                  | 0.01                          |
| 097      | 1000       | 1                  | 0.01                          |
| 098      | 1000       | 1                  | 0.01                          |
| 099      | 1000       | 1                  | 0.01                          |
| 100      | 1000       | 1                  | 0.01                          |

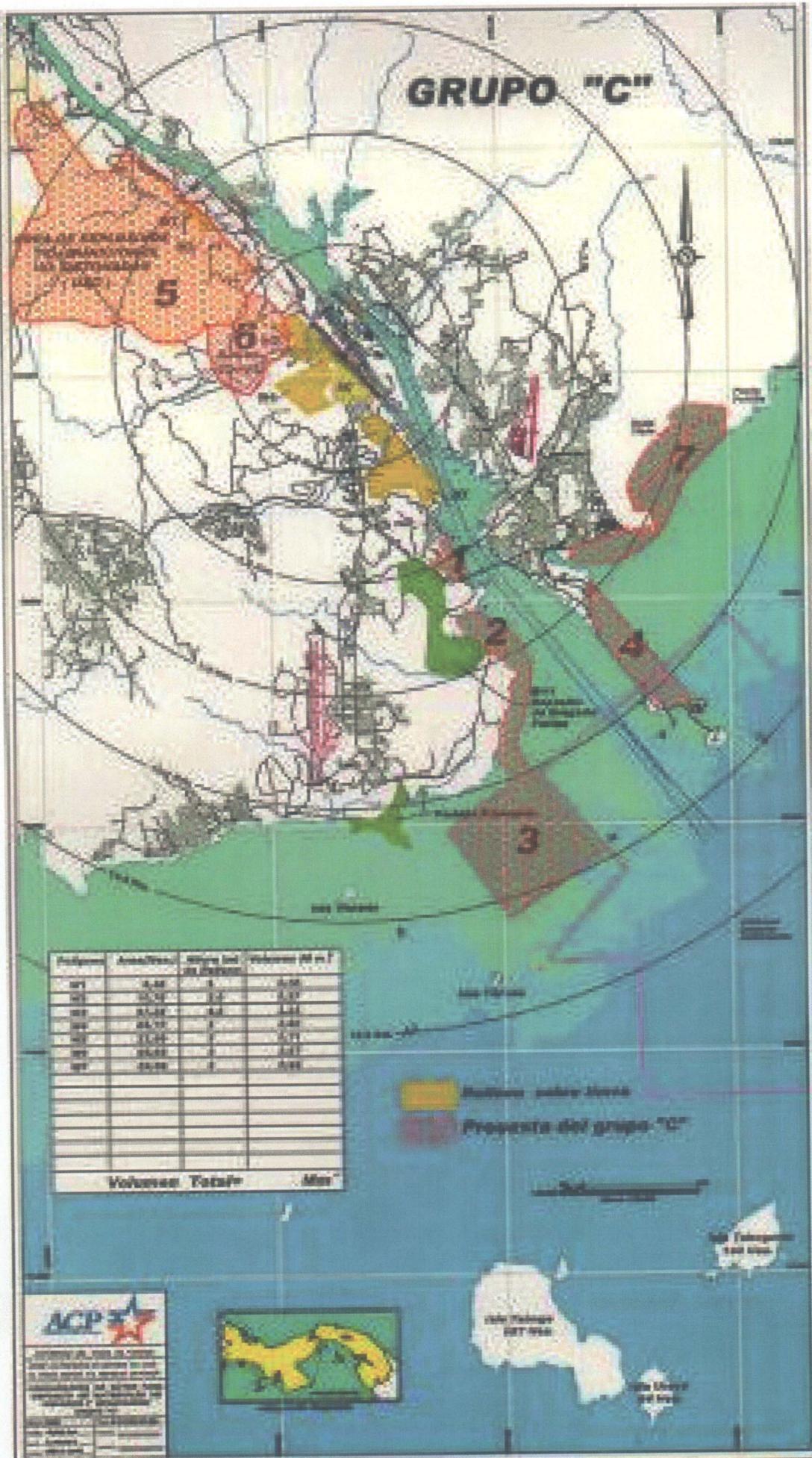
Volumen Total: 10.00 Mm<sup>3</sup>

Redes sobre tierra  
Propuesta del grupo "B"

Asociación Civil de Planificación  
Calle de la Independencia No. 100  
P.O. Box 10000, México D.F.  
Tel. 52-55-52-10-10



# GRUPO "C"



| Provincia               | Area (km <sup>2</sup> ) | Alto (m) | Volcanes del grupo "C" |
|-------------------------|-------------------------|----------|------------------------|
| ST                      | 5,48                    | 5        | 0,05                   |
| SE                      | 22,24                   | 12       | 1,07                   |
| SS                      | 21,22                   | 12       | 1,11                   |
| SA                      | 24,75                   | 7        | 0,28                   |
| SI                      | 11,24                   | 7        | 0,11                   |
| SO                      | 25,22                   | 7        | 0,11                   |
| ST                      | 22,22                   | 8        | 0,22                   |
| <b>Volcanes Totales</b> |                         |          | <b>Min</b>             |

Volcanes sobre tierra  
 Proyección del grupo "C"

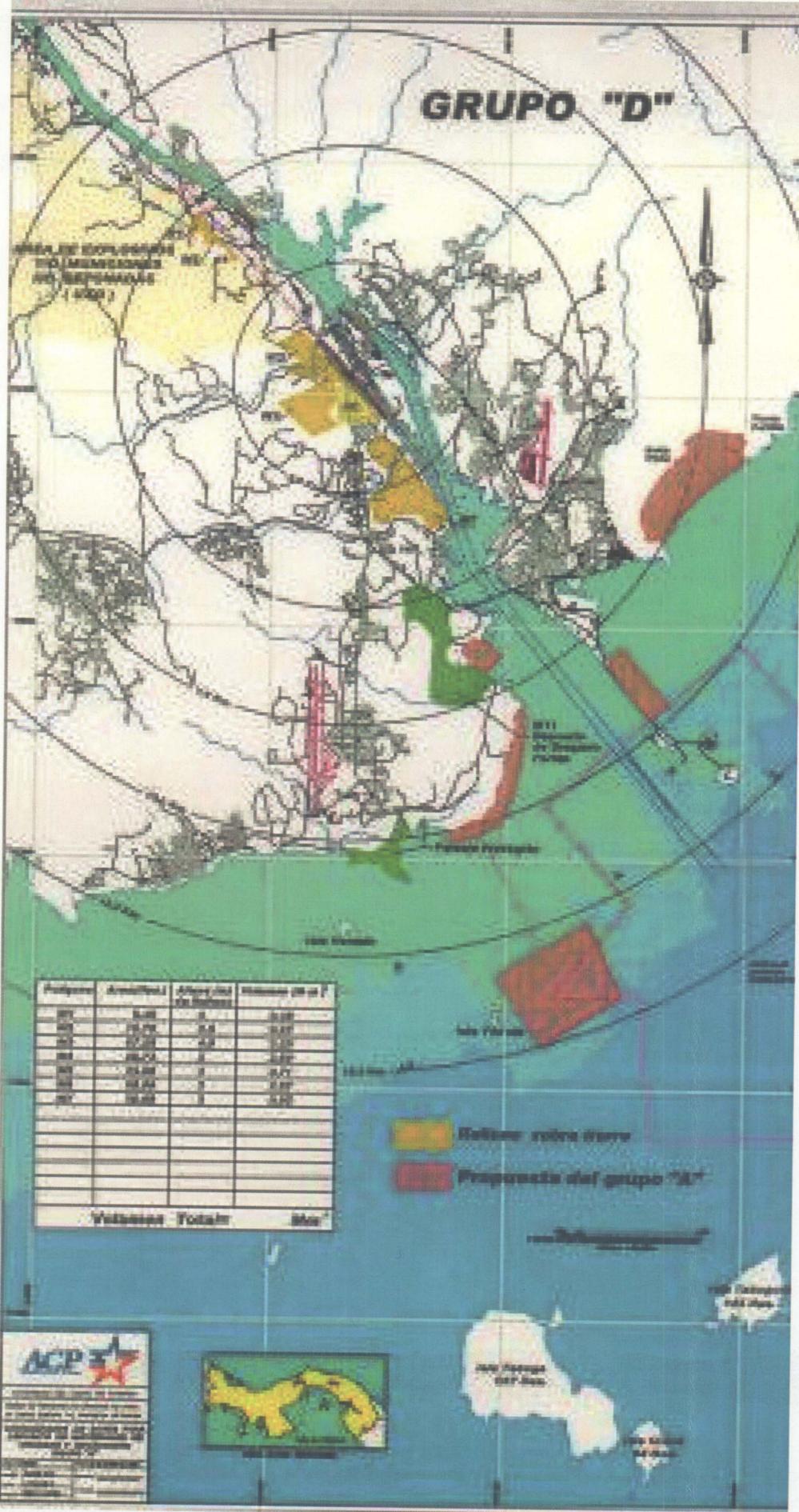
**ACP**

INSTITUTO AGROPECUARIO  
 DE CUBA  
 INSTITUTO AGROPECUARIO  
 DE CUBA  
 INSTITUTO AGROPECUARIO  
 DE CUBA



# GRUPO "D"

AREA DE EXPLORACION  
Y MANEJO DE  
RECURSOS  
(AMR)



| Proyecto        | Actividad | Alcance (en millones) | Reserva (en millones) |
|-----------------|-----------|-----------------------|-----------------------|
| 1               | 1         | 1                     | 1                     |
| 2               | 2         | 2                     | 2                     |
| 3               | 3         | 3                     | 3                     |
| 4               | 4         | 4                     | 4                     |
| 5               | 5         | 5                     | 5                     |
| 6               | 6         | 6                     | 6                     |
| 7               | 7         | 7                     | 7                     |
| 8               | 8         | 8                     | 8                     |
| 9               | 9         | 9                     | 9                     |
| 10              | 10        | 10                    | 10                    |
| 11              | 11        | 11                    | 11                    |
| 12              | 12        | 12                    | 12                    |
| 13              | 13        | 13                    | 13                    |
| 14              | 14        | 14                    | 14                    |
| 15              | 15        | 15                    | 15                    |
| 16              | 16        | 16                    | 16                    |
| 17              | 17        | 17                    | 17                    |
| 18              | 18        | 18                    | 18                    |
| 19              | 19        | 19                    | 19                    |
| 20              | 20        | 20                    | 20                    |
| 21              | 21        | 21                    | 21                    |
| 22              | 22        | 22                    | 22                    |
| 23              | 23        | 23                    | 23                    |
| 24              | 24        | 24                    | 24                    |
| 25              | 25        | 25                    | 25                    |
| 26              | 26        | 26                    | 26                    |
| 27              | 27        | 27                    | 27                    |
| 28              | 28        | 28                    | 28                    |
| 29              | 29        | 29                    | 29                    |
| 30              | 30        | 30                    | 30                    |
| 31              | 31        | 31                    | 31                    |
| 32              | 32        | 32                    | 32                    |
| 33              | 33        | 33                    | 33                    |
| 34              | 34        | 34                    | 34                    |
| 35              | 35        | 35                    | 35                    |
| 36              | 36        | 36                    | 36                    |
| 37              | 37        | 37                    | 37                    |
| 38              | 38        | 38                    | 38                    |
| 39              | 39        | 39                    | 39                    |
| 40              | 40        | 40                    | 40                    |
| 41              | 41        | 41                    | 41                    |
| 42              | 42        | 42                    | 42                    |
| 43              | 43        | 43                    | 43                    |
| 44              | 44        | 44                    | 44                    |
| 45              | 45        | 45                    | 45                    |
| 46              | 46        | 46                    | 46                    |
| 47              | 47        | 47                    | 47                    |
| 48              | 48        | 48                    | 48                    |
| 49              | 49        | 49                    | 49                    |
| 50              | 50        | 50                    | 50                    |
| 51              | 51        | 51                    | 51                    |
| 52              | 52        | 52                    | 52                    |
| 53              | 53        | 53                    | 53                    |
| 54              | 54        | 54                    | 54                    |
| 55              | 55        | 55                    | 55                    |
| 56              | 56        | 56                    | 56                    |
| 57              | 57        | 57                    | 57                    |
| 58              | 58        | 58                    | 58                    |
| 59              | 59        | 59                    | 59                    |
| 60              | 60        | 60                    | 60                    |
| 61              | 61        | 61                    | 61                    |
| 62              | 62        | 62                    | 62                    |
| 63              | 63        | 63                    | 63                    |
| 64              | 64        | 64                    | 64                    |
| 65              | 65        | 65                    | 65                    |
| 66              | 66        | 66                    | 66                    |
| 67              | 67        | 67                    | 67                    |
| 68              | 68        | 68                    | 68                    |
| 69              | 69        | 69                    | 69                    |
| 70              | 70        | 70                    | 70                    |
| 71              | 71        | 71                    | 71                    |
| 72              | 72        | 72                    | 72                    |
| 73              | 73        | 73                    | 73                    |
| 74              | 74        | 74                    | 74                    |
| 75              | 75        | 75                    | 75                    |
| 76              | 76        | 76                    | 76                    |
| 77              | 77        | 77                    | 77                    |
| 78              | 78        | 78                    | 78                    |
| 79              | 79        | 79                    | 79                    |
| 80              | 80        | 80                    | 80                    |
| 81              | 81        | 81                    | 81                    |
| 82              | 82        | 82                    | 82                    |
| 83              | 83        | 83                    | 83                    |
| 84              | 84        | 84                    | 84                    |
| 85              | 85        | 85                    | 85                    |
| 86              | 86        | 86                    | 86                    |
| 87              | 87        | 87                    | 87                    |
| 88              | 88        | 88                    | 88                    |
| 89              | 89        | 89                    | 89                    |
| 90              | 90        | 90                    | 90                    |
| 91              | 91        | 91                    | 91                    |
| 92              | 92        | 92                    | 92                    |
| 93              | 93        | 93                    | 93                    |
| 94              | 94        | 94                    | 94                    |
| 95              | 95        | 95                    | 95                    |
| 96              | 96        | 96                    | 96                    |
| 97              | 97        | 97                    | 97                    |
| 98              | 98        | 98                    | 98                    |
| 99              | 99        | 99                    | 99                    |
| 100             | 100       | 100                   | 100                   |
| Valores Totales |           |                       | Mo                    |

Reservas sobre tierra  
 Propiedades del grupo "D"

**AGP**

ACTIVIDADES DE SERVICIOS DE  
 PETROLIO Y GAS EN EL  
 ESTADO DE GUERRERO  
 S. DE RL DE CV

Calle 100 No. 100  
 C. P. 91000  
 Acapulco, Guerrero, México  
 Tel: (01) 777 777 7777  
 Fax: (01) 777 777 7777  
 E-mail: info@agp.com.mx



**APPENDIX G - ACP WORKSHOP – SEPTEMBER 2002**

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# **CANAL CAPACITY PROGRAM STUDIES NAVIGATION AND DREDGING TEAM WORKSHOP**

Compendium for the Workshop "Alternatives for Depositing Material  
Excavated from the Proposed  
New Pacific Locks Site"

Autoridad del Canal de Panamá  
September 27, 2002  
Ascanio Arosemena Training Center  
Balboa, Republic of Panama

# CANAL CAPACITY PROGRAM STUDIES NAVIGATION AND DREDGING TEAM WORKSHOP

Compendium for the Workshop “Alternatives for Depositing Material  
Excavated from the Proposed  
New Pacific Locks Site”

## 1 EXECUTIVE SUMMARY

### 1.1 Introduction

The Panama Canal Expansion study includes the feasibility analysis of constructing new sets of locks on the Pacific and Atlantic sides of the Panama Canal to accommodate vessels larger than Panamax-size ships.

Specifically, the proposed Pacific new locks alignments involve the excavation of 40 to 70 million cubic meters of high quality material. Because of this large volume, good excavation material, and unavailability of disposal sites with large capacities, the Autoridad del Canal de Panama (ACP) has been exploring and analyzing other options to dispose of or to find beneficial uses or potential financial returns for this material.

Among ACP efforts to find other options for using or depositing Pacific new locks excavation material is the use of workshops with ACP and contractors personnel to discuss the issue. Selecting the best option(s) to accommodate the dry excavation material is not an easy task, as there are many considerations, and their weighting could be very difficult because of different interests in the use of a selected option. Some of the criteria or considerations for screening the alternatives include: technical factors, such as site capacity, hauling distance or transportation, site physical features, and Panama Canal operations conflicts; environmental issues; jurisdictional factors; and public opinion.

### 1.2 Workshop Objectives and Methodology

The workshop objectives were to obtain and become acquainted with the opinions, ideas and concerns of all personnel who work directly or indirectly with new locks study, Panama Canal operations, disposal sites, excavation and dredging operations, environmental factors, corporate communication issues, ACP patrimonial economic assets, ACP compatibility areas, and jurisdictional and legal issues. The workshop was conducted in a manner that required active participation of the participants.

In general, disposal sites studies workshops follow similar agendas and methodologies. Each agenda is adapted to the needs and complexity of the discussion.

## **General Workshop Agenda**

1. Explanation of the workshop methodology by personnel from the Department of Human Resources
2. Introduction to the topic by personnel from the Canal Capacity Projects Division
3. Presentation of the data and background needed to develop the workshop cases, questions or topics. In this case, the presentation was made by Michael Horton, contractor for Moffatt & Nichol
4. Group discussion of workshop topics
5. Presentation of each group's ideas, concerns and conclusion
6. Plenary discussion of the conclusions
7. Workshop closure

### **1.3 Results**

The original list of six disposal options identified in the preliminary screening of alternative disposal sites (for material from the Pacific new locks excavation) was augmented after the workshop because workshop participants concluded that some of the basic criteria to screen the initial sites were discarding some potential and attractive site options.

Based on the alternative of using several sites as multi-sites, most participants agreed that site capacity should not be used as criteria to discard a disposal site option; that is, they recommended an option using several sites to accommodate the dry excavation material rather than depositing all in one single site. Therefore, more alternatives, many of them multi-sites, were added to the original six disposal site options. Also, another site option, in addition to the 54 sites originally identified for receiving dry excavation material, was identified in the areas adjacent to the new locks alignment.

In general the ACP and the firms Moffatt & Nichol and Louis Berger International agreed to keep the original proposed six sites, although some with reservations because of political and public opinion impacts that could be raised by some sites. More site options were included in this original list, such as the areas alongside the new locks construction; 1993 Canal Alternatives Study Site Nos. 2, 6 and 7; and the 1939 old third set of locks excavation. Some participants proposed reducing the size of land reclamation areas to minimize negative environmental impacts and reduce negative public opinion implications.

As for the criteria to be used for the next stage of evaluation, there were many opinions about discarding some of the factors; however, all technical, environmental, economic, social, jurisdictional, public opinion, added value, and legal issues will be considered and weighted to select the best options. Another criterion that came up during the workshop is performing a cumulative weighted analysis for each site for its proper assessment.

## 2 PARTICIPANTS

|                                     |  |                       |
|-------------------------------------|--|-----------------------|
| Manager                             | <b>Dept. of Engineering and Projects</b>           | Agustín Arias         |
| Manager                             | <b>Canal Capacity Projects Division</b>            | Jorge de la Guardia   |
| Multidisciplinary Engineer          |  | Yolanda Chin          |
| Multidisciplinary Engineer          |  | Rolando Rivera        |
| Civil Engineer                      |  | César Kiamco          |
| Civil Engineer                      |  | Rigoberto Delgado     |
| Civil Engineer                      |  | Cheryl George         |
| Multidisciplinary Engineer          |  | Juan Wong             |
| Multidisciplinary Engineer          |  | Boris Moreno          |
| Civil Engineer                      |  | José Pascal           |
| Technical writer                    |  | Velda Blencowe        |
| Technical writer                    |  | Susan Harp            |
|                                     | <b>Environmental Administration División</b>       |                       |
| Environmental specialist            |  | Hortensia Broce       |
|                                     | <b>Environmental Policies and Programs Section</b> |                       |
| Environmental specialist            |  | Daniel Francis        |
| Environmental specialist            |  | Javier Morón          |
| Environmental specialist            |  | Javier Guerrero       |
| Manager                             | <b>Canal Watershed Monitoring Section</b>          | Daniel Muschett       |
| Chemist                             |  | Alejandro Veces       |
| Environmental protection specialist |  | Marilyn Dieguez       |
| Sociologist                         |  | Amelia Sanjur         |
|                                     | <b>Planning and Marketing Department</b>           |                       |
| Leader                              | <b>Liquid Bulk Carriers</b>                        | Silvia Marucci        |
| Leader                              | <b>Container Ships</b>                             | Eduardo Lugo          |
| Acting Manager                      | <b>Strategy Section</b>                            | Ricardo Len           |
|                                     | <b>Internal and Local Communications Section</b>   |                       |
| Writer                              |  | Maricarmen Sarsanedas |

**Dredging Division**

|   |   |                    |
|---|---|--------------------|
| Manager                                 | <b>Engineering Plans and Programs Section</b> | Leonardo Paredes   |
| Manager                                 | <b>Engineering Division</b>                   | Luis Alfaro        |
| Manager                                 | <b>Geo-technical Section</b>                  | Max DePuy          |
| Manager                                 | <b>Topography and Cartography Section</b>     | Jaime Rodríguez    |
| Architect                               | <b>Architecture Section</b>                   | Regina Moynes      |
| Civil Engineer                          | <b>Civil Engineering Section</b>              | César Saavedra     |
| Civil Engineer                          | <b>Maintenance Section</b>                    | Luis Paniza        |
| Civil Engineer                          | <b>Maintenance Section</b>                    | Virgilio Mirones   |
|   | <b>Maritime Operations Department</b>         |                    |
| Canal Port Captain                      | <b>Maritime Transit División</b>              | Federico Cockburn  |
| Pilot Training Coordinator              | <b>Training and Development División</b>      | Rogelio Altafulla  |
| Pilot Training Coordinator              | <b>Training and Development División</b>      | David Constable    |
| Multidisciplinary Engineer              | <b>Canal Expansion Program Office</b>         | Ilya Marotta       |
|   | <b>Consultants</b>                            |                    |
| Consultant                              | <b>PARSONS BRICKENHOFF</b>                    | Bruce Johnke       |
| Consultant                              | <b>HARZA-MONTGOMERY</b>                       | Pete Saunders      |
| Consultant                              | <b>MOFFATT &amp; NICHOL</b>                   | Michael Horton     |
| Consultant                              | <b>LOUIS BERGER INTERNATIONAL</b>             | Ariel Cuschnir     |
| Consultant                              | <b>LOUIS BERGER INTERNATIONAL</b>             | Marcelo de la Rosa |
| Consultant                              | <b>LOUIS BERGER INTERNATIONAL</b>             | Abdiel Adames      |
| Consultant                              | <b>LOUIS BERGER INTERNATIONAL</b>             | Rosario Galván     |
| Consultant                              | <b>LOUIS BERGER INTERNATIONAL</b>             | Gladys de Broce    |
| Consultant                              | <b>LOUIS BERGER INTERNATIONAL</b>             | Rafael Ostia       |
| Human Resources Development. Specialist | <b>Human Resources Department</b>             | Sandra Ubben       |

### 3 WORKSHOP OBJECTIVES AND METHODOLOGY

#### 3.1 Objectives

The workshop objectives were to obtain and become acquainted with the opinions, ideas and concerns of personnel who work directly or indirectly with new locks studies, Panama Canal operations, disposal sites, excavation and dredging operations, environmental factors, corporate communication issues, ACP patrimonial economic assets, ACP compatibility areas, and jurisdictional and legal issues. The workshop was conducted in a manner that required active participation of the participants. The specific objectives of the workshop were:

- Obtain different ACP units' opinions and concerns on the preliminary screening draft report by MOFFATT & NICHOL (M&N)
- Obtain ACP agreement on the total amount of available options to dispose the material
- Discuss the basic criteria used by M&N to pre-screen the options or disposal sites alternatives
- Augment or diminish the final list of preferred options or alternatives for the subsequent in-depth feasibility analysis
- Identify criteria to be used for the subsequent analysis of final preferred alternatives

#### 3.2 Methodology

In general, dredging studies workshops follow similar agendas and methodologies. Each agenda is adapted to the needs and complexity of the discussion.

##### Workshop Agenda

1. Explanation of the workshop methodology by personnel from the Department of Human Resources
2. Introduction to the Topic by personnel from the Canal Capacity Projects Division
3. Presentation of the data and background needed to develop the workshop cases, questions or topics. In this case, the presentation was made by Michael Horton, contractor for Moffatt & Nichol
4. Group discussion of workshop topics
5. Presentation of each group's ideas, concerns and conclusion
6. Plenary discussion of the conclusions
7. Workshop closure

## 4 QUESTIONS AND SCENARIOS

M&N and ACP Canal Capacity Division personnel developed the questions discussed in the workshops. Their objective was to solicit ACP personnel opinions on the methodology and pre-screening process used to select the final disposal options for further analysis.

Following are the questions:

### 4.1 Questions

**Question 1** - Are there additional alternatives, other than the 54 sites described in the preliminary report that should be considered as deposit sites?

**Question 2** - Are you in agreement with the 6 final sites presented in the preliminary report, or should other sites be included? Six sites were selected from 29 sites based on the following basic criteria:

- Hauling distance
- Site capacity
- Existing or programmed use of the site

**Question 3** - What is your opinion of the 6 sites selected so far, based on the following criteria and any other criteria that you feel is important?:

- Added value (increased land value, generation of employment)
- Hauling system
- Site location (east or west)
- Public opinion (faction interests, visual impact, impact during construction and permanent site use)
- Environmental impact
- Political aspects (UXO, Panama Bay filled areas)
- Technical aspects
- Economic aspects (costs)
- Other

## 5 SUMMARY OF IDEAS

The workshop proved to be very effective and resulted in augmenting the list of preferred disposal options for the Pacific new locks excavation material. The contractors Moffatt & Nichol will proceed to assess the new list of Pacific side disposal options. The assessment will include technical, economical, environmental, jurisdictional, social, and added value factors.

The majority of the participants agreed that a multi-site option should not be discarded, as many of the preliminary sites were eliminated because of their lack of volumetric capacity. Therefore, some sites that had previously been discarded were incorporated in the list for further detailed evaluation.

A participant came up with an interesting disposal site option that was not included in the initial 54 sites identified in the preliminary draft report on disposal sites. The additional option is to deposit the material alongside the new locks alignment, similar to the method used for the Gaillard Cut widening. The new alignment would have several disposal sites adjacent to its navigation channel.

Many participants concurred in UXO site as an attractive option, especially if it is developed as a reforested area; however, there were many concerns about its political implications. The discussion indicated that it would be ideal if the Panama and US governments reach a fair agreement on cleaning the UXO site.

As for the land reclamation options, there was some agreement on their feasibility; however, many participants proposed that the original design area be smaller to mitigate negative impacts, especially in terms of the environment. Its initial cost and public opinion impact would be the major factors to overcome.

In general, most of the groups agreed on the criteria that will be used to assess the disposal site options, although some disagree on some issues, such as public opinion. The only new criterion raised during the discussion was to perform a cumulative analysis for each candidate site.

## 6 PRESENTATIONS AND PRELIMINARY DISCUSSIONS

### 6.1 Presentation by Michael Horton, Moffatt & Nichol

A copy of Mr. Horton's PowerPoint presentation is included in the Appendix. Following the presentation, members of the audience commented on and asked questions about the presentation.

### 6.2 Transcription of the discussions:

... beginning of recorded session on tape

Michael Horton

I totally agree; a priority order for the criteria is important. Last night I tried to make a priority list, but I thought it was not my place to make one, because each person and each group will have their own opinions about it. But yes, it is a critical point. That is why I have you the three basic questions, and perhaps we have to present a fourth one: "Which are the most important criteria?"

Peter Saunders

This study does not consider the other work that will have to be done to make use of the new locks. In other words, it does not look at the excavation necessary for the Pacific channel that would be required to make an entrance to the new locks.

M. Horton

It includes the cut into the locks but it doesn't include the 7 million, I think it is, that is in the existing Canal area. The reason we did not include that is because it would probably be more economic for the dredging work, *per se*, to go to one of the designated disposal sites. In planning the fill, one would make allowances for future fill, possibly, or additional material to come from that. I think in earlier Harza reports, about 60 percent of the material was going to be dry, and basically we focused on that. But in the original report that we did, we did acknowledge that it was not the total amount of material; there could be another 7 to 10 million cubic meters.

P. Saunders

The other point is that this is for the maximum volume development, but there are other developments that require about half the volume, and you have excluded some sites on the basis of lack of capacity. If another alignment were chosen, other than the P1 alignment, then you might want to go back and look at some of those other sites.

M. Horton

Yes, that is a good point.

Max de Puy

In the documents that you sent by e-mail, it says, "If another alternative should be considered other than the 54 sites." Well, if you choose the P1 alignment, it will require 70 million (cubic meters) more of excavation, and we could deposit at least one third to one half of that material in the area of the alignment channel, and that option is not listed. You can deposit at least one third to one half of the whole volume along the P1 alignment because it will require at least two saddle dams. You can put at least 20 to 30 million cubic meters. That is not included in the other (possible sites).

M. Horton

That is a good point.

M. de Puy

Also, as was mentioned before, for the other alignment, the excavation will be at least one third.

Yolanda Chin

In response to Mr. De Puy's question, it is true that there are two alternative sites for the new locks construction. One will produce 70 million cubic meters, the other 40 million. We are studying the larger amount. But this can also influence the choice of which alignment to use and, thus, influence the disposal of the material. Yes, that must be taken under consideration. We did not consider that, but we did use the maximum amount of excavated material

Luis Paniza

When you mention putting 70 million cubic meters in deposit sites, are you saying that the volume or the area of the deposit site will be 70 million, or are you going to have a big swelling effect? When you say you will make one trip every 30 minutes with the excavated material, are you also including the energy it takes to compact/consolidate the fill? Or will it be the same as all those, which grow (expand) a lot?

M. Horton

At this level we have not calculated costs or made detailed evaluations. For the calculations of capacity, we measured the area, made some assumptions about the topography, established a fill level and included a bulking factor for expansion and also for compaction. But I can't say, at this level of evaluation the calculations are very general, they are not very sophisticated.

L. Paniza

Because normally for this type of fill, compaction energy is not included except for the traffic that goes over it..

M. Horton

We have made some investigations of the quality or the characteristics of the material that will be excavated. That was the first table that was shown with the four categories of material. We are analyzing the material hauling purposes, to see how it could be transported, how the rock will be, what size and form, and obviously this will be very important for the fill site. Especially for the question of the empty areas. And whether we have to process the excavated material for it to be suitable for fill. For land as well as marine (sites). But detailed studies have not yet been made. We made some very general assumptions.

## 7 RESULTS OF THE PLENARY SESSION FOR THE QUESTIONS

### 7.1 Questions 1 and 2

Question 1: Are there additional alternatives, other than the 54 sites described in the preliminary report that should be considered as deposit sites?

Question 2: Are you in agreement with the 6 final sites presented in the preliminary report, or should other sites be included? Six sites were selected from 29 sites based on the following basic criteria:

- Hauling distance
- Site capacity
- Existing or programmed use of the site

### 7.2 Results for Questions 1 and 2

For questions No. 1 and 2, following are the results from each group:

- Try to sell the dry excavation material to cement companies for concrete preparation
- Use dry excavation material for new locks construction
- The proposed filling areas on the east side of the Pacific entrance, Panama Bay reclamation and Chorrillo and Amador Causeway filling will have enormous social impact, political problems, and Canal operation interference.
- Assign low priority in Panama Bay, and Chorrillo & Amador Causeway filling because of tourism projects going on in these areas
- Eliminate site capacity as a basic criterion because multi-sites could be used as disposal site alternatives, as opposed to disposing all the material in just one site.
- Amador Causeway filling is reasonable if it will be used to add two more traffic lanes for a total of 4 traffic lanes on the Causeway; however, its filling is not visually attractive and might raise problems with public opinion. Also this filling might alter water current patterns in the bay that could cause sedimentation problems.
- Filling a UXO site is reasonable if the site is developed as a reforested area to support the Canal's hydrological reliability, and it could be used as a disposal site for further Canal expansion projects if proper cleaning is executed; however, this area implicates political problems between the Panama and US governments. Because of its short hauling distance from the potential new locks excavation, the UXO site is a very attractive option.
- The 1993 Canal Alternative Study proposed that sites 7, 6, and part of 5 should not be included within the 54 potential disposal sites because they could be used for future Gaillard Cut widening projects.

- Use multi-sites and do not concentrate on using just a single site to deposit all the dry excavation material. For instance, land reclamation could be divided in two sites, an island and a peninsula, so the proposed island and peninsula could be much smaller than originally proposed by M&N in their preliminary report.
- Use the sites adjacent to new locks alignment to deposit part of dry excavation material, similar to the widening projects in Gaillard Cut. This could be the cheapest option.
- Enlarging Tortolita Island with dry excavation material instead of creating a new island. The idea to enlarge an island might be easier to sell to the public than building a new island.
- Another criteria in selecting disposal options should be cumulative analysis.
- In analyzing the UXO and Panama Bay options, the cost for cleaning these sites should be included.
- Evaluation of depositing the material in open seas versus constructing an island, since the latter requires more control and appropriate compacting. The artificial island is an excellent solution but a cost-benefit analysis should be performed for these two options, open seas and island. The open seas option does not have any added value, but its cost could be low enough to make it an attractive option.
- Use the dry excavation material for implementation of the Trinidad dam study.
- From the point of view of excavation material volume and cost, alignment P2 could be more attractive than P1 although P2 presents navigation problems. Alignment P2 excavation material could be deposited in one single site.
- The artificial island and peninsula options should only be considered if ACP will not be required to pay for their filling. A private company should absorb the material transportation and construction costs of these options. The peninsula shape should be designed as not to disturb existing sedimentation rates.
- The 1993 Canal Alternatives Study proposed site No. 2, behind the Horoko area, was eliminated because of its lack of capacity; however, if it is considered as a multi-site, Site No. 2 should be included in the list of preferred options for its further technical and environmental assessment.
- There were some disagreements on multi-sites and single-site environmental impacts. An analysis of the environmental impacts of multi-sites versus single sites is required.

### **7.3 Question 3**

What is your opinion of the 6 sites selected so far, based on the following criteria and any other criteria that you feel is important?:

- Added value (increased land value, generation of employment)
- Hauling system
- Site location (east or west)
- Public opinion (faction interests, visual impact, impact during construction and permanent site use)
- Environmental impact
- Political aspects (UXO, Panama Bay filled areas)
- Technical aspects
- Economic aspects (costs)
- Other

#### **7.4 Results for Question 3**

For questions No. 3, following are the opinions expressed:

- Environmental and political impacts should be criteria No. 1, following with technical issues, such as transportation, location, construction aspects and mobilization, as criteria No. 2. Legal issues, criteria No. 3, and economic criteria, No. 4. Added value is part of the economic issue and is also covered as part of the other aspects of the analysis.
- Cumulative analysis should be added as selection criteria.
- Legal and economic issues are important, especially the inter-institutional part. Cost and conditions are also important because some sites require costly preparation.
- Sites that do not have added value should not be discarded as potential disposal sites. They could have other aspects that make them attractive as disposal sites.
- The sites located at the east side of the Pacific entrance should not be eliminated, as there are several convenient transportation options to avoid interrupting the traffic through the Canal. Another group commented that the sites on the east side are not worth considering, as there are solutions available at the west side.
- Another group selected cost as criteria No. 1, environmental aspects as criteria No. 2, socio-economic issues as criteria No. 3, technical aspects as No. 4, added value as No. 5, and legal and political aspects as No. 6. Public opinion is included in the environmental and socio-economic aspects.
- Include multi-site as a disposal site option
- Another group considered that only three criteria are worth considering: cost-benefit, political problems, and environmental impact
- Another group assessed the 6 sites proposed by M&N based on the criteria listed. They judged the least viable as being Panama Bay, the UXO, and artificial islands. The least critical are the El Arado site and the peninsula.

## 8 PRESENTATIONS FOR QUESTIONS 1 & 2, FIRST PART OF THE WORKSHOP

**Note:** each group presented a written outline accompanied by a verbal discussion of the outline points.

### 8.1 Group 1 Verbal Presentations

**Presenter: Leonardo Paredes**

#### **Question 1, Group 1**

For the first question, if we think there are other alternatives to also consider, we have concluded that really, more than identifying a site, we propose the idea of identifying the dredged material. When dredging, there are certain materials that have no use, and you can anticipate a use. We are always going to reach limits of hardness, when we reach basalt rock, where a large percentage of what we find can be used for something, used for preparation of concrete, for fill, and could be offered for sale or used in negotiations with the cement companies that will be providing the concrete for construction of the locks. With this concept, more than saying that another alternative exists, we are proposing that the use of the material be negotiated with the different contractors, or be used for whatever project that might be brought up in the future.

#### **Question 2, Group 1**

As for the second question, which asks, are you in agreement with the six sites presented in the preliminary report?, we have the following comments:

- First, we want to split up the defined basic criteria, hauling distance, site capacity, existing or programmed use; also we want to include and consider the merit of the environmental and social impacts. All the areas on the east side, sites 4 and 1 in the bay, will have a big social impact because of the development of tourism projects. We will be entering into competition with them and we will be diminishing objectives that are already being established at the government level.
- We are also recommending that the criteria of site capacity be prevented from determining whether a site can be used for disposal. Why? Because we can use multi-sites and realign or accommodate, depending on the various projects.
- Because of their social impact, we recommend moving sites 1 and 4 to low priority, or eliminate them from consideration to not detract from the tourism projects or to diminish the social impacts that could occur. Nevertheless, we want to keep them on the list.
- For site 4, we agree and are recommending it. Nevertheless, we propose reviewing it and modifying it so it does not affect the Smithsonian laboratories or the government and tourism plans already studied, and it

should be filled enough to be able to support two more lanes of traffic so we can have four lanes instead of two, that is, two going out and two returning – we can use the site as a partial fill site. In this sense we are totally in agreement.

- For site 3, we want to mention the following: in an ideal world, we are in agreement because of its closeness; nevertheless, there are several attenuating circumstances for selecting it. We can begin with the problems caused by the unexploded ordnance (UXO) that it contains and could cause accidents, and uncertainty about the cost that this problem represents.
- The other issue for site 3 is environmental impact. The site has primary forest with the potential for development and for maintaining what we need – a tropical environment – for maintaining hydrological reliability (of Canal operations). We feel this option should be included, because of the large amount of material it could receive, but with these reservations.

## **8.2 Group 1 Written Outline**

### **Question 1, Group 1**

What is the percentage of excavated/dredged material that could be used (define the percentage of material that would qualify as being suitable for use in a fill).

### **Question 2, Group 1**

- Include social and environmental impacts
- Postpone elimination of a criteria because of its capacity
- Because of the social impact, recommend eliminate or move to a low priority sites 1 and 4
- Site 4, modify it so it creates the infrastructure for building a two-lane causeway road.

## **8.3 Group 2 Verbal Presentation**

**Presentation by: Hortensia Broce**

### **Question 1, Group 2**

In respect to the first question, additional alternatives to the 54 listed that should be included, we have a few new ideas.

- One is that with construction of the new locks we will have to deposit material on the north end of the west side. We had the idea that sites 6 and 7 and part of 5 would have to be set aside for the Gaillard Cut widening that would also have to be done in the future. This restricts us in relation to the 54 sites.

- Another possibility that we see is to use more multi-site deposits. In other words, divide the material and don't deposit it in one single area.
- One possibility us to make a smaller island instead of the 300-hectare island, with a fill site at the Palo Seco peninsula, and, as Mr. De Puy said, along the sides of the new locks alignment.
- Another alternative to the island option is to enlarge Tortolita Island, because many people will oppose creating a new island, the idea of "enlarging" and island would be easier to sell. In addition, from the point of view of scenic value, and environment of natural rock is already present there, and it would not be like a 300-hectare bare-top island, but would be much prettier.
- Related to the idea of dividing the material in multi-sites, part of the material could be places in some of the UXO sites in order to recuperate that land. This would be a matter to negotiate with the United States to sell them on the idea that they should finance. This would have to be discussed with (José Miguel) Alemán the Foreign Relations Minister.

### Question 2, Group 2

We agree with the criteria that were presented. In addition is the idea that Pete Saunders brought up: we are going to have to make a **cumulative analysis**. This has to be considered in some way as one of the criteria. We should also include as a criterion the cost of cleaning or preparing the UXO sites if the Americans don't pay for it, and the cleanup of the bay, which would also be necessary in order to use the bay site.

## 8.4 Group 2 Written Outline

### Table 2, Questions 1 y 2

Yes

Reserve sites 6,7 and part of 5 for Gaillard Cut improvements (evaluate now)

Multiple deposit sites with less volume. So they will be easier to manage and have a lower environmental impact

- Smallest island (artificial)
- Palo Seco – costal landfill
- Deposit along the sides of the new channel (the alignment) (alternative mentioned by Mr. De Puy)
- Enlarge Tortolita Island
- Part of the UXO area (USA pays compensation)
- West of Horoko (site #2) Make new golf course or a residential development
- Additional Selection Criteria:

- Cumulative analysis, including dredging+Gaillard Cut
- Cleaning/preparation cost for fill sites
- Cumulative impact
- Legal/economic and inter-institutional aspects
- Costs/conditions for preparing the sites
- Probability (political difficulty) of being able to use the site
- Impact on Canal operations

## **8.5 Group 3 Verbal Presentation**

**Presented by: Luis Alfaro**

### **Question 1, Group 3**

Our group discussion led to the identification of three alternatives that are complementary to those in the report. The first is the one the Mr. De Puy mentioned this morning, which is: identify sites adjacent to the excavation. Obviously this would be the cheapest option if it meets with environmental requirements. For this reason, it should not be set-aside during this phase of review.

- Another alternative that we identified was to deposit material in the open ocean. Without a doubt this is much less costly than depositing the same material to form an island, because that requires much more control and appropriate compacting. It would be a matter of evaluating the cost-benefit of both alternatives, and it is possible, despite not producing any added benefits, that the cost of the open ocean option would be low enough to make it an attractive option.
- The third option that we identified is the Trinidad dam, one of the water projects that is still being considered by the Canal Capacity water team. This is situated in the west arm of Gatun Lake, near Gatun Dam. Without a doubt, it does not comply with the hauling distance limitation. Nevertheless, if you identify the benefits, and if they might justify paying the additional cost of transportation, then this option should be remained on the table. Mr. Bruce Johnke told me that the program manager group has received a work order to evaluate the Trinidad project in more detail to see if the costs permit it to be a competitive option for meeting future Canal water demands. An additional benefit of this project, if implemented, is that it would provide an alternative to the Transisthmian highway connecting the Pacific and Atlantic sides and could provide the additional benefit of development opportunities for the country. Additionally, the Ministry of Public Works could consider building just the road, passing over the area where the Trinidad dam would have been built with a bridge that would not have to be very expensive because there is no ship navigation in that area. The bridge could be a marine highway section like the Southern Corridor, and would connect to the Atlantic side.

### **Question 2, Group 3**

- For the six options presented in the report, our group considers that options 1 and 4, the marine-city and the Amador fill, could represent political problems.
- Site 3, the UXO site, could have political problems, including binational ones, since it is already a topic of negotiation between the Ministry of Foreign Relations and the US government. For this reason, it could be very sensitive and cause complications in our projects because of outside interests.
- Regarding site 5, the fill in front of the causeway, at this time there are many unknowns about the foundation material, which has a big impact on its construction. Additionally, we think this could have or cause sedimentation problems if it alters current patterns in the bay. This could possibly affect sedimentation in the Canal entrance. Also, some members of the group say it would affect visual environmental quality, which could also raise problems with public opinion.
- Site 6, the artificial island, could be an excellent solution. Nevertheless, there are also lots of uncertainties about the foundation and thus the cost of the project. One of our recommendations is to perform the appropriate geological studies to allow a reasonable estimate of a cost range, so we could see if it continues to be an attractive option. Really, the cost of depositing material in the open ocean would have to be less than the benefits that you could obtain by making an island. That would be the basic criteria. Another point that was made is that the benefits from the island project would probably be spread over 10 years or so, which is relatively long term. Financially, then, that could have an impact on the benefits and thus on the decision.

## **8.6 Group 3 Written Outline**

### **Question 1, Group 3**

#### **Alternatives:**

- Sites adjacent to the excavation
- Deposit in open ocean
- Trinidad Dam and alternate highway to the Atlantic side

### **Question 2, Group 3 (hauling distance)**

- Sites 1 and 4: represents possible political problems
- Site 3: bi-national political problems

- Site 5: uncertainty about foundation and cost. Problems with sedimentation, affects visual quality and problems with public opinion
- Site 6: uncertainty about foundation and cost Site requires a minimum of material. Benefits in 10 years or so.

## **8.7 Group 4 Verbal Presentation**

**Presented by: Max de Puy**

### **Question 1, Group 4**

I think the main objective for the project is: how to do the project in the cheapest way possible with the minimum of environmental damage? The additional alternatives are:

- One alternative is to deposit part of the material along the sides of the new locks alignment channels
- The second is number 3, the UXO location. The short hauling distance make it very economical, and our environmental expert (H. Broce) agrees. The cleanup cost could be \$62,000 per hectare – \$25,000 per acre – and we would maybe need a maximum of 100 hectares in this area. That would be and additional \$6 million cost for the project, and the earnings from it will be immense, you would have an area there that would not be dangerous, could be further used as a deposit site for future Canal expansions and could be converted in to forested areas.
- The other point is that all of these comments are based on the choice of Alignement P1. The excavation and the cost for Alignment P2 would be less because the volume is a lot smaller. Maybe from the point of view of navigation, some pilots do not like P2 because it includes a turn. For P2 you are going to be able to deposit all the material on one side. You will not have to go to any other side.

### **Question 2, Group 4**

- The deposit sites that are on the east side present several logistical problems because they are going to interfere with Canal operations. In addition there will be secondary costs that are out of the Canal's control.
- Island projects 5 and 6, in our opinion should only be considered if we don't have to pay for it or if someone will transport the material for free. If not, the hauling cost could kill the project.
- The material could also be divided among several sites instead of requiring just one site.

## 8.8 Group 4 Written Outline

### Question 1, Group 4

Place the material along the sides of the new alignments

- 20M m3 along the sides, like in Gaillard Cut
- 50M m3 in the UXO areas \$62,500 / hectare is the cost of cleaning the UXO areas. If you clean 10 hectares = \$600,000
- We have enough capacity to accommodate excavated material

For alignment P2, the 40M m3 could be deposited in the Cocolí area

If the deposit of material becomes a critical factor, then alignment P2 would become the preferred site for new locks.

### Question 2, Group 4

Deposit sites along the new locks alignment meet the basic requirements, and should be considered in addition to the 6 sites.

If the ACP has to pay to transport material to the island and peninsula sites, then those sites should not be considered viable.

The sites to the east of the Canal should not be eliminated because they could provide benefits for Panama. The Canal would be supporting national development.

Multi-sites should be considered, especially if they provide added value

Initial costs could be high, but the benefits also have to be analyzed

## **8.9 Transcription of additional comments:**

Agustín Arias

Among the alternatives that we are looking at, we should also consider site 2 if we choose an alignment that is not P1 and has a smaller amount of material to excavate, because site 2 was eliminated for its lack of capacity and should therefore be included in the evaluation. This is the area of Corozal, and I think this area should also be evaluated.

Yolanda Chin

A comment on the proposal of Boris Moreno's group, which proposes using several sites to receive the material. The environmental impact will be multiplied, you will have to build an infrastructure for hauling the material, and the costs will rise. This is the disadvantage of using multi-sites, unless you can limit the number of multi-sites.

Cheryl George

A question for Yolanda: it appears to me that if you use multi-sites, the impact on the sites will be improved because by depositing less material at a site, we would be lowering the impact on the existing site.

Yolanda Chin

You are right about that point, but there are other points, for example hauling and noise, that will be increased in several areas. Also many areas would require providing a permanent infrastructure. Costs would rise. A series of factors would have to be evaluated. The number of multi-sites would have to be limited. Having multi-sites helps, but too many deposit sites would be a problem.

Rigoberto Delgado

I think that sites for sites 5 and 6, site 6 has a big impact on the Howard airport, where the Inter-oceanic Regional Authority (ARI) is trying to market. It seems that the artificial island, at this scale, is far away, about 9 kilometers from the Canal channel. Would we have to dredge an access channel to allow ships to approach the island? We should consider the possibility of combining sites 5 and 6, instead of making an island, make a peninsula with a shape that does not cause a sedimentation impact, since right now the Amador-Flamenco causeway is blocking. If we avoid going beyond Flamenco, as in the peninsula site 5, we would have a shape that none of the studies mentioned, for example those of Moffat & Nichol and Louis Berger. For example, ICA (the constructor of one of the toll roads) studied making some islands over here, something very similar. Among the options, I don't see much of anything new. I would like to request that you consider making something like this, between sites 5 and 6, since site 6 is very far away, and that you consider depositing the material to make a peninsula that is not as big as site 5.

Daniel Muschett

It is preliminary to say that the multi-sites, because of their required infrastructure, would make a bigger impact because you have to inspect to see whether the existing infrastructure would support continuous hauling traffic up to a certain point. It is an

impact that could be bigger than developing different or multiple infrastructure at other sites that could additionally serve to improve existing or deteriorated infrastructure. What I mean is that I think to compare all the multi-sites to the use of a single site, you have to make a complete impact evaluation – what impact there would be on existing infrastructure, what alternate infrastructure would be required, and the social and environmental impacts. Because we already have experience in the city with the toll roads, the highways and deterioration of the existing infrastructure and alterations in residential traffic and the rules for specific hours of relief from continuous interruption by heavy truck traffic. In order to haul any dry material to any of these sites, no matter which ones, implies the use of an infrastructure that was not designed for that use and that will have an impact, even if we make them smaller; perhaps by using several the impact can be diluted or can be used as a means to improve an insufficient infrastructure in order to reach the sites.

Hortensia Broce

Before we can make a final plan for all of the alternatives, since port development is already going on, we are going to have to discuss the matter with other agencies to ensure that, if we build a port facility, the port companies will use it. There are other port projects being planned in Panama, like the one in Chiriquí, and they will be in conflict with development of a port here.

Agustín Arias

It would be good to return to, since some of you have partially responded to this question, I think that this would be a good opportunity to review the criteria that are listed here. Review the criteria to see if there are additional criteria to add or if you want to identify something specific about the criteria. If you think that there are criteria that are important to consider or if there are additional criteria that should be added. I think that Michael Horton initially gave out four questions. It would be good to review the questions and take advantage of this opportunity to review them all and not just focus on the six options, because I see that you have already answered one of the questions. We should also take advantage of the meeting to receive information and feedback about the next stages of evaluation from you.

## 9 PRESENTATIONS FOR QUESTION 3, SECOND PART OF THE WORKSHOP

### 9.1 Group 1 Verbal Presentation

#### Question 3, Group 1

**Presented by: Leonardo Paredes**

For the first point, we say “no”, there are other important aspects. We recommend environmental and political impact, and do not necessarily give added value the same weight as the two that we are recommending. We have to sit down and evaluate which of them should be given more weight or percentage for the evaluations.

For the second point, we do not recommend totally eliminating the east-of-the-Canal sites. We do agree that site #1 should be eliminated because of the many reasons we have already discussed. We are recommending that site #4 be modified, supporting our initial position that it could be a partial fill that would contribute to the infrastructure of the islands (causeway).

For the third point, yes. Our answer is: we should include the multi-sites. We have already mentioned that there is a possibility that the total impact of using multi-sites could be less than using one big area to receive everything. With this question in mind, we recommend that a study of the multi-sites be made.

For point number 4, we think that the criteria should be weighted. We are establishing environmental/social aspects as criteria number 1, then technical, including transportation, location and all the aspects of construction and mobilization, as criteria number 2. Then legal, covering all legal aspects, since other government entities exist that have already established various development projects in other investment sectors, such as tourism, and should carry a lot of weight. We would definitely put economic considerations there, but remember that the costs established for each of the previous margins will be an influence, or cost will be connected with other aspects. That is why we begin with the first group. The political, after economic, we feel that should be the order because public opinion really will not be a part of every one of these groups of study. There will always be proposals, scenarios or alternatives, and the best one will be chosen according to the environmental, social and public aspects of the moment.

Added value, according to our table, could include the economic aspect, which is the first thing that comes to mind when thinking about added value. The concept of added value really covers a little of each of the other aspects of the analysis

### 9.2 Group 1 Written Outline

#### Question 3, Group 1

- First: Other important aspects are: environmental and political impact.

- Second: The east sites are not recommended in their totality. Eliminate site #1 and modify site #4.
- Third: Yes.
- Fourth: We think that the evaluation criteria should not all have the same weight. They should be weighted.

**Weighted order for criteria:**

- Environmental/Social
- Technical/transport/location
- Legal (jurisdiction) example: tourism, development, sectors
- Economics
- Political (public opinion)
- Added value

### **9.3 Group 2 Verbal Presentation**

**Presented by: Agustin Arias**

We think that there are some additional criteria that should be considered in addition to those listed here. An analysis of the cumulative impact must be made. This has to be added in some form, especially for considering all the sites as multi-sites. The possibility exists to use more than one site. The cumulative impact would have to be considered. The legal, economic and especially the inter-institutional part are very important.

The costs and conditions for preparing the sites: Some of the sites require costly preparation. Others do not. We also think it is a very important criteria.

Consider what the probability of being able to use the site is - the political aspects will be difficult. For example, we have the bay option. This has to be considered in some way. Because it is very complex, political relations will enter into it in order to develop a site, and this has to be given a weight, and the site should maybe be given a lower priority. Because we could pick a site that is very hard to use, even though it looks good for its economic and environmental aspects. And if we depend on developing these (politically sensitive) sites and later we cannot get stakeholder approval, then what are we going to do with that option. This has to be taken into account some way, the difficulty in developing the site, not just on its technical and economic aspects, but also on its political ones, on having to align in many ways with the state or with private business. The site's impact on Canal operations should also be included.

Referring to the questions, the sites that do not have added value should be included. So our answer to the question whether further studies should be limited to the sites with added value is "no".

For number 2, whether we should eliminate the sites east of the Canal, we think that a traffic analysis should be made, because if we are going to move barges, here Captain Altafulla suggested that we could move barges (across the Canal) in groups of four or five, and this is a new idea. We don't necessarily have to move them one by one. This could diminish the impact on Canal operations. So we need to analyze this a bit more, and we don't think that the east side sites should be eliminated, for this reason, because we could find a way to minimize interference with Canal operations.

Third, whether we should include multi-sites, the answer is "yes". We think all the sites should be considered as multi-sites. More than one site could be used. We are referring to the six sites and possibly one more, but we are not referring to the 29, we want to be clear on that.

**... Javier Moron continues giving the presentation for Group 2**

Regarding which of the written criteria was given the most points, cost won first place. In second place are environmental aspects, in third are socio-economic aspects, fourth place the technical aspects, fifth is added value and sixth are the legal/political aspects. The subject of public opinion is included or implicit on the environmental and socio-economic aspects. We consider it to be related to these two aspects. The topic of how public opinion perceives the environmental and socio-economic impacts does have importance, because we have given those two aspects second and third place in the ranking.

## **9.4 Group 2 Written Outline**

Question 3, Group 2

First: No

Second: Traffic analysis for operations area

Third: All should be considered as multi-sites / cumulative impact

Fourth: Weigh the criteria in order of importance

- Costs
- Environmental
- Socio-economic (including public opinion)
- Technical
- Added value / economics
- Political / legal

## 9.5 Group 3 Verbal Presentation

### Question 3, Group 3

**Presented by: César Kiamco**

In response to the final questions, we think that you should not be limited to using sites with added value. This is a project to expand the Canal and not necessarily commercialize and island. We think getting the material deposited should be the main preoccupation. So we should be focused on the method of disposing of the excavated material.

We think the sites to the east of the Canal are not worth considering. We could consider them, but just for inspection – we know that they present big problems on the one hand – and on the other hand we do have solutions on the west side that we can use. It seems to me that we should not dedicate resources to studying these sites.

Include multi-sites, yes that is worthwhile.

The relative importance of the criteria: we are going to summarize, from the point of view of engineers, what we think are the most important criteria. Then it will be the environmentalists' job to make a more detailed analysis. Of all the criteria, there are really only three that are worth considering: cost-benefit, avoid political problems and environmental impact. We think that the rest of the criteria can be included in one way or another in these three main ones. In order to present a more refined analysis, we are going to hand things over to the environmental experts.

### ... Marilyn Dieguez continues the presentation by Group 3

In order to apply the criteria to the six sites, we made a table. We took all the criteria and tried to identify variables and a system for weighting the criteria.

1. Added value: We assigned high, medium or low in terms of land value and generation of employment.
2. Transportation system: we consider the distance and the need for infrastructure
3. Site location: We think it is negative if the site is located on the east and positive if the site is on the west
4. Public opinion: as related to sector interests, we assigned high, medium and low values
5. Visual impact: high, medium, low
6. Impact during construction: high, medium, low, and we think that all the projects that place a fill in the bay have a high impact.
7. Permanent use of the site: if it provided or not
8. Environmental impact: could be positive or negative, and in one case it tends to balance out.

9. Political aspects: positive or negative
10. Technical aspects: whether it requires high tech labor, technology and equipment
11. Economic aspects: high, medium or low cost
12. Others

Upon making an evaluation that is qualitative, subjective and based on perceptions, our results say that the least viable options are the use of Panama City bay, the former firing ranges and the artificial islands. The Panama City bay fill implies high public opinion costs and requires high technology, even though it would generate high added value, employment for construction and continued employment. We should remember the experience a few years ago when someone proposed building a cast-in-place box culvert on the Mataznillo River, and the environmental organizations chained themselves together along the bay. When anyone brings up the idea of filling in the bay, the community jumps into action.

There are several projects that a project like this would cause conflict. These projects are the construction of a coastal greenbelt (along Balboa Avenue) and the cleanup of the bay (sewage control), which imply a large government investment in terms of projections. In terms of putting them in action also means big investments and costs.

On the case of using the firing ranges to deposit material, one of the things that would have to be evaluated is what kind of project would be proposed for the fill sites. Because we consider that it has negative and positive impacts, if you take into account the matter of cleaning up the firing ranges. The costs will be a lot higher because this implies cleaning up the area before depositing any material. But if you tie it to a landscaping or reforestation project in the fill sites, the environmental impact could be positive. But there exists a delicate situation for this area in terms of the conflicts that our country has presented to the United States in terms of the cleanup. This discussion is going on at a bilateral level, and transcends the country in terms of our interests.

For the case of the artificial island, we think it will have high impact, for costs as well as public opinion, since the economic costs are high. It requires high technology and a highly trained workforce. We also have an antecedent in the island that ICA wanted to create. Public opinion affected the release of funds that the company had borrowed on the international banking market. So these are the three most critical in terms of options.

The least critical are the El Arado site, if the added value of the land is low and later use is also low. It implies the purchase of private property, and high transportation required infrastructure costs. A total value has to be calculated for all of this in order to judge whether they are good options. Right now they remain at the level of a quick application of technical criteria.

The other of the options is the peninsula, keeping in mind what the other groups have already said about the water currents and improving its alignment.

**Additional comment: Hortensia Broce**

... and abandon it at the site, otherwise the costs should include making terraces and planting the area. Equally, whichever other deposit site that implies a long-term cost after using it, that cost should also be included in the cost criteria; for example reforestation costs.

**Comment: Maximiliano de Puy**

I disagree with Mr. Kiamco's group with respect to site 3. First, you have to (doubt) whether we are going to get anything out of the United States to clean it up. The area has zero value; it has no value at all. The only thing it is good for it as a fill for excavated material. I think it is an ideal site. At least we are going to get something out of an area that has no value at all.

**Additional comments:**

A discussion followed of the political, economic and environmental aspects of the firing ranges and the possibility of cleaning up a part of them for beneficial use, or of using a relatively small, non-forested area as a fill site.

**9.6 Group 3 Written Outline**

**Question 3, Group 3**

In order to form an opinion:

- Require investigation of sites to calculate costs of the marine options.
- Marketing study required for estimating the benefits
- Cost-benefit analysis
- Consider using multiple sites

Four additional questions:

- First: Should not be limited to sites with added value. Depositing the material should be the main concern without site discrimination
- Second: Yes
- Third: Yes
- Fourth: Cost-benefit, avoid political problems and environmental impact

**Note: see the Appendix for the weighted table presented by Table 3.**

**9.7 Group 4 Verbal Presentation**

**Question 3, Group 4**

**Presented by: Luis Paniza**

First we answered the first four questions. On eliminating sites to the east of the Canal, we don't think they should be eliminated, but kept as alternatives for multi-sites, as was mentioned earlier, because there are certain benefits that could contribute to national development plans.

We also think that multi-sites should be considered, that is, consider all the sites as Mr. Arias said. That gives us versatility in placing, say 20 million (cubic meters) of basalt aggregate, if it can't be used to reinforce the Canal or the locks. We are always thinking about the technical aspect, since the people at this table are mostly technical. That is why we like site #3, which is the one we consider to be closest and with the lowest transportation cost. An economic analysis must be made to determine how to overcome the initial costs and get later benefits.

Regarding the questions, as for added value, we have assigned priorities. We think that site 6 and 5-modified – we always say that 5 has to be changed to not just make a rectangle like in the drawing because the effect of currents and ship maneuverability. For site 1, partial, because we are of the opinion that the bay fill could be used for government projects, because you can't eliminate this option because it could be used to hold a water treatment plant, an island. You can't eliminate this option. Site 3 gives us a value that seems more reasonable because of the transportation. Transportation distance is shorter and it affects Canal traffic less.

Regarding the transportation system and its cost, we have two alternatives, terrestrial and marine, if we haul using barges, railroad or trucks. We think it would be difficult to use trucks for transport to sites 5 and 6, so that would be completely eliminated.

As for prioritizing the location of the disposal sites, we think the west has priority. This is a state project for alternative development. This goes parallel with a marketing study that we will be obtaining. In many countries this material is valuable. We have to market it, back it up and see if maritime industry companies are interested in making it into a port.

As for public opinion, site 3 definitely has little impact on public opinion. It would be a job like the one we have been doing until recently in Gaillard Cut – totally dedicated to widening the Cut.

Environmental impact – we think a reduced site 3, because it has some forested areas that would be affected. We propose using a smaller area, and simply control the height of the material. We have experience with 50 meters, and there might be a valley area that has been taken over by grass that could provide an adequate site and would not affect the forested areas.

We have the multi-sites parallel to the canal centerline, and these sites must be considered along with the six proposed sites. Political aspects, the former use of the area as a firing range, the bay fill, we have listed which will have the biggest political impact, from most to least, which is site 4, 1 and 6. They would of course affect other development, there would be claims, and those costs would be added to the project.

Sites 5 and 6 present problems that impact other viaducts.

Technical effects, in order, from 1, 4, 5 and 6. The problem with sites 1 and 4 is the project to clean up the bay, location of the emisario, and crossing the Canal channel, which creates a conflict between our barges and our clients.

Site 5 has a problem that the ocean currents affect navigation and the canal would already be narrow and would have to be modified. For economic aspects, we already know that there are fixed costs for a volume of 70 million cubic meters, and the excavation amount would not vary. The variables are the methods of transport and the distance. So those variables and the side benefits would have to be manipulated. Another site that should be included in the modified site 5, because it affects Canal operations as it has been presented; it is very close to the Canal.

## **9.8 Group 4 Written Outline**

### **Question 3, Group 4**

Added value listed in order by priority

1. Sites #6 and #5 (#5 modified)
2. Site #1 (partial and multi-sites)
3. Site #3 (transportation distance)

Hauling system

1. Marine – barges
2. Terrestrial – railroad, trucks

Site location:

1. West has priority
2. East – government projects / development

Public Opinion

1. Site #3 has less impact

Environmental Impact

1. Site #3 reduced and multi-sites parallel to the ¿?

Political Aspects (UXO + fill in the bay), listed from greatest to smallest

1. Sites #4 and #1.... #6  
visual – interferes with other development – legal problems
2. Sites #5-6 Transportation routes

Technical Aspects

1. Sites #1, 4, 5, 6 have the most problems
2. Sites 1, 4 have to cross the Canal and Canal traffic, project to clean up the bay
3. Site #5 water currents affect navigation

Economic aspects:

1. Fixed costs: excavation
2. Variable costs
  - Transportation method – marine, terrestrial
  - Distance – the longer the distance, the higher the cost
  - Time for execution

Others:

- Modification of Site #5 because it affects Canal operations since it is located very close to the Canal

10 APPENDIX

10.1 Application of the Criteria to the Deposit Site Alternatives (Table 3, Question 3)

| Criteria  | Sites | 1<br>Panama<br>City bay | 2 El Arado | 3 UXO   | 4 Widen Amador<br>Causeway | 5 Peninsula | 6 Artificial<br>Island |
|---|-------|-------------------------|------------|---------|----------------------------|-------------|------------------------|
| 1. Added value  |       | High +                  | Low -      | Low -   | High +                     | High +      | High +                 |
| 1.1 Land value  |       | High +                  | Low -      | Low -   | High +                     | High +      | High +                 |
| 1.2 Generation of employment<br>(high, medium, low)   |       | High +                  | Low -      | Low -   | High +                     | High +      | High +                 |
| 2. Transportation system – distance, need for<br>(high, medium, low)                            |       | Medium                  | High -     | Low +   | Medium                     | Medium      | High -                 |
| 3. Site locations: east - , west +  |       | --                      | +          | +       | --                         | +           | +                      |
| 4. Public opinion   |       | High -                  | Low +      | High -  | High -                     | High -      | High -                 |
| 4.1 Sector interests  |       | High -                  | Low +      | Medium  | High -                     | High -      | Medio                  |
| 4.2 Visual impact   |       | High -                  | Medium     | Medium  | High -                     | High -      | High -                 |
| 4.3 Construcion impact  |       | High -                  | Medium     | Medium  | High -                     | High -      | High -                 |
| 4.4 Permanent use of the site yes/no  |       | Yes +                   | No -       | No -    | Yes +                      | Yes +       | Sí +                   |
| 5. Environmental impact -, 0, +   |       | --                      | Medium/low | - and + | Medium                     | High -      | High -                 |
| 6. Political aspects (UXO, Panama City bay fill) -, 0, +  |       | High -                  | 0 and +    | High -  | High -                     | Low +       | High -                 |
| 7 Technical aspects, (requirements) skilled labor,<br>technology, equipment (high, medium, low) |       | High -                  | Medium     | High -  | High -                     | High -      | High -                 |
| 8. Economic aspects, costs (high, medium, low)  |       | High -                  | Medium     | High -  | High -                     | High -      | Alto -                 |
| 9. Other: Neg/Pos, Med  |       | 8/3, 1M                 | 4/4, 4M    | 8/2, 2M | 7/3, 2M                    | 6/5, 1M     | 7/4, 1M                |
| Ranges  |       |                         | #1         |         |                            | #2          |                        |

## 10.2 Powerpoint Presentation by Michael Horton

### Preliminary Screening of Alternative Disposal Sites for Materials from Locks Excavation

Draft Report  
September, 2002

### Site Selection Process

- ✓ Pre-screen land and marine sites
- ✓ Reject those that do not meet basic criteria
- ✓ Prepare a Short list for ACP review
- Workshop to Establish Priorities/Options
- Selection of Preferred locations/projects
- Move to More Detailed Study
- Select Preferred Site

### Site Selection Process

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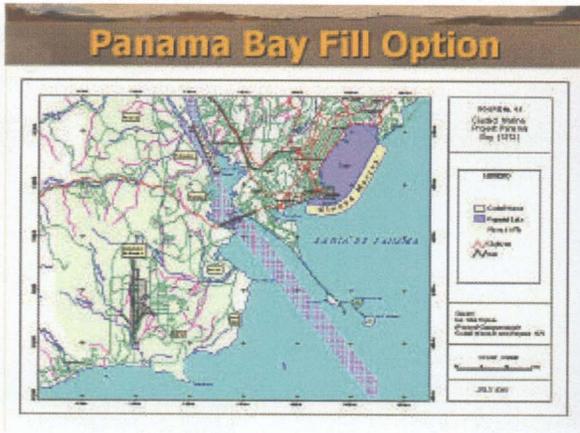
### Screening Process

- Elimination of Sites that do not meet basic criteria.
  - Duplication or similarity to other Site
  - Capacity (70 mm<sup>3</sup> + bulking)
  - Distance from Excavation (> 20 km)
  - Existing or Proposed Land Use

### Preliminary Screening Process

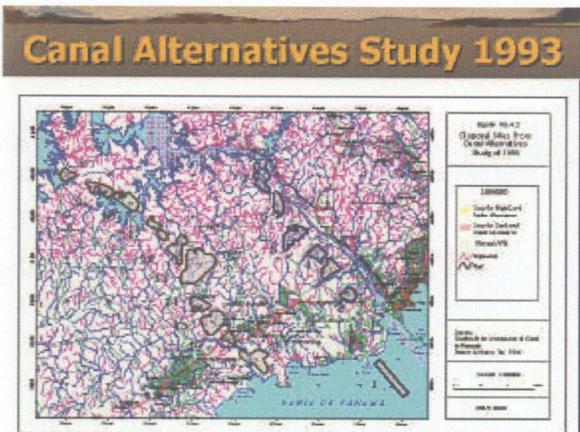
### Identification of Candidate Sites

- Previous Reports (Various)
- 1993 Canal Alternatives Study
- Panama Canal Designated Disposal Areas
- Options from ACP Workshop Sessions



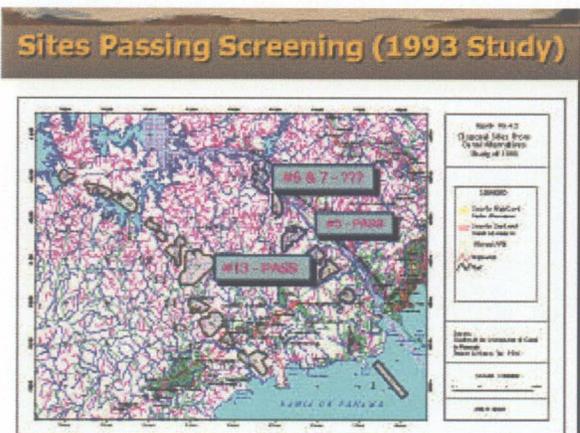
### Panama Bay Reclamation - - Conclusions

- Capacity to Receive all material
- Within Acceptable Haul Distance
- No Insurmountable Land Use Conflicts
- **Site Passes Preliminary Screening**



### Evaluation – Groups 1 & 2

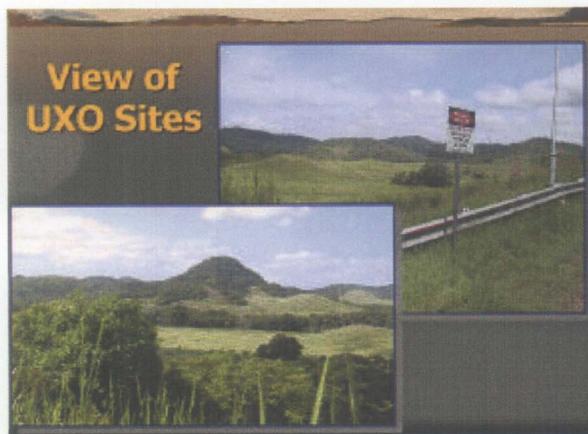
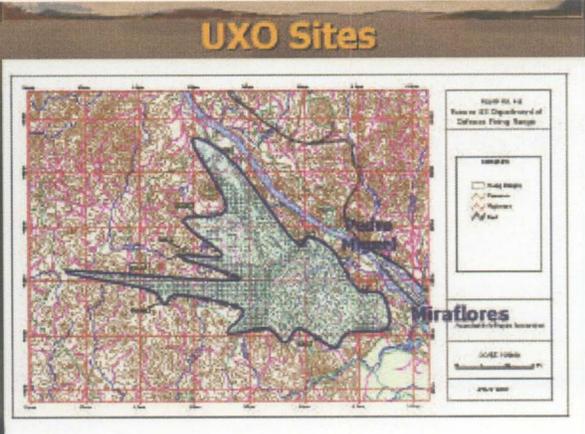
| Ref No.  | Site | Capacity or Tonnage | Area (ha) | Distance from proposed area (km) | Capacity within 100 km                      | Comments or Constraints | Recommendation |
|--|------|---------------------|-----------|----------------------------------|---|-------------------------|----------------|
| <b>Group 1 - High Level Locks Alternative - Disposal Sites</b> |      |                     |           |                                  |   |                         |                |
| 1  | A    | 550                 | 50        | 28                               | In Front of Isotane beach                   |                         | Fail           |
| 2  | T    | 121                 | 0         | 12                               | Within Howard AFB, Limited Capacity         |                         | Fail           |
| 5  | T    | 585                 | 4         | 20                               | Limited Capacity                            |                         | Fail           |
| 6  | T    | 182                 | 0         | 18                               | Limited Capacity                            |                         | Fail           |
| 7  | T    | 530                 | 50        | 24                               | Limited Capacity                            |                         | Fail           |
| <b>Group 2 - Sea Level Locks Alternative - Disposal Sites</b>  |      |                     |           |                                  |   |                         |                |
| 9  | T    | 140                 | 31        | 23                               | Exceeds 20 km haul                          |                         | Fail           |
| 10   | T    | 230                 | 36        | 23                               | Exceeds 20 km haul                          |                         | Fail           |
| 18   | T    | 281                 | 33        | 28                               | Exceeds 20 km haul                          |                         | Fail           |
| 11   | T    | 284                 | 58        | 28                               | Exceeds Capacity, or limit of haul distance |                         | Fail           |
| 13   | T    | 290                 | 11        | 28                               | Exceeds Capacity, or limit of haul distance |                         | Fail           |
| 12 (El Prado Site)   | T    | 1,048               | 76        | 105                              | Acceptable as Canal Use                     |                         | Pass           |
| 14   | T    | 295                 | 11        | 25                               | Populated, low capacity                     |                         | Fail           |
| 15   | T    | 235                 | 11        | 42                               | Exceeds Capacity                            |                         | Fail           |
| 16   | T    | 130                 | 11        | 13                               | Populated, low capacity                     |                         | Fail           |
| 17   | T    | 480                 | 11        | 44                               | Populated                                   |                         | Fail           |



### Panama Canal Designated Disposal Sites

### Dredged Materials Disposal Sites - Conclusion

- 1) Exclude all Sites Currently in Use or programmed for use
  - Farfan
  - Velasquez
  - Rosseau
- 2) Exclude Sites East of Cut, due to transportation problems and low capacity

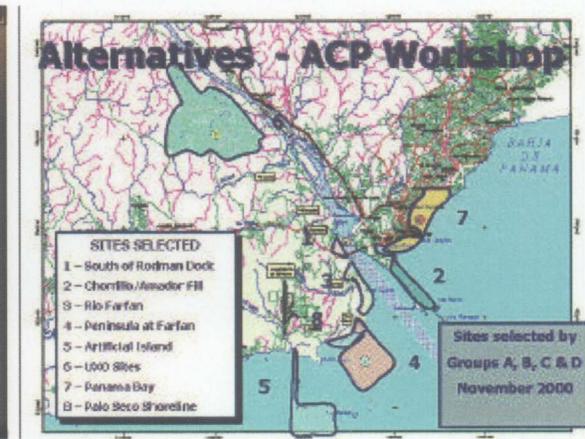


### UXO Sites - Conclusion

- Site Meets criteria to pass to next stage of Evaluation

### ACP Disposal Options Workshop November 2000

- 4 Groups in Workshop (A, B, C & D)
- 18 Sites/Projects Proposed
- 8 Sites after elimination of duplicates
- Favored Artificial Island Project

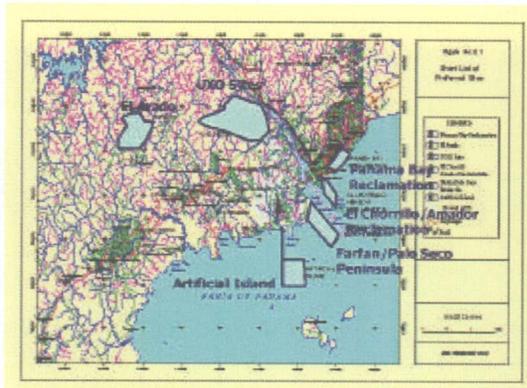


| ACP Sites - Conclusions                    |   |   |          |       |      |  |      |
|--|---|---|----------|-------|------|--|------|
| <b>Group A</b>                             |   |   |          |       |      |  |      |
| 1  | South of Redman Pier                          | A | 35       | 1.1   | 4    | Low Capacity, part of Concession, prime development area | Fail |
| 2  | South of Channels & East of Arado's Causeway  | A | < 12M    | 10.00 | > 30 | Potential Economic Benefits, Canal Closings required     | Pass |
| 3  | South of Farfan/Palo Seco & River Farfan area | A | UNWRITES | 1.5   | > 30 | Significant Visual Impact, Value added potential         | Pass |
| <b>Group B</b>                             |   |   |          |       |      |  |      |
| 1  | Artificial Island close to 1939 channel       | A | UNWRITES | 2.8   | > 30 | Proved to be more expensive + more added                 | Pass |
| <b>Group C</b>                             |   |   |          |       |      |  |      |
| 2  | Pier at River Farfan shoreline area           | A | 161      | 1.4   | 18   | Close to Canal, existing structure, 800,000 capacity     | Fail |
| <b>Group D</b>                             |   |   |          |       |      |  |      |
| 3  | Concrete pier along Palo Seco area            | A | 108      | 1.3   | 5    | Low capacity, small area impact                          | Fail |
| <b>Other sites identified during study</b> |   |   |          |       |      |  |      |
|  | Stockpile Rock for Reefs                      | T | n/a      |       |      | Limited Demand   | Fail |

### Results of Preliminary Screening of 29 sites

1. Panama Bay Reclamation (M)
2. El Arado (T)
3. UXO Sites (T)
4. El Chorrillo/Amador Reclamation (M)
5. Palo Seco/Farfan (peninsular) (M)
6. Artificial Island (M)

M = Marine Site  
 T = Upland Site



### Issues of Significance Panama Bay Reclamation/Restoration

- Advantages
  - Resolution of Long standing problem
  - Could generate significant benefits
- Concerns
  - Movement of material from Locks Site
  - Preparatory cost requirements
  - Jurisdictional Issues
  - Timing

### Issues of Significance Arado Site

- Advantages
  - Single location
  - Less environmental impacts than marine sites
- Concerns
  - Little or no added value
  - On limit of acceptable haul distance
  - Outside ACP/ARI controlled area
  - Private land ownership

### Issues of Significance UXO Sites

- Advantages
  - Resolution of Important National Issue
  - Potential for Added value after Bridge Project
  - Shortest Haul distance
- Concerns
  - Clearance of Ordnance
  - Environmental Impacts
  - Topography
  - Requirements for Locks Construction
  - User Acceptance of Cleared & Filled areas

|  |  |
|--|--|
| <p><b>Issues of Significance<br/>Chorrillo/Amador Reclamation &amp;<br/>Expansion</b></p> <ul style="list-style-type: none"><li>○ Advantages<ul style="list-style-type: none"><li>• <i>Potential for Added Value</i></li><li>• <i>Resolves contamination issues at Chorrillo</i></li></ul></li><li>○ Concerns<ul style="list-style-type: none"><li>• <i>Public Opinion (Amador Expansion)</i></li><li>• <i>On East Side of Canal</i></li><li>• <i>Road or Barge haul limitations</i></li></ul></li></ul> | <p><b>Issues of Significance<br/>Farfan/Palo Seco Peninsula</b></p> <ul style="list-style-type: none"><li>○ Advantages<ul style="list-style-type: none"><li>• <i>High Potential for Added Value</i></li><li>• <i>Good wave protection</i></li><li>• <i>Clear of Veracruz Beach areas</i></li><li>• <i>Excellent Port Site</i></li></ul></li><li>○ Concerns<ul style="list-style-type: none"><li>• <i>Public Opinion (Visual Impact)</i></li><li>• <i>Height of Rock layer (Port Installations)</i></li><li>• <i>Development Cost</i></li><li>• <i>Impacts on Kabbe development</i></li><li>• <i>Environmental Issues</i></li></ul></li></ul> |
|--|--|

|   |   |
|---|---|
| <p><b>Issues of Significance<br/>Artificial Island</b></p> <ul style="list-style-type: none"><li>○ Advantages<ul style="list-style-type: none"><li>• <i>Good Potential for Added Value</i></li><li>• <i>Excellent Port Site</i></li><li>• <i>Distanced from Amador view points</i></li></ul></li><li>○ Concerns<ul style="list-style-type: none"><li>• <i>Public Opinion (Visual Impact)</i></li><li>• <i>Height of Rock layer (Port Installations)</i></li><li>• <i>Development Cost (Causeway etc)</i></li><li>• <i>Impacts on Veracruz &amp; Beaches</i></li><li>• <i>Environmental Issues</i></li></ul></li></ul> | <p><b>Next Step in the<br/>Evaluation Process</b></p> <ul style="list-style-type: none"><li>○ <b>Confirm or Modify Selection Criteria for Preliminary Assessment</b></li><li>○ <b>Confirm or Modify Short List of Sites</b></li><li>○ <b>Agree on Criteria for Next Level of Evaluation</b></li><li>○ Undertake Evaluation Studies</li><li>○ Draft Report</li><li>○ Second Workshop</li><li>○ Select Final Alternative</li><li>○ Detailed Feasibility Study</li></ul> |
|---|---|

**Proposed Criteria for  
Final Site Selection**

- Technical Assessment & Concepts
- Land Use (Existing & Future)
- Environmental Impacts
- Public Opinion
- Construction & Development Costs
- Value Added Potential
- Economic Benefits Potential
- Socio Economic Values
- Jurisdictional Issues
- Multi-sites or not?

**APPENDIX H - ACP WORKSHOP – AUGUST 2003**

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**Summary of Panama Canal Authority (ACP) Internal  
Workshop on the Excavation Material Deposition  
Sites**

**– Panama Canal Expansion Program –**

**September 23<sup>rd</sup>, 2003**

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| 2.2      | Afternoon Session: Discussion Tables .....  | 10       |
| 2.2.1    | Results.....  | 10       |

# 1 INTRODUCTION

---

Workshop started at 8:30 am with:

- a) Presentation of speakers and
- b) Agenda for the day.

The structure of the workshop consisted of two half days of activities. During the morning session 4 summaries by Michael Horton, Eng. (Moffat & Nichol) and Dr. Ariel Cuschnir (The Louis Berger Group, Inc.) were presented:

- *“General Characterization of Deposition Sites for Excavation Material from the Panama Canal”*
- *“Environmental Evaluation of Alternative Sites*
- *“Technical Evaluation of Alternative Sites”*
- *“Site Classification”*

In the second session (afternoon) a round table with analysis of the issues presented, and recommendations, was conducted.

Reduced slides from the morning and afternoon presentations are presented at the end of the Workshop Notes.

## **2 MORNING SESSION**

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### **2.1.1 1st Presentation: Michael Horton, P.E. (Moffat & Nichol)**

#### *"General Characterization of Deposition Sites for Excavation Material from the Panama Canal"*

Mr. Horton initiated the presentation indicating that the Draft Report for this study consisted in 5 extensive volumes of technical/environmental material which was under review by ACP officials. He also mentioned that the purpose of the workshop was to serve as a platform for the attendees' participation in the decision-making process for the selection of alternative disposal sites. This participation includes the elaboration of the principal criteria for site selection.

It is important to emphasize that the proposed number of sites for evaluation had evolved from an identified 59 original sites, to a final number of 17. This was a process that took into consideration socioeconomic, environmental, institutional, and technical issues, as well as the engineering needs of the expansion program. That is, the grouping of "areas of excavation" and subsequent "disposal flows" from the excavation areas. The site selection process is described below:

The list of original 59 proposed sites was developed from a variety of sources that included:

- Sea-level Canal studies
- Sites excavated before 1993
- Sites identified during the 1993 Study of Alternative for Panama Canal Expansion
- Sites proposed by ACP for dredging activities
- USADOE Abandoned sites
- Sites considered during the November 2001 ACP workshop
- Sites recommended by the consultants

Preliminary technical and environmental evaluations conducted by the consultants (including the elimination of repetitions) screened the number of sites down to 29. These 29 sites underwent a second-tier screening based on 3 criteria:

1. Sites must accommodate the entire excavation volume (70 million m<sup>3</sup>)
2. Site must be within an economically feasible transport distance of no more than 20 km
3. Site with obvious conflicts of land ownership/jurisdiction will be eliminated

The implementation of this screening process led to a final number of 6 proposed sites that were presented at the September 2002 workshop. At this event it was recommended that the evaluation considers additional options for the disposal of excavation material and that the use of multi-sites should be kept as an open option against the mono-site alternative originally decided. This step led to the inclusion of additional sites for evaluation and the final number of 17 presented at this workshop.

Mr. Horton proceeded to present the technical evaluation of each of the 17 sites and their characteristics, such as:

- Panama Bay site (M1): there is no final concept since it is a very sensitive area with overlapping institutional jurisdiction.
- Site M2 (Chorrillo Bay fill) can have a double function of value-added and contribution to the improvement of the bay's water quality.
- Site M3 (widening of Amador Causeway to 500m) could be a feasible option
- Site M4 (Palo Seco peninsular expansion) presents various environmental, social, and institutional problems.
- Site M5 (Artificial Island) Mr. Horton mentioned that the study is being conducted simultaneously and that in a few weeks there will be a report submittal.
- Site M6 (underwater disposal) will consider a minimal depth of 20 mts to avoid interference with navigation
- Sites T1 through T10 were also evaluated and Mr. Horton presented the advantages and disadvantages of each site.

### **2.1.2 Questions and Answers (Examples)**

Q. What is the quantity of material that the site identified as Trinidad Madden?

A. At this site only transport calculations were made

Q. How will the excavation material be removed?

A. It will not be done as it is done nowadays. An international company could be hired for this work

### **2.1.3 2nd Presentation: Dr. Ariel Cuschnir (The Louis Berger Group, Inc.)**

#### *"Environmental Evaluation of Alternative Sites"*

Dr. Cuschnir presented a detailed description of the utilized methodology for the environmental evaluation of each site, distinguishing between marine and terrestrial sites:

- Terrestrial Sites – physical and biological characterization
- Marine sites – general characterization of the Bay and sampling of marine benthos, plankton, and water quality parameters
- Methodology for the analysis of information
- Methodology for the analysis of environmental impacts
- Results
- Preliminary environmental recommendations
- Preliminary cultural resources recommendations
- Preliminary socioeconomic recommendations

### **2.1.4 Questions and Answers (examples):**

Q. All drainage studies were conducted similarly to the methods implemented at Site T1 (Mandinga River?)

A. Yes. Studies were conducted in duplicates. Each site was treated in a similar way.

Q. Did the socioeconomic studies evaluated positive and negative impacts?

A. The identified socioeconomic impacts were primarily those of a negative effect. In the characterization studies only the negative effects were evaluated since most of the available information was of a secondary nature. In this phase of the study there were no

surveys, interviews, etc. Future impact assessment studies should also take into consideration the positive (Economic) effects of the project.

Q. Why do Sites M2 and M3 showed low impact values in the matrix but the effects on marine life are positive?

A. No. From the benthic communities point of view the sandy bottom did not show the species diversity shown at other sampling stations. There will be negative impacts to these communities (habitat destruction) and a quantitative impact analysis of the extent of this loss should be implemented. However, from the point of view of water quality and planktonic organisms, the reconfiguration of Chorrillo Bay could lead to an improvement in the hydrodynamics of the area and better water quality.

Q. Why is there higher biomass of plankton in Chorrillo Bay and Causeway stations if these sites are in contaminated areas?

A. The presence of planktonic communities is directly related to the currents of the area. Currently, organisms entering the bay suffered both the contamination problem as well as the stagnation of the waters. There was a high concentration of fish eggs during certain times of the year. In the case of the Causeway station, this place acts as a funnel for water being displaced along the bay.

Q. How is it feasible to fill in Chorrillo Bay and at the same time obtain positive environmental conditions?

A. This alternative can reduce water stagnation, improve water circulation, and create new types of habitats (rocky) for a variety of marine organisms. In any case, a full EIA is necessary.

Q. Why weren't sites E1 and E2 included in the study?

A. The ACP answered that these sites are needed for operation purposes

Q. Why were there no BOD analyses conducted in the streams?

A. The studies were conducted during the dry season and most streams did not have enough flow or were dry. A physical evaluation of the streams was conducted, together with measurement of water quality parameters areas with water.

Q. What was found in relation to socioeconomic impacts?

A. A limiting factor in this study was the minimization of direct contact with the population. It was decided that at this stage of the project (with no defined alternative) direct surveys, etc. will have a negative impact on the continuation of the project. Consequently, the studies defined the potential effects within a radius of influence. In spite of the lack of contact with the population, the study was able to obtain extensive secondary information and data from informal interviews. This information was utilized in the impact analysis and ranking of alternative sites.

Q. Was a legal analysis for each site conducted?

A. Yes. Several legal documents obtained from various institutions were evaluated and an analysis of the institutional consequences was also implemented.

Q. Why was the water samples conducted during the dry season?

A. Time-contract limitations

Q. There is evidence of archeological/paleontological resources. Why weren't they included in the study?

A. The area of the study is very broad (30 km long). It is impossible to evaluate such an extended area with traditional scientific methods, available time and budget. Once the final alternatives are selected (which may require full EIA studies), then it will be possible to conduct those paleontological studies.

Q. What quantity of forests will be lost?

A. The sites were delineated to exclude sensitive wooded areas.

Q. In Site T8 there is an important population of Ostiones. Where they considered in your analysis?

A. This is not an endemic or species in danger and is located in a man-made contaminated habitat. However, they will be included in future ecological restoration/mitigation plans.

Q. Site T1 west of Mandinga River is in an UXO area?

A. No.

Q. Regarding protected species: is there a different treatment?

A. Yes. This constitutes an important determining factor

### **2.1.5 3rd Presentation: Mr. Michael Horton (Moffat & Nichol) –**

#### *“Technical Evaluation of Alternative Sites”*

Mr. Horton referred primarily to the volumes of excavation material and de transport costs for each site. He also presented the reconfigured sites, the filling alternatives within the existing topography, and the evaluation of site's maximum capacity. Another important data presented was the development of Combined Transport Cost Models (Barges with bottom openings/Trucks).

In relation to the Artificial Island option 2 alternatives were presented:

- Urban/Conservation Development with natural landscapes
- Port Development

Mr. Horton mentioned that the Artificial Island Concept was elaborated taking into consideration local hydrology, location, and its multiple uses.

### **2.1.6 Questions and Answers (Examples)**

Comment: UXO utilization implies a value-added approach

Q. Was material extraction method evaluated?

A. A more detailed analysis is required

### **2.1.7 4<sup>th</sup> Presentation: Dr. Ariel Cuschnir (The Louis Berger Group, Inc.)**

#### *"Site Classification"*

A classification of all sites evaluated was presented. This classification was implemented upon completion of the technical and environmental evaluations. In addition, the potential environmental impacts (such as habitat loss, habitat restoration) were described.

Finally Dr Cuschnir mentioned that a reconfiguration and reclassification of sites based on environmental and technical factors was conducted.

Mr. Horton concluded the first half of the workshop with an evaluation of each alternative site as follows:

- T1: Not feasible due to environmental concerns – Excluded and reconfigured
- T2: Similar to T1
- T3: Feasible, already in use by ACP
- T4: Feasible but certain environmental/social considerations must be included
- T5: Similar to T3
- T6: The environmentally reconfigured site of UXOs shows technical and institutional problems. However filling is feasible.
- T7: Site is the most economically feasible (location and jurisdiction). No restoration costs
- T8: The site could be used for deposition depending on final alignment design
- T9: Excluded for environmental, capacity, and institutional issues
- T10: Could be expensive to purchase the private lands and it is outside ACP's jurisdiction. Mitigation can also be expensive
- M1: Panama bay Fill – Out of scope and very controversial
- M2: Chorrillo Bay: jurisdictional problems but feasible and economically/socially positive. High value-added.
- M3: Positive impact on Amador Causeway. High value-added.
- M4: Highly sensitive environmentally and institutionally. High value-added.

- M5: 2 possible concepts as previously described. High value-added

### **2.1.8 Questions and Answers (Examples)**

Q. Was the potential value-added for the Gaillard areas considered within the mitigation measures?

A. Yes. If the area is restored it would have a significant value-added.

## **2.2 Afternoon Session: Discussion Tables**

During the afternoon session the participants were divided into 3 working groups with the purpose of obtaining their opinion on the information presented and to answer questions regarding the final selection of disposal materials sites.

The questions were:

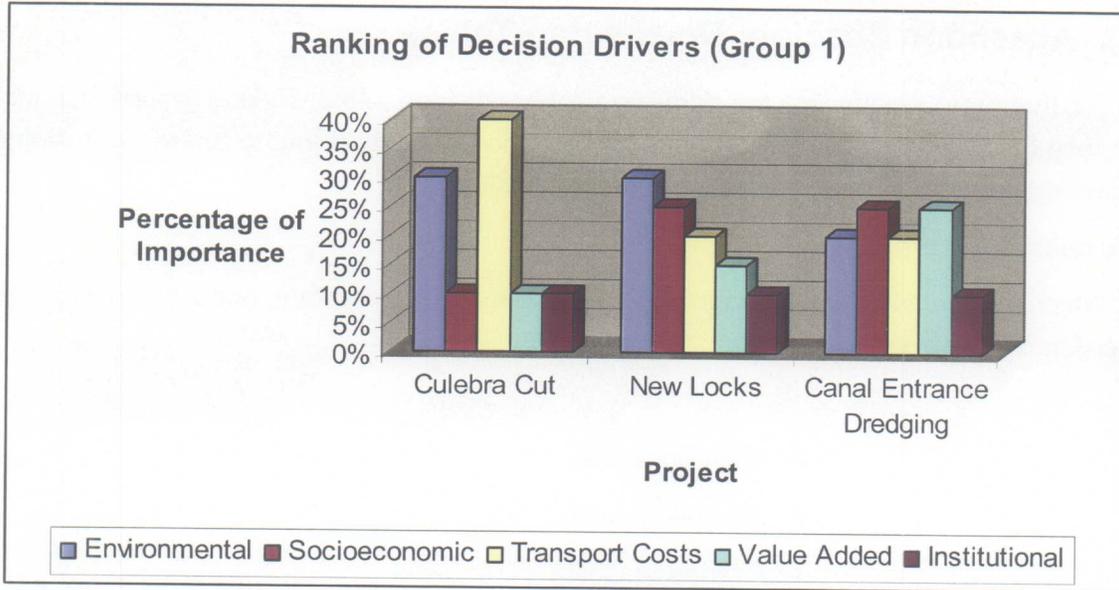
1) Which of the following factors should be the most important ones in driving the decision of selection for the sites?

- Environmental
- Socioeconomic
- Transport Costs
- Value-added
- Institutional Approval

2) Are there other criteria to be considered?

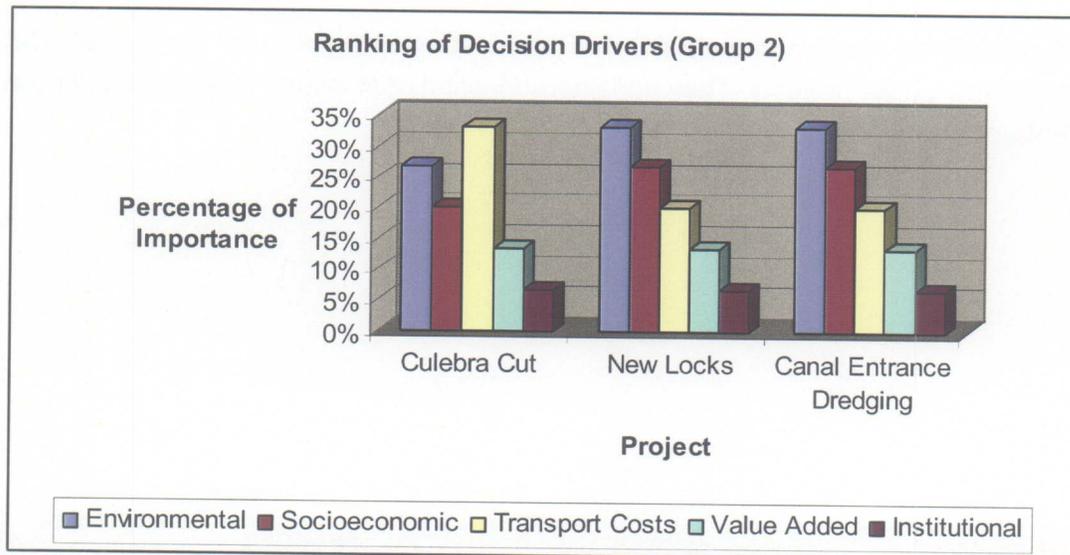
### **2.2.1 Results**

Group 1 considered the environmental factor the most important one for the Culebra Cut and for the New Locks projects. They considered institutional issues to be crucial for the Canal Entrance project

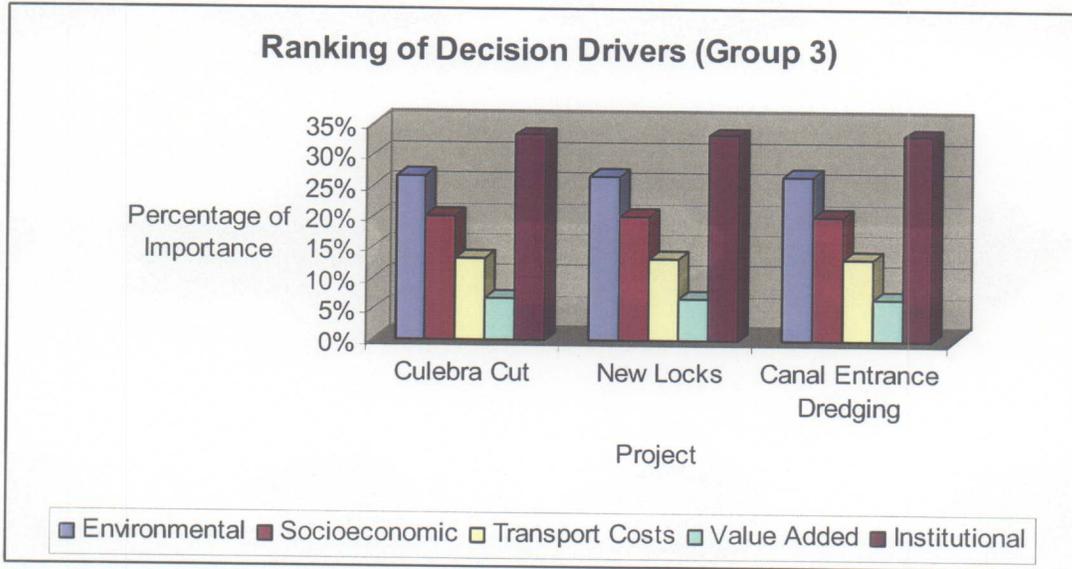


Group 2 was more uniform in their evaluation of factor importance. For the most part they classified the drivers in the following order:

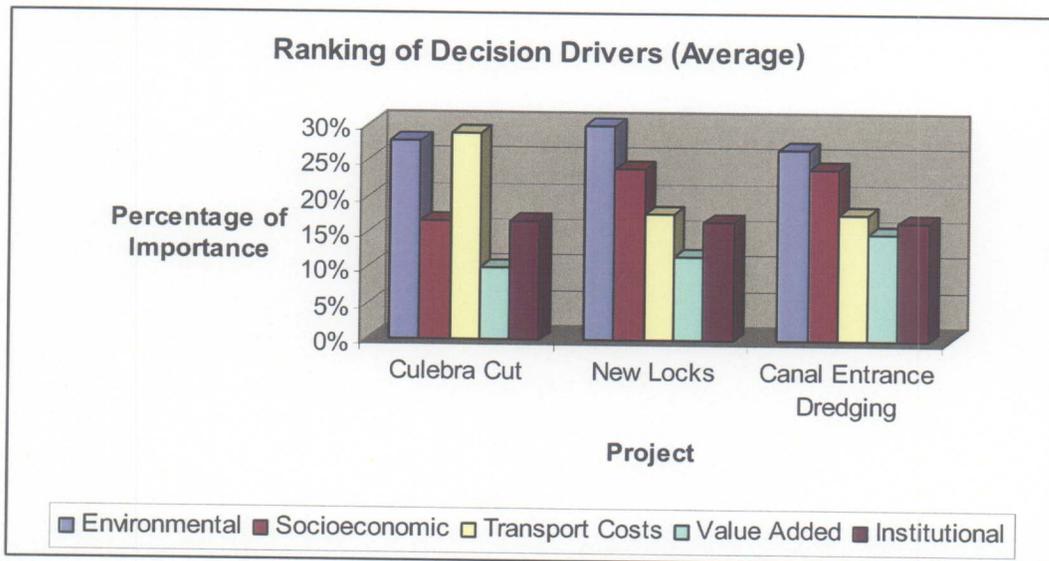
Environmental > Socioeconomic > Costs > Value-added > Institutional



Group 3 show a similar trend but gave strong importance to institutional related issues:



As a whole the participants showed a tendency to consider environmental and socioeconomic factors a considerable higher importance in the decision-making process for the selection of final alternative sites for the disposal of excavation materials:

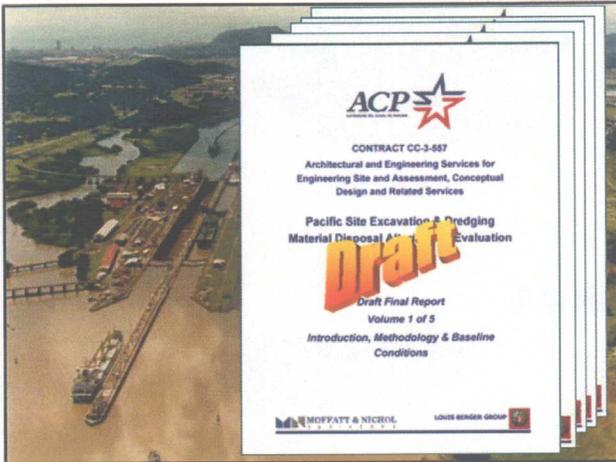


**PRESENTATION # 1**

**STUDY METHODOLOGY AND SITES OVERVIEW**

**PRESENTATION # 1**

**STUDY METHODOLOGY AND SITES OVERVIEW**



## Agenda for Today

- ◆ Overview of Materials Sources
- ◆ Overview of Sites
- ◆ Environmental Baseline Study
- ◆ Environmental Sites Assessment
  
- ◆ Technical Analysis of Modified Sites
- ◆ Cost Estimates
- ◆ Summary & Sites Classifications
- ◆ Conclusions
  
- ◆ Discussion

Slide 3

## Study Process to Date

*Earlier Studies, ACP Disposal sites, Other project Reports*

- ACP Workshop – November 2000
- Preliminary Island Study – Dec. 2001
- Disposal Pre-Screening – August 2002
- Disposal Options Workshop – Sept. 2002
- Preliminary Findings Report – March 2003
- Draft Final Disposal Options Report – July 2003

Slide 4

## MATERIALS QUANTITIES

| SOURCE                   | VOLUME (m3)           |
|--------------------------|-----------------------|
| Gaillard Cut             | 80.00 million         |
| Locks Excavation         | 90.17 million         |
| Pacific Entrance Channel | 14.30 million         |
| <b>TOTAL</b>             | <b>184.47 million</b> |

Slide 5

## Gaillard Cut Material

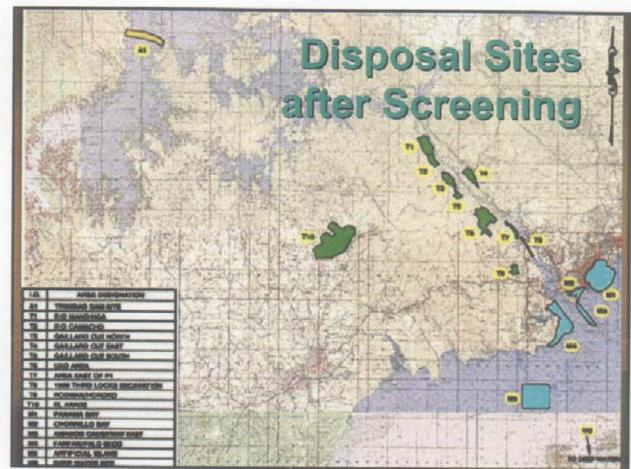
| Project                                       | Materials Volume (m3) |                          |
|---|-----------------------|--------------------------|
|   | In-situ               | including bulking factor |
| Gaillard Cut Widening from 192m - 260m        |                       |                          |
| •East side excavation (dry)                   | 4,985,000             | 6,480,500                |
| •West side excavation (dry)                   | 23,305,500            | 30,297,150               |
| •Excavation (wet)                             | 20,485,705            | 26,631,417               |
| Gaillard Cut Dredging from 32'PLD to 25.5'PLD | 6,071,304             | 7,892,695                |
| Gaillard Cut Dredging Site Stabilization      | 6,675,713             | 8,678,427                |
| Estimated Total Volume to be Removed          | 61,523,222            | 79,980,189               |

Slide 6

## Locks Excavation Volume

| Material Classification | Materials Volume (m3) |                          |
|-------------------------|-----------------------|--------------------------|
|                         | In situ Volume        | Including Bulking Factor |
| Overburden              | 24,750,000            | 32,175,000               |
| Sedimentary Rock        | 7,020,000             | 9,126,000                |
| Basalt                  | 19,110,000            | 24,843,000               |
| Agglomerate             | 18,500,000            | 24,050,000               |
| <b>Totals</b>           | <b>69,360,000</b>     | <b>90,168,000</b>        |

Slide 7

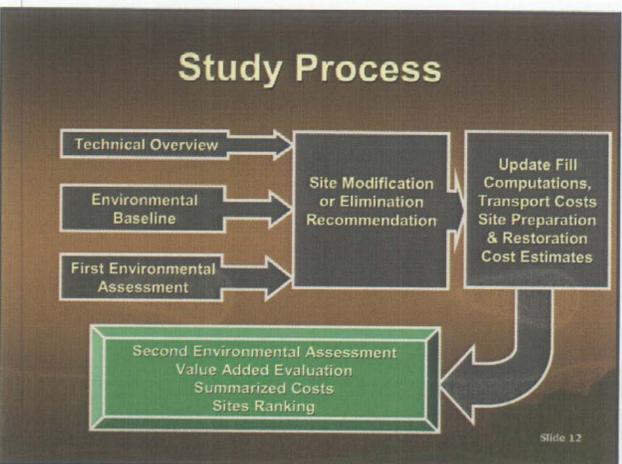


### Candidate Disposal Sites

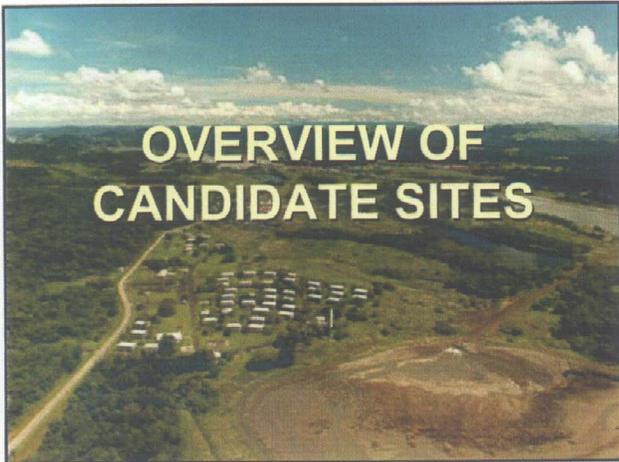
| Site Ref                 | Designation                            | Former Name (from earlier studies)      |
|--------------------------|--|---|
| <b>Terrestrial Sites</b> |  |   |
| T1                       | Rio Mandinga                           | 1993 Study Site 7                       |
| T2                       | Rio Camacho                            | 1993 Study Site 6                       |
| T3                       | Gaillard Cut North (W3)                | ACP - W3                                |
| T4                       | Gaillard Cut East (E2)                 | ACP - E2                                |
| T5                       | Gaillard Cut South (W5)                | ACP - W5                                |
| T6                       | UXO Area                               | UXO                                     |
| T7                       | Miraflores West Bank                   | Area East of Alignment P1               |
| T8                       | 1939 Third Locks Expansion             | 1939 Third Locks Expansion              |
| T9                       | Rodman/Horoko                          | 1993 Study Site 2                       |
| T10                      | El Arado                               | El Arado- Site 13 Sea Level Canal Study |
| <b>Marine Sites</b>      |  |   |
| M1                       | Panama Bay Fill                        | Ciudad Marina et al.                    |
| M2                       | Chorrillo Bay Fill                     |   |
| M3                       | Amador Causeway East                   | Widen Amador Causeway                   |
| M4                       | Farfan/Pajo Seco                       |   |
| M5                       | Artificial Island                      |   |
| <b>Others</b>            |  |   |
| M6                       | Site M6 - Offshore Open Water Disposal |   |
| A1                       | Site A1 - Trinidad Dam Project         |   |

Slide 10

- ### Disposal Sites Study Work Tasks
- ◆ Environmental Evaluations
    - Baseline Conditions
    - Impacts Assessment
  - ◆ Cultural Resource Evaluation
  - ◆ Socio-Economic Assessment
  - ◆ Technical Evaluations
  - ◆ Fill or Development Concepts
  - ◆ Cost Estimates
    - Transport
    - Site Prep. and Restoration
  - ◆ Value Added Assessment
  - ◆ Summary & Ranking
- Slide 11



- ### Limited Evaluations
- ◆ A1 - Trinidad Dam (transp. cost)
  - ◆ M1 - Panama Bay Fill (transp. cost)
  - ◆ M2 - Chorrillo Bay Fill (transp. + environmental baseline)
  - ◆ M6 - Open Water Disposal (transp. cost + environmental baseline)
- Slide 13



## Site T1 Río Mandinga Area = 444 ha

## Site T1 Drainage Catchment Area

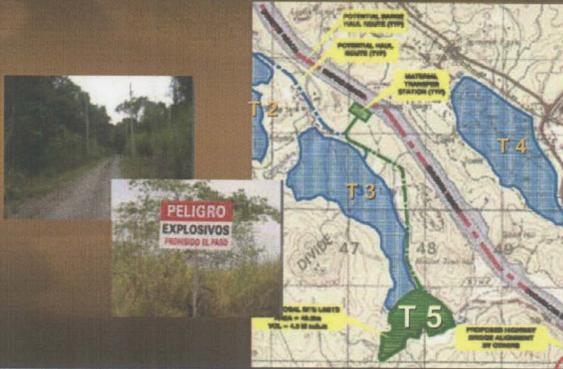
## Site T2 Río Camacho Area = 144 ha

## Site T3 - Gaillard Cut North Area = 127 ha

Slide 18

## Site T4 - Gaillard Cut East Area = 127 ha

**Site T5 - Gaillard Cut South**  
Area = 41 ha



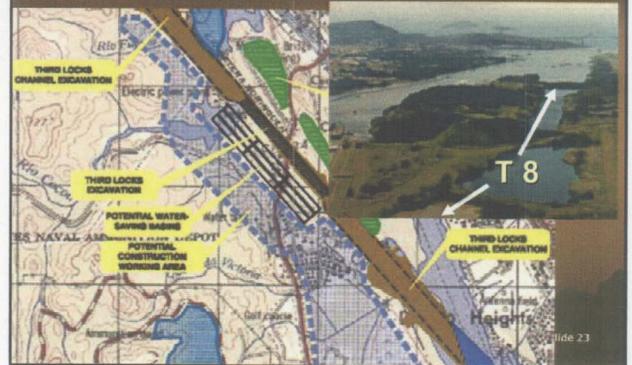
**Site T6 - UXO Area**  
Area = 431 ha



**Site T7 - Miraflores Locks Lake West Shore**  
Area = 45 ha



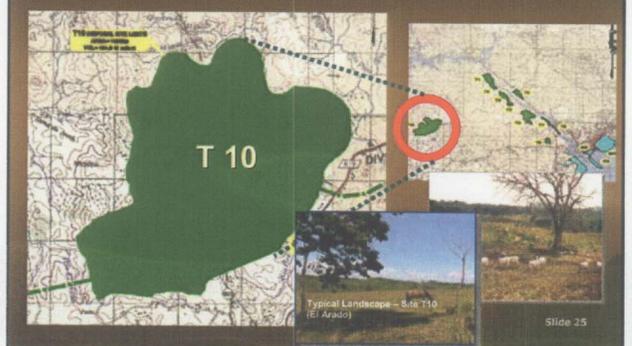
**Site T8 - 1939 Locks Excavation Lagoons**  
Area = 27 ha



**Site T9 - Rodman/Horoko**  
Area = 59 ha



**Site T10 - El Arado**  
Area = 1050 ha

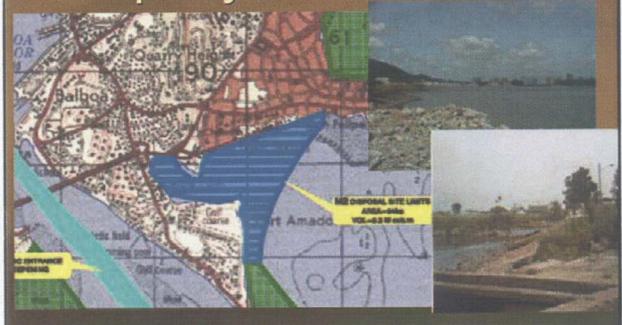


**Site M1 – Panama Bay Fill  
Projects – Max area = 520 ha  
Approx capacity = 62 million m<sup>3</sup>**

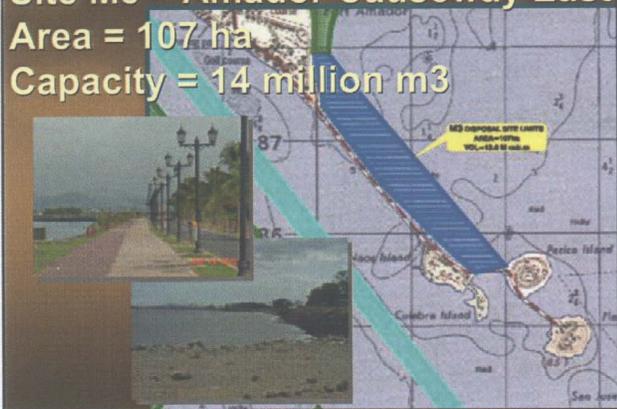


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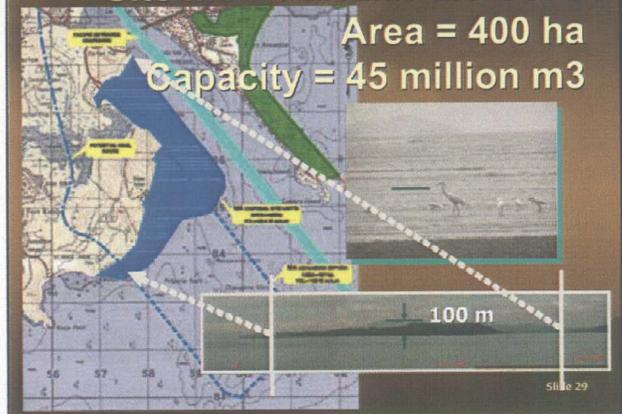
**Site M2 – Chorrillo Bay Project  
Area = 94 ha  
Capacity = 9.3 million m<sup>3</sup>**



**Site M3 – Amador Causeway East  
Area = 107 ha  
Capacity = 14 million m<sup>3</sup>**

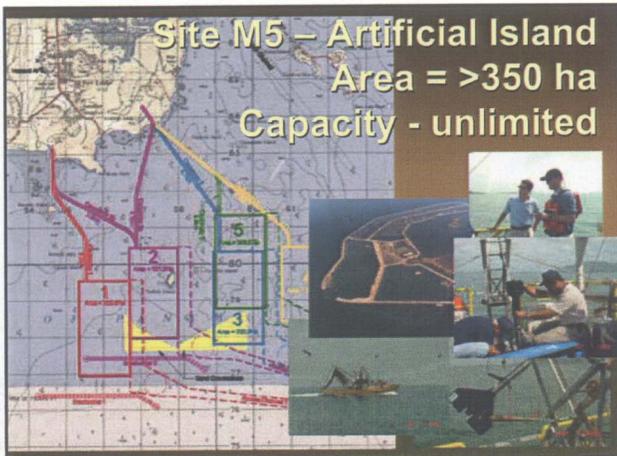


**Site M4 – Farfan/Palo Seco  
Area = 400 ha  
Capacity = 45 million m<sup>3</sup>**

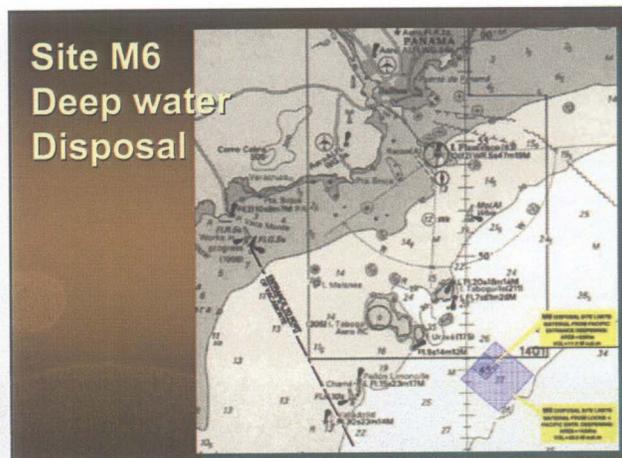


Slide 29

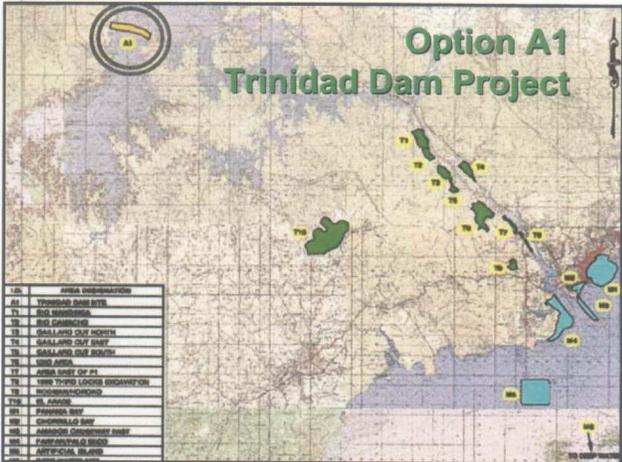
**Site M5 – Artificial Island  
Area = >350 ha  
Capacity - unlimited**



**Site M6  
Deep water  
Disposal**



# Option A1 Trinidad Dam Project



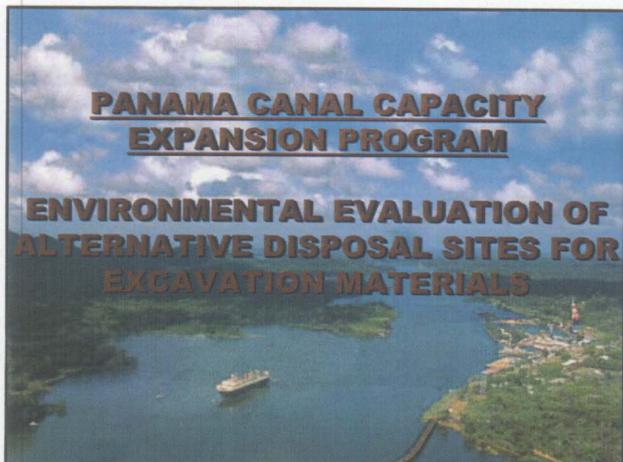
| NO. | AREA DESCRIPTION       |
|-----|------------------------|
| 1A  | TRINIDAD DAM SITE      |
| 1B  | RESERVOIR              |
| 1C  | RES. CANALS            |
| 1D  | RES. CANALS OUT RIGHTS |
| 1E  | RES. CANALS OUT RIGHTS |
| 1F  | RES. CANALS OUT RIGHTS |
| 1G  | RES. CANALS            |
| 1H  | RES. CANALS            |
| 1I  | RES. CANALS            |
| 1J  | RES. CANALS            |
| 1K  | RES. CANALS            |
| 1L  | RES. CANALS            |
| 1M  | RES. CANALS            |
| 1N  | RES. CANALS            |
| 1O  | RES. CANALS            |
| 1P  | RES. CANALS            |
| 1Q  | RES. CANALS            |
| 1R  | RES. CANALS            |
| 1S  | RES. CANALS            |
| 1T  | RES. CANALS            |
| 1U  | RES. CANALS            |
| 1V  | RES. CANALS            |
| 1W  | RES. CANALS            |
| 1X  | RES. CANALS            |
| 1Y  | RES. CANALS            |
| 1Z  | RES. CANALS            |

**PRESENTATION # 2**

**ENVIRONMENTAL CHARACTERIZATION OF SITES AND FIRST  
ENVIRONMENTAL ASSESSMENT**

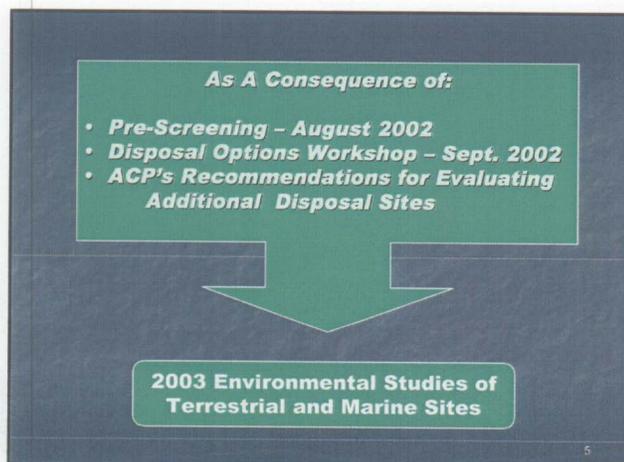
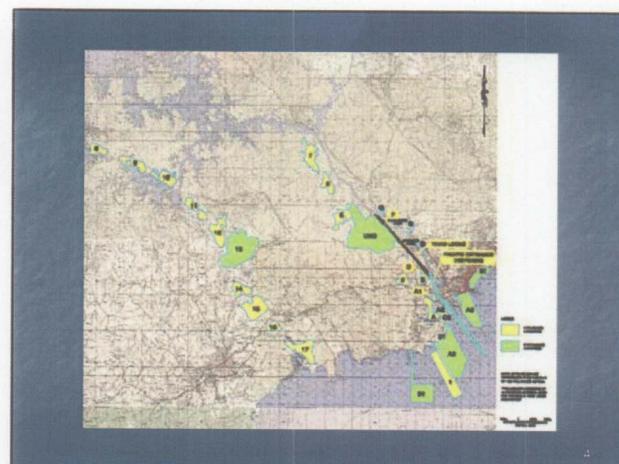
**PANAMA CANAL CAPACITY  
EXPANSION PROGRAM**

**ENVIRONMENTAL EVALUATION OF  
ALTERNATIVE DISPOSAL SITES FOR  
EXCAVATION MATERIALS**



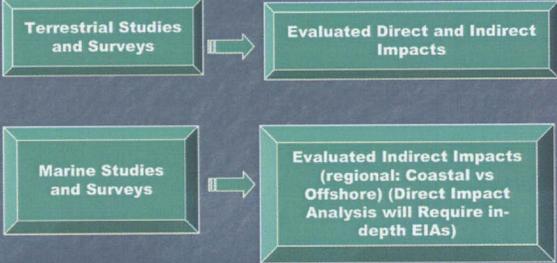
- Project's History**
- List of Potential Sites
- Projects identified before 1993
  - Sites listed in the Panama Canal Alternatives Study (1993)
  - Existing or Proposed ACP materials Disposal Sites
  - Abandoned US Dept of Defense Firing Ranges within the former Canal Zone
  - Listing of Sites considered by ACP during a Workshop in November 2001
  - Additional Sites suggested by the Consultant(s) or identified during ongoing capacity Expansion Studies

- Initial screening identified 59 sites
- Elimination of replicates/overlaps reduced this number to 29
- These were then reduced to six basic alternatives which were presented to the ACP Workshop in 2002 for discussion and consideration

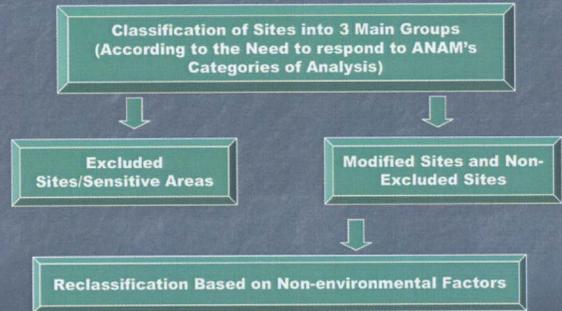


- Main comments at Disposal Options Workshop  
September 2002**
- It is not necessary to select a single site with the capacity to hold all the material from the Locks excavation work.
  - Consultants should look for opportunities for beneficial use of the materials, which could well involve the use of relatively small amounts of material at some of the smaller sites.
  - Use of material for the potential construction of a water savings lagoon at Trinidad Dam.
  - Cost estimates and preliminary evaluation should include the disposal of material from the Pacific entrance dredging and also for the Third Locks excavation.

**Important to Emphasize that the 2003 Environmental Studies Differed in Nature**



**Studies: Environmental Analysis of Original Configurations**



**Objectives of the Environmental Studies**

- Characterize each site
- Define sensitive areas within and adjacent to the candidate sites
- Make recommendations for re-configuration or elimination of sensitive sites
- Determine the relative significance of the key environmental concerns or characteristics
- Develop an environmental classification of the evaluated sites.

**Terrestrial Field Investigations - Environmental Characterization**

- 1) Preliminary site visits to all terrestrial sites
  - a) General characterization of the area
  - b) Identify the specific habitats for study
- 2) Establishment of Study Transects (mapped and GIS located)
- 3) Site Visits (a total of 43 site visits were conducted)
  - a) Rapid Ecological Assessments - REA
  - b) Rapid Biological Assessment Protocols - RBA

**Team:** 3-4 wildlife biologists, 1 archeologist, 1 hydrologist, and 1 water quality expert

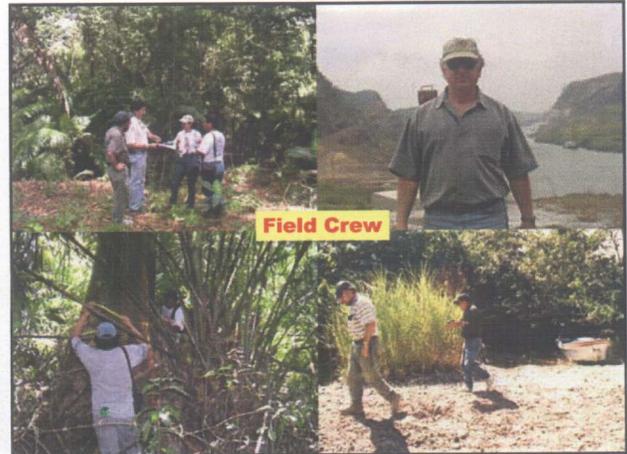
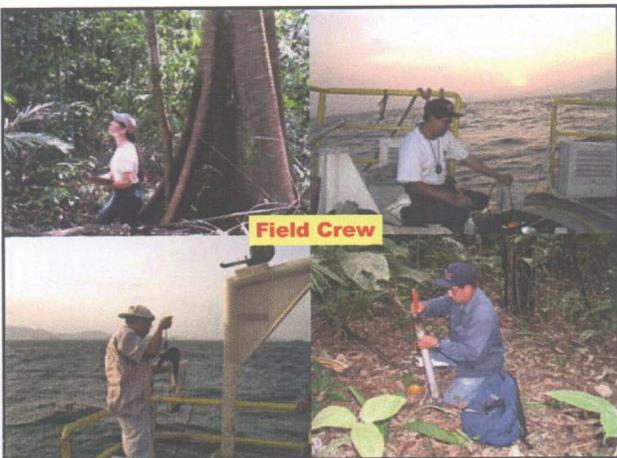


Table 3-1: List of Sites under Consideration

| Site Ref                 | Designation                            | Former Name<br>(from earlier studies)   |
|--------------------------|--|---|
| <b>Terrestrial Sites</b> |  |   |
| T1                       | Rio Mandinga                           | 1993 Study Site 7                       |
| T2                       | Rio Camacho                            | 1993 Study Site 8                       |
| T3                       | Gaillard Cut North (W3)                | ACP - W3                                |
| T4                       | Gaillard Cut East (E2)                 | ACP - E2                                |
| T5                       | Gaillard Cut South (W5)                | ACP - W5                                |
| T6                       | UXO Area                               | UXO                                     |
| T7                       | Miraflores West Bank                   | Area East of Alignment P1               |
| T8                       | 1939 Third Locks Expansion             | 1939 Third Locks Expansion              |
| T9                       | Rodman/Horoko                          | 1993 Study Site 2                       |
| T10                      | El Arado                               | El Arado- Site 13 Sea Level Canal Study |
| <b>Marine Sites</b>      |  |   |
| M1                       | Panama Bay Fill                        | Ciudad Marina et al.                    |
| M2                       | Chorrillo Bay Fill                     |   |
| M3                       | Amador Causeway East                   | Widen Amador Causeway                   |
| M4                       | Farfan/Palo Seco                       |   |
| M5                       | Artificial Island                      |   |
| <b>Others</b>            |  |   |
| M6                       | Site M6 - Offshore Open Water Disposal |   |
| A1                       | Site A1 - Trinidad Dam Project         |   |

Selected Disposal Sites for Evaluation



### Environmental Studies Tasks and Methodology

### Field Tasks

- Evaluated study transects based on pre-site visit locations
- Collection of qualitative/quantitative environmental information
- RBA, RBP, and REA assessments implemented

### Environmental Evaluations & Assessments Methods

Rapid Ecological Assessments (REA)  
Nature in Focus 2000 (developed by The Nature Conservancy)

The TNC's "Rapid Ecological Assessment" utilizes analysis of aerial photographs, site surveys, and literature reviews to obtain a broad overview of the study area's ecosystems and potential diversity.

Ecological Classification of Plant Formations of the Earth.  
(Developed by UNESCO). Used in the classification of the identified specimens

Rapid Biological Assessments Protocols (RBP). 1999.  
Developed by USEPA for use in streams and wadeable rivers.

Only the Habitat Assessment and Physicochemical Parameters portion of this methodology was implemented during the study of the alternatives for disposal of excavation material.

Biological parameters was characterized to "extent of coverage".

This includes:

- Epifaunal substrate / available coverage
- Bank vegetative protection
- Riparian vegetative zone width
- Canopy cover
- The physical parameters to be evaluated will include:
  - Pool substrate characterization
  - Pool variability
  - Channel alteration
  - Sediment deposition
  - Channel sinuosity
  - Channel flow status

The fauna and flora was classified according to commonly Used Panameñan and international structures:

- “Ecological structures” proposed by Holdridge and used by Tosi in the elaboration of the bioclimatic map of Panama. According to these structures there are 12 “zonas de vida” in the country and 2 identified in the area of the Canal
  - a) Premountain Humid Forest
  - b) Tropical Humid Forest
- UNESCO Vegetation Classification System
  - a) Semideciduous tropical forest of low lands intervened
  - b) Productive system with firewood vegetation or significant spontaneous (10-50%)
  - c) Productive system with natural firewood vegetation or significant spontaneous (less 10%)

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## Classification of Threatened & Endangered Species

### • Global and National Rankings

Table 4-4: Description of Global and National Ranking Priorities According to the Natural Heritage Program

| Rank                  | Description  | Reported Counts    |
|-----------------------|--|--------------------|
| <b>Global Ranks</b>   |  |                    |
| G1                    | Extremely rare worldwide   | 5 or less          |
| G2                    | In danger worldwide for its rarity                                       | 6 to 20            |
| G3                    | Rare in its distribution or found only locally                           | 21 to 100          |
| G4                    | Abundant, extended and apparently safe worldwide                         | More than 100      |
| G5                    | Very abundant, extended, and safe worldwide                              | Much more than 100 |
| G6                    | Historical records but existing populations unknown                      | None recently      |
| <b>National Ranks</b> |  |                    |
| N1                    | Critically in danger for its rarity                                      | 5 or less          |
| N2                    | In danger for its rarity   | 6 to 20            |
| N3                    | Very rare in its national distribution or found only locally             | 21 to 100          |
| N4                    | Abundant, extended and apparently safe nationally                        | More than 100      |
| N5                    | Very abundant and safe nationally  | Much more than 100 |
| N6                    | Accidental national occurrence, not a component of the established biota | Much more than 100 |
| N7                    | Exotic and established in the country                                    | None recently      |
| N8                    | Unknown condition of distribution for lack of information                | —                  |

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### • Endemic Species

Endemic for Panama and bi-national endemic.

In the case of mammals, the binational endemic species were those inhabiting locations in Panama and Costa Rica.

For birds we considered species restricted within the Areas for Endemic Birds (AAE) that form part of the program of Important Avian Areas (IA) for Panama developed by Bird Life International (AUDUBON).

### • Species Protected by Panameñan Laws

The Autoridad Nacional del Ambiente (ANAM)

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### • Species Considered in CITES

Panama is a signatory of the International Treaty on Commerce of Threatened species of Fauna and Flora (CITES, 1998). This treaty regulates the traffic of endangered species and of rare species.

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### • Species registered in IUCN (International Union for the Conservation of Nature)

IUCN classification categories (1996) for fauna species that may need special protection. Walter & Gillett (1998) for flora species:

**Extinct (Ex):** No individuals Exist

**Extinct in the Wild (EW):** Individuals only exist outside wild areas

**Critically in Danger (CR):** In danger of extinction in the wild

**In Danger (EN):** Danger of extinction in near future

**Vulnerable (VU):** Danger of extinction in mid-term future

**Low Risk (LR):** does not fit into previous categories

**Insufficient Data (DD):** Insufficient data to characterize the species' distribution and abundance

**Not Evaluated (NE):** not evaluated for any of the previous criteria

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### Fauna Studies

#### • Bird surveys

a) observed and heard in a 50 mts radius over 10 minutes)

b) establishing stationary points (point-based surveys)

c) 5 observations points 100-200 meters apart

#### • Mammals Surveys

a) Direct identifications

b) Indirect evidence (presence of hair, skeletons, tracks, feces, dwellings)

#### • Amphibians and Reptiles Surveys

a) focused in the proximity of streams or low wetlands (due to dry season)

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## Flora Studies

- Identification of species present at the studied transect
- Canopy coverage determined
- Dominant tree species, trees age, and productivity levels
- Associated flora and invasive species were also characterized.

### Transect Size:

Length: 600 meters (average); Width: 10 meters  
Total Surface Area Studied: 6,000 m<sup>2</sup>

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The selection of sampling sites was influenced by factors such as:

- The area should contain species representative and endemic to the ecosystem
- Common or dominant species should be represented
- The plot must be located within one vegetation type to give a true representation of the area's diversity
- The species identified during the rapid ecological assessments were crosschecked with IUCN lists for conservation status (species of concern) and the Autoridad Nacional del Ambiente (ANAM), and their spatial distribution established/mapped using aerial photography, GPS-GIS methodology

This field methodology has been utilized in many biological inventories in Panama since 1963 and by the UNESCO (1974).

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## Water Quality Analyses in Streams

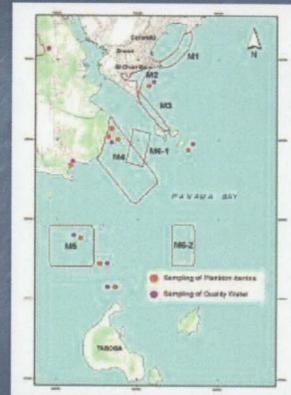
- Conducted at all sites except those affected by dry season.
- Chemical Measurements (e.g. dissolved oxygen, temperature, salinity, conductivity)
- General environmental conditions (e.g. bank stability and basin width, physical structure)
- Data from each cross section of a stream complemented with upstream and downstream data
- A total of 15 streams were evaluated during this field effort.

## Soil Analyses

- Soil samples were taken at all studied transects. A 3-inch wide core sampler was utilized to collect soil to a depth of 30 cm

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## Marine Sampling Stations



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## Environmental Evaluation Criteria for Marine Sites

The driving factors in the selection criteria of alternatives and in their environmental evaluation included:

- Habitat alteration and/or destruction
- Water quality impacts
- Impacts to biota
- Impacts to commercially important species
- Impacts to the socio-economic conditions of surrounding populations
- Legal and institutional issues

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## Marine Field Investigations Sampling Program Water Quality and Marine Data Collection Methodology

The marine team conducted coastal intertidal and offshore studies of the potential areas for marine disposal.

In intertidal areas the studies included:

- Collection of benthic organisms
- Collection of water quality parameters
- Observations of the general coastal characteristics of the selected areas

In open water areas the environmental studies consisted in two sets of collections (day and night) for zooplankton and phytoplankton, one set for benthic organisms, and two sets for water quality parameters.

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Zooplankton net used in collections



Standardized Cylinders



Folsom Fractionator

### Sample Collection and Handling

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Data obtained was processed to develop the total average density of organisms, dry biomass and ash weight of all three replicates in the collected samples.

The diversity of species was determined taking into account the number of taxonomic species captured and their relation to the density of captured organisms.

The diversity of Shannon-Wiener was also calculated

To estimate the maximum local diversity, and determine how to count the number of captured individuals for each species, every time the sample increases invariably, we calculated the index of maximum diversity using the following formula:

$H_{max} = \log k$  where;  
Equitability was determined through the following formula:  
 $J = H / H_{max}$

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## Archeological/Cultural Resources Surveys

### Evaluation Criteria and Archeological Survey Methods

Important themes in Panamanian archaeology include:

- Paleindian migration through the isthmus, ca. 13,000 cal BP, as evidenced by Clovis-like stone tools
- Forager adaptations to early Holocene environments
- Origins of tropical agriculture
- Development of chiefdoms
- Early Spanish colonial settlements and trade routes

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A Predictive Archaeological-Sensitivity Model (PASM) was developed for areas where no previous investigations have been performed.

Based upon consistent associations of archaeological sites with topographic and hydrologic features (e.g., rockshelters, stream confluences, lithic outcrops, knolls in floodplains), high-probability locations were designated for further surveys. Using the predictive model, field surveys were designed and implemented. Results from these surveys were used to compile evidence of sites with potential archeological/cultural resources.

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## Socio Economic Evaluations

### Field Observations Assessment Matrix Development Impact Assessment

- a) Physical Impact
- b) Direct Economic Impact
- c) Indirect Economic Impact
- d) Hedonic Value

Based on the scope of work, the El Arado and Palo Seco sites required additional field observations.

These socio-economic evaluations were based on:

- Secondary data
- Direct observations
- Indirect surveys

Due to the sensitive nature of the study, no official interviews of local residents were conducted at this early stage of the project.

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### Communities visited during this study included:

El Arado  
Rio Congo  
El Lirio  
Chorrera,  
Santa Cruz

These included visits to:

The Ministerio de Desarrollo Agropecuario  
The Regional Agency CAPIRA  
The Ministerio de Salud y Centro de Salud  
The Centro de Capacitacion - Granja de Rio Congo (a project in cooperation with the Agencia Española de Cooperación Técnica)  
The Hospital Nacional de Larga Estancia (HNLE)

Secondary information included

Statistical information obtained from the Contraloría General de La Republica.

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### Methodology for the elaboration of the assessment matrix

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

Four criteria were selected and defined, in order to determine the degree of socioeconomic impact that communities or economic sectors may suffer.

- a) Physical Impact on the Communities or Economic Sectors
- b) Direct Economic Impact (destruction of sector)
- c) Indirect Economic Impact (on labor)
- d) Hedonic Value (on real estate value)

### Environmental Impact Analysis

Two step process:

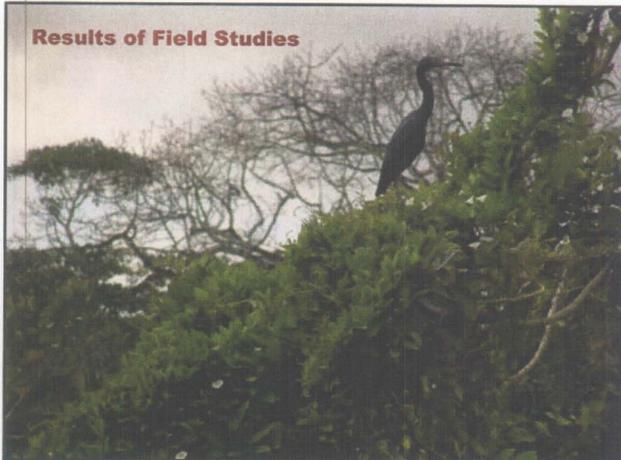
Evaluation (or elimination) of site as initially configured from previous studies

2. Revised evaluation based on modifications to site boundaries to exclude highly sensitive areas (Exclusion Zones)

This two-step process generates two sets of environmental rankings:

- a) The initial ranking identifies and highlights the sensitive areas of the original site limits and the technical evaluation of each site is then based on the modified site configurations.
- b) The final environmental ranking represents the consultant's recommendations to address significant impact issues.

### Results of Field Studies



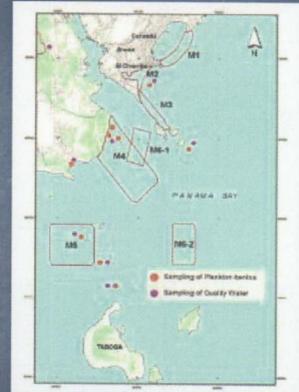
### Marine Studies

• Secondary data on physical and biological conditions

- a) Coral/reefs
- b) Mangroves
- c) Coastal birds and marine mammals
- d) Sea grasses
- e) Benthic organisms

• Primary data from day-night sampling/survey program

- a) Physical data
- b) Biological Data



### a) Physical data

Table 5-16: Physical Chemical parameters recorded at the collection sites.

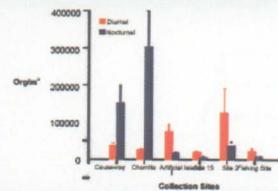
| Site            | Depth | TEMP (°C) | TURB (NTU) | DRY/SSR (mg/L) | SAL (‰) |
|-----------------|-------|-----------|------------|----------------|---------|
| Caracasay       | Day   | 27.5      | 2.5        | 5.9            | 34.0    |
| Caracasay       | Night | 25.0      | 4.7        | 6.1            | 35.0    |
| Chiriqui        | Day   | 28.0      | 3.1        | 6.8            | 35.0    |
| Chiriqui        | Night | 25.0      | 10.0       | 5.3            | 37.0    |
| Artificial Site | Day   | 28.4      | 2.5        | 6.9            | 32.0    |
| Artificial Site | Night | 24.0      | 4.3        | 6.4            | 31.9    |
| Site 15         | Day   | 26.7      | 1.7        | 6.7            | 35.9    |
| Site 15         | Night | 25.0      | 1.9        | 7.8            | 35.1    |
| Site 2          | Day   | 26.1      | 10.2       | 9.2            | 31.9    |
| Site 2          | Night | 24.7      | 8.3        | 6.4            | 31.2    |
| Fishing Site    | Day   | 26.3      | 2.1        | 6.9            | 35.0    |
| Fishing Site    | Night | 25.2      | 2.0        | 6.5            | 35.4    |

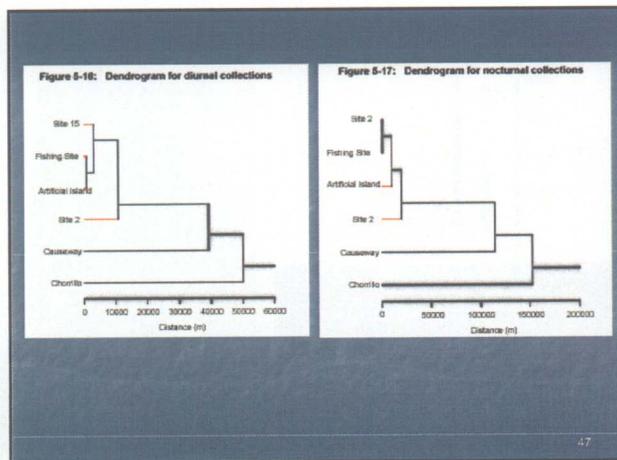
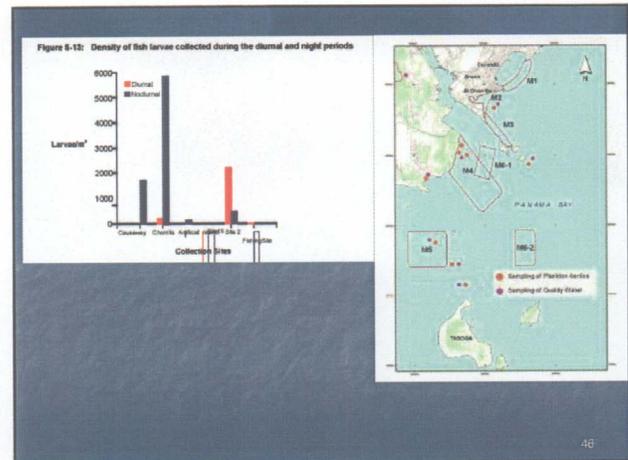
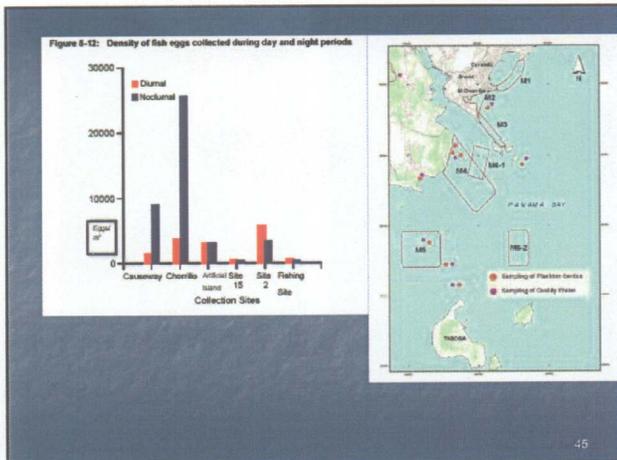
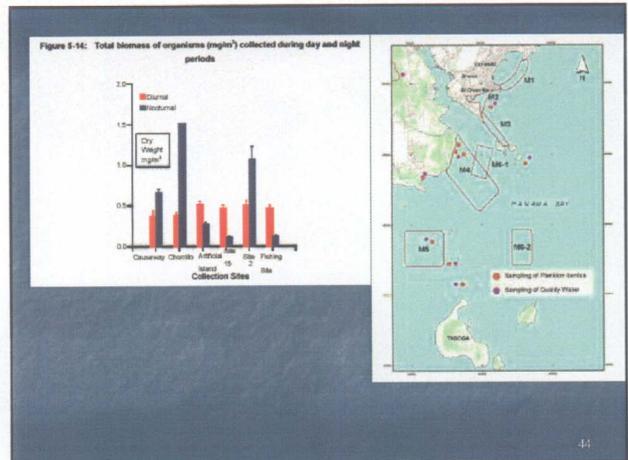
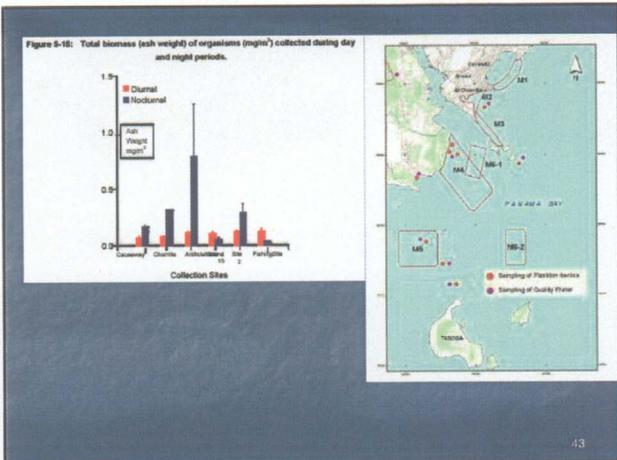
### b) Biological data

Table 5-17: Density of organisms (organs/m<sup>2</sup>) N=3. Biomass expressed in (mg/m<sup>2</sup>)

| Site            | Date  | Total # of organisms |            | Dry weight (mg/m <sup>2</sup> ) |         | Ash weight (mg/m <sup>2</sup> ) |         |
|-----------------|-------|----------------------|------------|---------------------------------|---------|---------------------------------|---------|
|                 |       | From                 | ± 6.688    | From                            | ± 2.668 | From                            | ± 0.688 |
| Caracasay       | Day   | 20,790.00            | 1,802.00   | 0.57                            | 0.57    | 0.00                            | 0.00    |
| Caracasay       | Night | 18,790.00            | 18,119.26  | 0.67                            | 0.58    | 0.17                            | 0.00    |
| Chiriqui        | Day   | 22,904.00            | 4,094.61   | 0.38                            | 0.36    | 0.08                            | 0.01    |
| Chiriqui        | Night | 302,044.00           | 107,546.00 | 1.50                            | 0.91    | 0.31                            | 0.01    |
| Artificial Site | Day   | 70,040.00            | 10,726.00  | 1.83                            | 0.58    | 0.11                            | 0.01    |
| Artificial Site | Night | 19,372.00            | 1,207.00   | 0.27                            | 0.26    | 0.19                            | 0.00    |
| Site 15         | Day   | 16,816.00            | 1,200.00   | 0.24                            | 0.24    | 0.13                            | 0.00    |
| Site 15         | Night | 4,421.00             | 913.24     | 0.11                            | 0.01    | 0.00                            | 0.00    |
| Site 2          | Day   | 120,070.00           | 68,150.75  | 0.80                            | 0.37    | 0.12                            | 0.01    |
| Site 2          | Night | 56,182.00            | 10,561.48  | 1.07                            | 0.16    | 0.38                            | 0.00    |
| Fishing Site    | Day   | 21,980.00            | 7,866.00   | 0.47                            | 0.33    | 0.13                            | 0.00    |
| Fishing Site    | Night | 9,226.00             | 1,488.00   | 0.13                            | 0.02    | 0.03                            | 0.00    |

Figure 5-11: Density total of organisms collected during night and day periods.





The density of organisms during the collection period, had the following sequence:

**Night:** Chorrillo > Causeway > Site2 > Artificial Island > Fishing Site > Site 15.

**Day:** Site2 > Artificial Island > Causeway > Chorrillo > Fishing Site > Site 15.

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## Benthic Samples

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Table 6-40: List and abundance of the macrofauna collected at the 11 stations included in this study.

| TAXA        | PS-West HT | PS-West LT | PS-East | Kobbe-HT | Kobbe-LT | Site 2 | Artificial Island | Site 16 | Fishing zone | Chorrillo | Causeway |
|-------------|------------|------------|---------|----------|----------|--------|-------------------|---------|--------------|-----------|----------|
| Nematoda    |            |            |         |          |          | 15     | 18                | 4       | 15           | 8         |          |
| Polychaeta  | 4          | 14         | 15      | 34       | 6        | 194    | 90                | 26      | 69           | 45        | 34       |
| Mollusca    | 11         | 3          | 18      | 27       | 27       | 29     | 4                 | 4       | 2            | 14        | 7        |
| Crustacea   | 23         | 9          | 18      | 20       | 6        | 22     | 9                 | 11      | 31           | 3         | 7        |
| Echinura    |            |            |         | 6        |          | 4      | 6                 |         | 4            | 2         |          |
| Echinozoans |            |            |         | 2        | 2        |        | 1                 |         |              |           | 2        |
| Chordata    |            |            |         |          |          |        | 1                 |         |              |           | 1        |
| TOTAL       | 38         | 23         | 48      | 79       | 43       | 233    | 138               | 45      | 122          | 72        | 51       |
| TAXA        | 7          | 10         | 6       | 14       | 12       | 24     | 28                | 15      | 14           | 12        | 15       |

Table 6-41: List and abundance of macrofauna standardized for the 11 stations included in the study (Densities per m<sup>2</sup>).

| TAXA        | PS-West HT | PS-West LT | PS-East | Kobbe-HT | Kobbe-LT | Site 2 | Artificial Island | Site 16 | Fishing Zone | Chorrillo | Causeway | Average (Beach) | Average (Ocean) |
|-------------|------------|------------|---------|----------|----------|--------|-------------------|---------|--------------|-----------|----------|-----------------|-----------------|
| Nematoda    |            |            |         |          |          | 67     | 85                | 18      | 67           | 27        | 0        |                 |                 |
| Polychaeta  | 133        | 467        | 500     | 800      | 200      | 895    | 428               | 118     | 207          | 201       | 152      | 430             | 345             |
| Mollusca    | 267        | 100        | 530     | 900      | 900      | 120    | 18                | 18      | 9            | 62        | 31       | 590             | 45              |
| Crustacea   | 767        | 200        | 800     | 587      | 287      | 98     | 43                | 48      | 128          | 13        | 31       | 500             | 92              |
| Echinura    |            |            |         | 200      |          | 18     | 38                |         | 18           | 9         |          | 200             | 18              |
| Echinozoans |            |            |         | 87       | 87       |        | 4                 |         |              |           | 8        | 87              | 7               |
| Chordata    |            |            |         |          |          |        | 4                 |         |              | 4         |          |                 | 3               |
| TOTAL       | 1267       | 767        | 1633    | 2633     | 1433     | 1034   | 615               | 301     | 544          | 321       | 227      | 1547            | 488             |
| TAXA        | 233        | 333        | 267     | 487      | 400      | 107    | 125               | 67      | 62           | 53        | 67       | 340             | 80              |

## Terrestrial Field Investigations

- Streams Physical-chemical Characteristics
- Terrestrial Ecology

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## Water Quality Characteristics

### Measured Parameters:

- Dissolved Oxygen
- Electric Conductivity
- pH
- Total Dissolved Solids
- Temperature
- Salinity
- Turbidity

| Parameter       | Standard values | Unit  |
|-----------------|-----------------|-------|
| pH              | 6.0 – 9.0       | U     |
| Conductivity    | < 300           | uS/cm |
| DO              | > 4.0           | mg/L  |
| Turbidity (NTU) | < 5.0           | NTU   |
| Nitrates        | < 600           | mg/L  |
| Ammonia         | < 1.2           | mg/L  |

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| Site | River name       | pH      | EC (uS/cm) | Temp. (°C) | Turb (NTU) | DO (mg/L) | Sal (ppm) | TDS (mg/L) |
|------|------------------|---------|------------|------------|------------|-----------|-----------|------------|
| M4   | Dajal Creek      | 7.7     | 55400      | 34.5       | 8.7        | 4.5       | 35.8      | 34,500     |
| M4   | Rio Paríán       | 8.0     | 52600      | 28.0       | 23.5       | 7.3       | 32.3      | 24,206     |
| T7   | Rio Cocul        | 6.5     | 1451       | 28.6       | 4.8        | 3.6       | 0.7       | 577.0      |
| T1   | Rio Mandinga     | 8.3     | 604        | 31.6       | 5.1        | 8.4       | 0.0       | 258.0      |
| T6   | Rio Grande PM    | 7.2     | 1552       | 27.5       | 9.2        | 4.0       | 0.0       | 715.0      |
| T2   | No Name          | no data | no data    | no data    | no data    | no data   | no data   | no data    |
| T10  | Rio Bernardino 1 | 6.4     | 180.3      | 25.1       | 7.2        | 3.4       | 0.0       | 84.0       |
| T10  | Rio Bernardino 2 | 6.8     | 123.2      | 25.1       | 2.3        | 5.7       | 0.0       | 55.7       |
| T4   | Branch Obispo 1  | 6.7     | 225.0      | 24.5       | 12.6       | 1.5       | 0.0       | 103.0      |
| T4   | Branch Obispo 2  | 5.2     | 215.0      | 24.5       | 5.5        | 1.8       | 0.0       | 95.3       |
| T4   | Branch Obispo 3  | 7.0     | 314.0      | 24.0       | 3.5        | 4.5       | 0.0       | 154.0      |
| T10  | Rio Lirio        | 6.1     | 142.2      | 24.5       | 5.3        | 3.9       | 0.0       | 65.2       |
| T10  | Rio El Arado     | 5.5     | 115.7      | 25.5       | 3.2        | 7.4       | 0.0       | 54.4       |
| T9   | Rio Velázquez    | 7.1     | 358        | 24.0       | 3.8        | 1.6       | 0.0       | 167.9      |
| T3   | Rio Camacho      | 7.6     | 244        | 27.4       | 4.6        | 4.2       | 0.0       | 112.3      |

## Stream Physical Characteristics

| RIVER NAME             | Effluent substrate | Embankment | Channel | Pool Variability | Sediment Deposition | Channel Flow Status | Channel Alteration | Channel Broominess | Bank Stability | Vegetation Protection | Riparian Vegetation | Total | Ranking |
|------------------------|--------------------|------------|---------|------------------|---------------------|---------------------|--------------------|--------------------|----------------|-----------------------|---------------------|-------|---------|
| COCUL RIVER (T7)       | 16.0               | 5.0        | 15.0    | 20.0             | 15.0                | 20.0                | 15.0               | 10.0               | 5.0            | 5.0                   | 141.0               | 0     |         |
| MANDINGA RIVER (T1)    | 10.0               | 20.0       | 5.0     | 8.0              | 5.0                 | 5.0                 | 29.0               | 15.0               | 10.0           | 5.0                   | 108.0               | 50    |         |
| VELAZQUEZ RIVER (T8)   | 10.0               | 15.0       | 10.0    | 13.0             | 5.0                 | 10.0                | 20.0               | 15.0               | 7.0            | 8.0                   | 5.0                 | 118.0 | 50      |
| CAMACHO RIVER (T3)     | 20.0               | 20.0       | 15.0    | 15.0             | 15.0                | 20.0                | 15.0               | 10.0               | 5.0            | 5.0                   | 155.0               | 0     |         |
| BERNARDINO RIVER (T10) | 15.0               | 20.0       | 15.0    | 20.0             | 15.0                | 20.0                | 15.0               | 8.0                | 2.0            | 5.0                   | 190.0               | 0     |         |
| EL LIRIO RIVER (T10)   | 16.0               | 15.0       | 15.0    | 16.0             | 15.0                | 20.0                | 13.0               | 5.0                | 5.0            | 5.0                   | 140.0               | 0     |         |
| ARADO RIVER (T6)       | 3.0                | 15.0       | 10.0    | 15.0             | 10.0                | 16.0                | 15.0               | 5.0                | 2.0            | 2.0                   | 111.0               | 50    |         |
| OBISPO RIVER (T4)      | 0.0                | 0.0        | 0.0     | 0.0              | 0.0                 | 0.0                 | 0.0                | 0.0                | 5.0            | 2.0                   | 2.0                 | 19    | P       |
| TREJO CREEK (M)        |                    |            |         |                  |                     |                     |                    |                    |                |                       |                     |       |         |
| WINDMILL RIVER (T2)    |                    |            |         |                  |                     |                     |                    |                    |                |                       |                     |       |         |
| FARFAN RIVER (M)       |                    |            |         |                  |                     |                     |                    |                    |                |                       |                     |       |         |
| RIO GRANDE (T6)        |                    |            |         |                  |                     |                     |                    |                    |                |                       |                     |       |         |
| REFERENCE VALUES       | 20.0               | 20.0       | 20.0    | 20.0             | 20.0                | 20.0                | 20.0               | 20.0               | 10.0           | 10.0                  | 10.0                | 190.0 |         |

Ranking variable from 0 - 75 (higher down) variable including both better (more between 0 and 10) results in order to rank the different riparian zones within the study stream, a reference value of 100 (higher) was selected.  
Quality numbers were calculated dividing the overall score by three.  
0.0 - 20.000  
20.0 - 100.000  
100 - 200.000  
200 - 300.000

53



Forest (1) Category A T10 Species  
 100 Species  
 100 Species  
 100 Species  
 100 Species

| FAMILY  | SPECIES                        | COMMON NAME   | T1     |        | CITES | IUCN | OTHER |
|---------|--------------------------------|---------------|--------|--------|-------|------|-------|
|         |                                |               | STATUS | REASON |       |      |       |
| MAMMALS | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
| BIRDS   | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |



| FAMILY  | SPECIES                        | COMMON NAME   | T1     |        | CITES | IUCN | OTHER |
|---------|--------------------------------|---------------|--------|--------|-------|------|-------|
|         |                                |               | STATUS | REASON |       |      |       |
| MAMMALS | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
| BIRDS   | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |

Provisional list of species that are protected by Panamanian laws. Based on ecological and socio-economic factors, animal growth, management.



| FAMILY  | SPECIES                        | COMMON NAME   | T1     |        | CITES | IUCN | OTHER |
|---------|--------------------------------|---------------|--------|--------|-------|------|-------|
|         |                                |               | STATUS | REASON |       |      |       |
| MAMMALS | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
|         | <i>Alouatta palliata</i>       | Howler monkey | LC     | LC     |       |      |       |
| BIRDS   | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |
|         | <i>Crotophaga sulcirostris</i> | Woodhoopoe    | LC     | LC     |       |      |       |

Redwood forest within the Mandinga River forest is a low-lying, shallow stream, typical for the region.



Redwood forest (dominated) along on a low-lying, shallow stream, typical for the region.

Archeological Resources



Field team surveying upper reaches of Mandinga River.

Predictive Archeological-Sensitivity Model (PASM)

Environmental Assessment of Site T1 (Rio Mandinga)

- is a Semi-Deciduous Tropical Forest in lowlands
- is a healthy forest, ecologically important, and with high value for human use (medicinal species, etc.)
- The soil is exceptionally rich in organic material
- Primates are a common part of the local fauna and include *Alouatta palliata* (mono arita) and *Alouatta palliata* (mono aullador), *Cebus capucinus* (mono cariblanco), *Saguinus oedipus* (mono lit)
- *Crotophaga sulcirostris* (lagorta aguja) is endangered, protected by Panamanian laws, and is also included in the lists of CITES and IUCN
- Site T1 is recommended for exclusion, since it has a highly diverse flora and fauna and due to the potential for soil-burials, which is presently popular.

Final reconfiguration of Site is shown in Technical Presentation



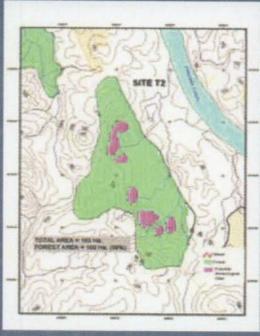
| CLASSI MAMMIFERA |                    | T2                     | T3                       | T5 | T6 | T7 | T8 | T9 |
|------------------|--------------------|------------------------|--------------------------|----|----|----|----|----|
| ORDINE           | FAMILIA            | SPECIES                | COMMON NAME              |    |    |    |    |    |
| LAGOMORFA        | MITRINA-CAPREOLIDA | Lepus ssp.             | Coniaco                  | 1  | 1  | 1  | 1  | 1  |
|                  | DIPYPIDIIDE        | Dipodomys deserti      | Arvicola de arena grande | 1  | 1  | 1  | 1  | 1  |
| CHIROPTERA       | PHYLLOSCOPIDAE     | Scotophilus orion      | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |
|                  | MOPLODIDAE         | Moplosyllis macrotis   | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |
| RODENTIA         | DIURIDE            | Peromyscus maniculatus | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |
|                  | SCIURIDAE          | Sciurus arizonae       | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |
| LACINCOMORFA     | LEPOTIDAE          | Lepus ssp.             | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |
|                  | PROCIACIDAE        | Procyon lotor          | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |
| CARNIVORA        | PROCIACIDAE        | Procyon lotor          | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |
|                  | CELVIDAE           | Cervus ssp.            | Arctiope grande          | 1  | 1  | 1  | 1  | 1  |



*Scotophilus orion*  
(Arctiope grande)

| CLASSI REPTILIA |             | T2             | T3              | T5 | T6 | T7 | T8 | T9 |
|-----------------|-------------|----------------|-----------------|----|----|----|----|----|
| ORDINE          | FAMILIA     | SPECIES        | COMMON NAME     |    |    |    |    |    |
| LACERTIDAE      | SCINCOPIDAE | Scincus ssp.   | Arctiope grande | 1  | 1  | 1  | 1  | 1  |
|                 | SCINCOPIDAE | Scincus ssp.   | Arctiope grande | 1  | 1  | 1  | 1  | 1  |
| SERPENTIDAE     | BOVINEAE    | Bufo ssp.      | Arctiope grande | 1  | 1  | 1  | 1  | 1  |
|                 | BOVINEAE    | Bufo ssp.      | Arctiope grande | 1  | 1  | 1  | 1  | 1  |
| TELEOSTEI       | TELEOSTEI   | Teleostei ssp. | Arctiope grande | 1  | 1  | 1  | 1  | 1  |
|                 | TELEOSTEI   | Teleostei ssp. | Arctiope grande | 1  | 1  | 1  | 1  | 1  |

Flora (2 Classes) = 120 Species  
 Birds = 30 Species  
 Mammals = 13 Species  
 Reptiles = 11 Species  
 Amphibians = 3 Species



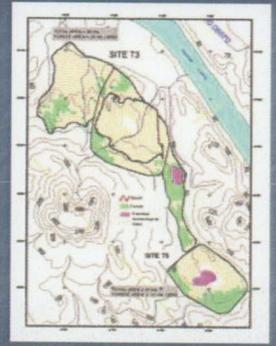
**Environmental Assessment**

- Site T2 can be classified as Semi-Deciduous Tropical Forest in lowlands (UNESCO classification system)
- Site T2 is connected with Site T1 forming a continuous forest.
- The forest in Site T2 has not been altered to a great extent
- The dominant species in this forest are typical of the dry vegetation of Panama
- The study area contains many valuable trees due to their wood
- Orchids species were also recorded
- Presents a great diversity of birds, mammals, reptiles, including species that are in danger of extinction, endemic, and species that are rare and have a restricted distribution range

**Site T3 & T5**



Flora (2 Classes) = 120 Species  
 Birds = 30 Species  
 Mammals = 13 Species  
 Reptiles = 11 Species  
 Amphibians = 3 Species



**Environmental Assessment Sites T3 & T5**

- The Sites is currently under use by AGP for filling with maintenance material
- As a severely altered ecosystem, there are no significant environmental concerns associated with its use as a disposal site.
- However, there are areas of medium sensitivity to the west of the site as well as the vegetation corridor in between Sites T3 and T5.

**Site T4**

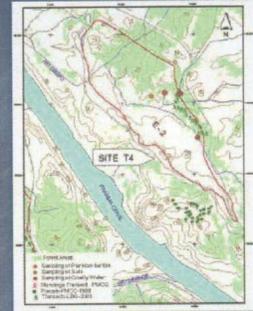
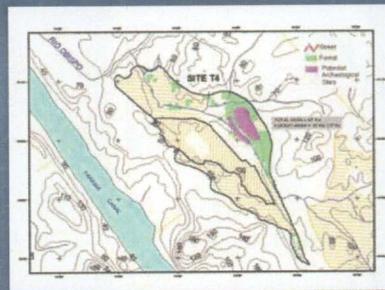


Figure 4.20a Cleaned & 55 Species  
 55 Species  
 14 Species  
 10 Species  
 2 Species



**Environmental Assessment T4**

- Site T4 contains a tropical semi-deciduous forest of low lands, heavy altered by anthropogenic activity
- Based on the information collected through site reconnaissance and studied transects, utilization of this site will not cause significant adverse effects on critical biota.
- However, like most alternative sites, selection of this site as one of final recommended alternative sites for disposal of excavation material will nevertheless require a more in-depth environmental evaluation, as well as mitigation measures

**Site T6**



Figure 4.20b Area of Environmental Sensitivity - Site T6





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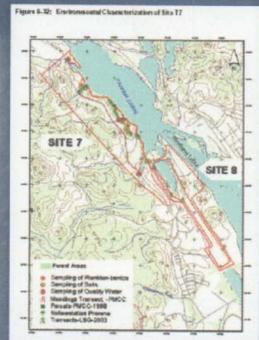
86

**Environmental Assessment**

- Site T6 is located within the areas listed as UXO (Unexploded Ordnance) where unexploded artifacts can be found
- Most of the biological data available comes from secondary sources and the report on the Characterization of Sector 3 and Access to the New Bridge over the Canal in the Emperor Polygon
- The western boundaries were classified as "Highly Sensible" and only the eastern sections (altered) of the area was recommended for filling

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**Sites T7 & T8**

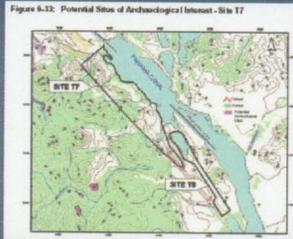


- Plant (2 Classes) = 730 Species
- Wetlands = 29 Species
- Marine = 16 Species
- Reptiles = 13 Species
- Amphibians = 4 Species

88



89



Similarly to previously described sites, the survey of this site was coupled with the implementation of the Predictive Archaeological-Sensitivity Model (PASM). No potential archeological sites within the area of study (T7 and T8 delineations) recommended for further investigations. However, there is a possibility for "off-site" findings in the vicinity of the upper reaches of Coccol River.

90

**Environmental Assessment**

- Sites T7 & T8 is comprised of intervened, lowland Semi-deciduous Tropical Forest
- Among the bird species observed in this site, was: *Ortalis cinereiceps* (chachalaca cabecigris), a species that is protected by Panamanian laws
- The *Boa constrictor* (boa). It lives on the margins of Site T7 near the border of the canal
- Site T7 is recommended for classification under the category of low sensibility for the placement of dredged material.

**Site T9**

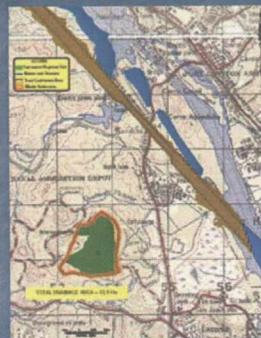
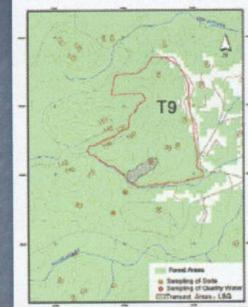
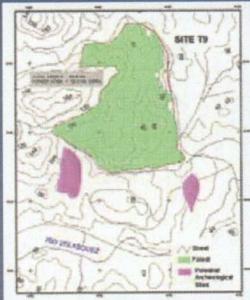


Figure 9-6: Environmental Classification of Site T9



- Flora: 18 Species
- Birds: 4
- Mammals: 2
- Reptiles: 1
- Amphibians: 1
- 27 Species
- 13 Species
- 2 Species
- 2 Species



The survey of this site coupled with the implementation of the Predictive Archaeological-Sensitivity Model (PASM), lead to the identification of the three potential archaeological sites of interest shown in Figure G-41. These are recommended for further investigations if Site T9 is selected for deposition of excavation material. These investigations should include a "discovery and avoidance" method

**Environmental Assessment**

Site T9 can be classified as a lowland Tropical Humid Forest, secondary growth forest with late succession, with a mid level of intervention.

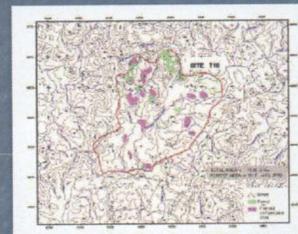
- The Rodman forests contain species that are within the N2 conservation rank, species in the national endangered list and species that are being protected by the Panamanian laws
- Despite the fragmentation due to the Pan-American highway, and the secondary roads towards the bunkers, site T9 is classified in a high sensitivity category because it is the habitat of *Herpailurus yaguarondi* (jaguarundi o tigrillo congo). The wild cat jaguarundi is known to exist in the area of Rodman (based on ARI personnel observation), who patrol the area periodically. The Jaguarundi is a protected species
- Another of the mammal species that can be found in the Rodman forest includes *Tayassu tajacu* (saino), which is a species protected by Panamanian wildlife laws; and *Nasua narica* (gato solo)
- The site presents adequate connectivity, which allows access to all habitats for the species, and necessary resources to complete their life cycle.

**Site T10**



- Flora: 4
- Birds: 7
- Mammals: 3
- Reptiles: 2
- Amphibians: 1
- 28 Species
- 18 Species
- 2 Species
- 7 Species
- 1 Species

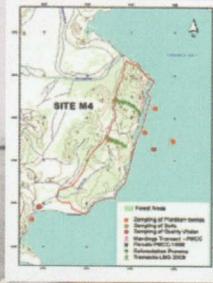
Proximity to river corridors



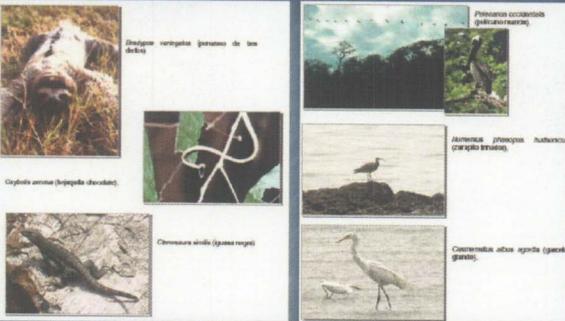
**Environmental Assessment**

- Site T10 is comprised of a humid tropical forest, lowlands, highly intervened, with a typical vegetative association of gallery forests
- Most of this site proposed for the disposal of dredged material, is comprised of pastures
- The forest that was evaluated in the riverside areas serve as corridors used by animals for transit.
- Plants that grow in the Lirio River, use the river as a common and efficient method for seed dispersion
- Currently, the ecological value and biodiversity of site T10 is diminishing and it has become an ecosystem of agricultural development, generating economic benefits for the human population in the area

**Site M4 (Terrestrial)**



- Flora = 123 Species
- Birds = 36 Species
- Mammals = 12 Species
- Reptiles = 9 Species
- Amphibians = 3 Species



**Archaeological Resources**

- It should be noted that one of the project alternatives possibly would entail transporting material through the Venado Beach vicinity. Locations of ancillary facilities on this route should be investigated for archaeological resources prior to construction

**Environmental Assessment Site M4**

- It represents a semi-deciduous tropical forest of low lands, but typically a dry forest
- There are no known previous studies on this dry forest. Only 1% of the original distribution of dry forests in central America is standing today.
- The dry forest of Palo Seco has a biological connection with the woods in Kobbe Beach and Guinea Point forming an almost continuous ecosystem with interconnected flora and fauna communities. This connectivity among the forests of the peninsula and the adjacent mangrove and coastal communities allow for the existence of complex and unique environments with high biodiversity whose alteration should be avoided

**Environmental Assessment Site M4 (Cont.)**

**Coastal Fauna**

- Among the most interesting areas of Palo Seco is the coastal zone where there is a wide variety of habitats for marine birds, mammals, reptiles and invertebrates
- Various migratory species find feeding grounds in the beaches and coastal areas of the M4 Site

## Impact Analysis

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## IMPACT SIGNIFICANCE

| 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  |  |    |

Source: Adapted from "Guía Metodológica para la Evaluación del Impacto Ambiental", 2nd. Ed. Madrid, 1990, by Vivante Corvea F.

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## TERRESTRIAL SITES

| SITE DESCRIPTION             | IMPACTS   | IMPACT SIGNIFICANCE |    |    |    |   |    | Significance | Ranking   |
|------------------------------|---|---------------------|----|----|----|---|----|--------------|-----------|
|                              |   | Sign                | DP | RO | EX | D | RV |              |           |
| 11 Mandinga Rr               | Aquatic: Affected hydrology and associated habitat  | -1                  | 12 | 4  | 4  | 4 | 4  | -28          | High      |
|                              | Terrestrial: Loss of habitat, biodiversity, protected species and temporary residence for migratory birds         | -1                  | 12 | 4  | 12 | 4 | 4  | -36          | Very High |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 1  | 1  | 4 | 4  | -18          | Medium    |
|                              | Average   |                     |    |    |    |   |    | -27          | High      |
| 12 North of Camacho Rr       | Aquatic: Affected hydrology and associated habitat  | -1                  | 12 | 4  | 4  | 4 | 4  | -28          | High      |
|                              | Terrestrial: Loss of habitat, protected and endemic species and temporary residence for migratory birds           | -1                  | 12 | 4  | 12 | 4 | 4  | -36          | Very High |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 1  | 1  | 4 | 4  | -18          | Medium    |
|                              | Average   |                     |    |    |    |   |    | -27          | High      |
| 13 Existing disposal site V3 | Aquatic: Affected hydrology and associated habitat  | -1                  | 12 | 4  | 1  | 4 | 4  | -25          | High      |
|                              | Terrestrial   |                     |    |    |    |   |    | 0            | None      |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 1  | 1  | 4 | 4  | -18          | Medium    |
|                              | Average   |                     |    |    |    |   |    | -14          | Low       |
| 14 South to Surral God       | Aquatic   |                     |    |    |    |   |    | 0            | None      |
|                              | Terrestrial: Loss of habitat, protected species   | -1                  | 12 | 4  | 8  | 4 | 4  | -4           | Very Low  |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 1  | 1  | 4 | 4  | -4           | Very Low  |
|                              | Average   |                     |    |    |    |   |    | 3            | Very Low  |
| 15 Existing disposal site V5 | Aquatic   |                     |    |    |    |   |    | 0            | None      |
|                              | Terrestrial: Loss of habitat, protected species   | -1                  | 8  | 1  | 1  | 4 | 4  | -8           | Medium    |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 1  | 1  | 4 | 4  | -8           | Medium    |
|                              | Average   |                     |    |    |    |   |    | 6            | Very Low  |
| 16 L02 site                  | Aquatic   |                     |    |    |    |   |    | 0            | None      |
|                              | Terrestrial: Loss of habitat, protected and endemic species and temporary residence for migratory birds (assumed) | -1                  | 12 | 4  | 8  | 4 | 4  | -32          | Medium    |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 1  | 1  | 4 | 4  | -13          | Low       |
|                              | Average   |                     |    |    |    |   |    | -13          | Low       |

## TERRESTRIAL SITES (cont.)

|                 |   |    |    |   |    |   |     |          |           |
|-----------------|---|----|----|---|----|---|-----|----------|-----------|
| 17 Alignment    | Aquatic: Affected hydrology and associated habitat  | -1 | 12 | 4 | 2  | 4 | 4   | -26      | High      |
|                 | Terrestrial   |    |    |   |    |   |     | 0        | None      |
|                 | Cultural  |    |    |   |    |   |     | 0        | None      |
| Average         |   |    |    |   |    |   | 9   | Very Low |           |
| 18 French Canal | Terrestrial: Loss of habitat, protected species, and support for migratory birds                | -1 | 12 | 4 | 8  | 4 | 4   | -32      | Very High |
|                 | Cultural  |    |    |   |    |   |     | 0        | None      |
|                 | Average   |    |    |   |    |   |     | -32      | Very High |
| 19 Hubium       | Aquatic: Affected hydrology and associated habitat  | -1 | 2  | 4 | 4  | 4 | 4   | -18      | Medium    |
|                 | Terrestrial: Loss of habitat, protected and endemic species, and support for migratory birds    | -1 | 12 | 4 | 12 | 4 | 4   | -36      | Very High |
|                 | Cultural: Potential for archaeological findings (S sites)                                       | -1 | 12 | 1 | 1  | 4 | 4   | -22      | Medium    |
| Average         |   |    |    |   |    |   | -24 | High     |           |
| 110 El Arado    | Aquatic: Affected hydrology and associated habitat  | -1 | 2  | 4 | 4  | 4 | 4   | -18      | Medium    |
|                 | Terrestrial: Loss of habitat  | -1 | 12 | 4 | 8  | 4 | 4   | -32      | Very High |
|                 | Cultural: Potential for archaeological findings (S sites)                                       | -1 | 8  | 1 | 1  | 4 | 4   | -18      | Medium    |
| Average         |   |    |    |   |    |   | -23 | High     |           |
| 181 Paso Seco   | Aquatic: Affected hydrology and associated habitat  | -1 | 12 | 4 | 12 | 4 | 4   | -36      | Very High |
|                 | Terrestrial   |    |    |   |    |   |     | 0        | None      |
|                 | Landscape loss  | -1 | 8  | 4 | 8  | 4 | 4   | -28      | High      |
| 182 Paso Seco   | Terrestrial: Loss of open habitat (category 1b level), protected and endemic species, water bed | -1 | 8  | 4 | 12 | 4 | 4   | -32      | Very High |
|                 | Cultural / historical   | -1 | 12 | 4 | 8  | 4 | 4   | -32      | Very High |
|                 | Average   |    |    |   |    |   |     | -32      | Very High |

## MARINE SITES

| SITE DESCRIPTION                      | IMPACTS                     | IMPACT SIGNIFICANCE |    |    |    |   |    | Significance | Ranking |
|---------------------------------------|-----------------------------|---------------------|----|----|----|---|----|--------------|---------|
|                                       |                             | Sign                | DP | RO | EX | D | RV |              |         |
| 183 Panama Bay                        | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -24          | High    |
| 182 El Chacolí                        | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -12          | Low     |
| 185 Caunway                           | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -17          | Medium  |
| 184 Paso Seco Marine                  | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -17          | Medium  |
| 186 Artificial Island                 | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -17          | Medium  |
| 187 Existing natural disposal site V3 | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -17          | Medium  |
| 188 Existing natural disposal site V5 | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -17          | Medium  |
| 189 Existing natural disposal site V5 | Water quality deterioration | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Water loss                  | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low     |
|                                       | Average                     |                     |    |    |    |   |    | -17          | Medium  |

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## Environmental Impact Analysis of Reconfigured Sites

| SITE DESCRIPTION             | IMPACTS   | IMPACT SIGNIFICANCE |    |    |    |   |    | Significance | Ranking  |
|------------------------------|---|---------------------|----|----|----|---|----|--------------|----------|
|                              |   | Sign                | DP | RO | EX | D | RV |              |          |
| 11 Mandinga Rr               | 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      |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 0  | 0  | 0 | 0  | 0            | 0        |
|                              | Average   |                     |    |    |    |   |    | -10          | Very Low |
| 12 North of Camacho Rr       | 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      |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 0  | 0  | 0 | 0  | 0            | 0        |
|                              | Average   |                     |    |    |    |   |    | -11          | Low      |
| 13 Existing disposal site V3 | Aquatic: Affected hydrology and associated habitat  | -1                  | 2  | 4  | 1  | 4 | 4  | -15          | Low      |
|                              | Terrestrial   |                     |    |    |    |   |    | 0            | None     |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 8  | 0  | 0  | 0 | 0  | 0            | 0        |
|                              | Average   |                     |    |    |    |   |    | -5           | Very Low |
| 14 South to Surral God       | Aquatic   |                     |    |    |    |   |    | 0            | None     |
|                              | Terrestrial: Loss of habitat, protected species   | -1                  | 2  | 4  | 2  | 4 | 4  | -16          | Low      |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 1  | 1  | 1  | 4 | 4  | -11          | Low      |
|                              | Average   |                     |    |    |    |   |    | -8           | Very Low |
| 15 Existing disposal site V5 | Aquatic   |                     |    |    |    |   |    | 0            | None     |
|                              | Terrestrial   |                     |    |    |    |   |    | 0            | None     |
|                              | Cultural: Potential for archaeological findings (S sites)   | -1                  | 1  | 1  | 1  | 4 | 4  | -11          | Low      |
|                              | Average   |                     |    |    |    |   |    | -4           | Very Low |

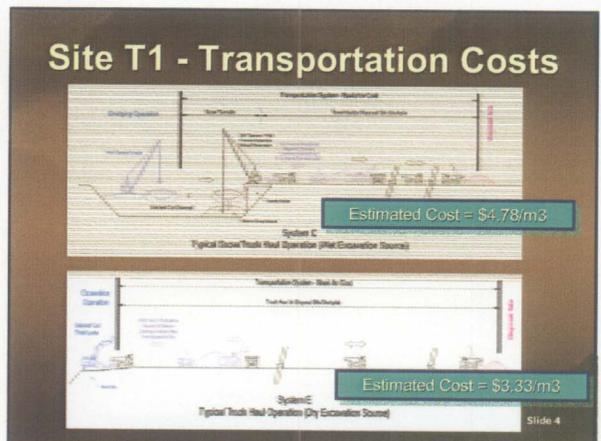
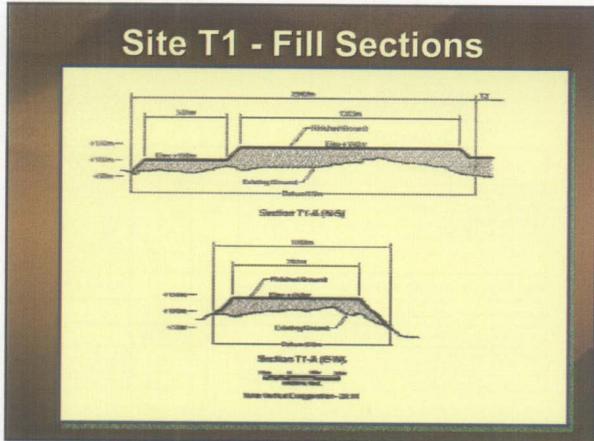
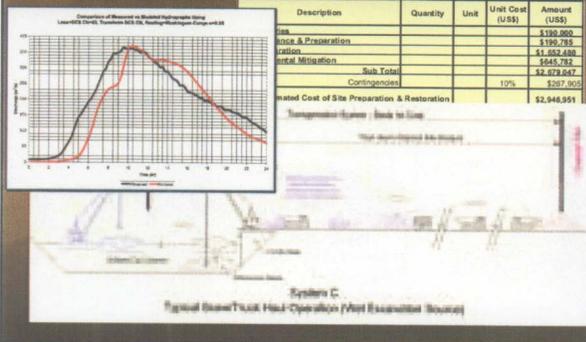
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**PRESENTATION #3**

**TECHNICAL EVALUATION AND TRANSPORTATION COST  
ESTIMATES**

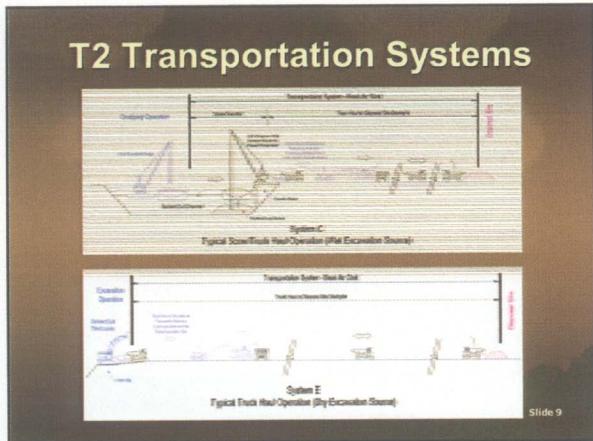
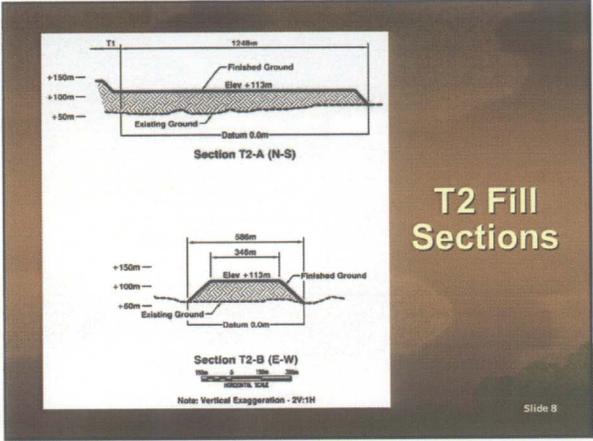
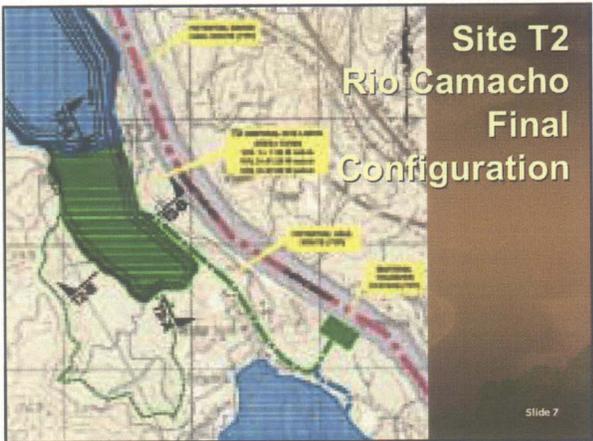
## FINAL TECHNICAL ASSESSMENTS & COST ESTIMATES



### Site T1 – Development Costs

| Description   | Quantity   | Unit | Unit Cost (US\$) | Amount (US\$)      |
|---|------------|------|------------------|--------------------|
| Preliminaries   |            |      |                  | \$365,000          |
| Site Clearance & Preparation                                      |            |      |                  | \$447,465          |
| Site Restoration  |            |      |                  | \$3,900,500        |
| Environmental Mitigation  |            |      |                  | \$1,470,989        |
| Sub Total   |            |      |                  | \$6,183,954        |
| Contingencies   |            |      | 15%              | \$912,593          |
| <b>Total Estimated Cost of Site Preparation &amp; Restoration</b> |            |      |                  | <b>\$7,096,547</b> |
| Equivalent Unit cost of Site Development (\$/m3 of fill)          | m3         |      | \$0.09           |                    |
| Equivalent Unit cost of Site Development (\$/ha)                  | ha         |      | \$48,275         |                    |
| <b>Materials Transport and Placement Costs</b>                    |            |      |                  |                    |
| Wet Materials Transport to Site                                   | 34,524,112 | m3   | 4.78             | \$165,025,255      |
| West bank dry Materials Transport to Site                         | 32,900,768 | m3   | 3.33             | \$109,559,557      |

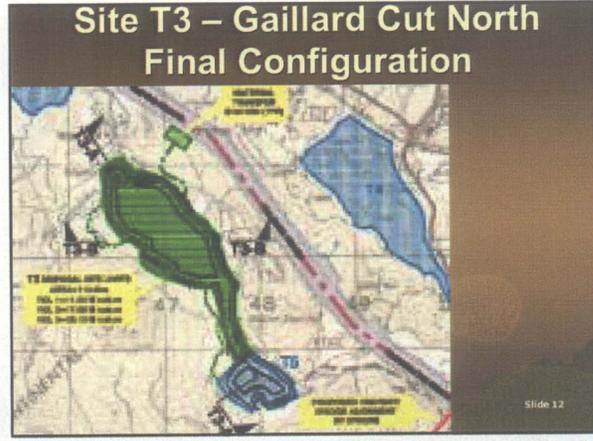
- ### Summary – Site T1 – Rio Mandinga (Modified)
- ◆ Area = 183 ha
  - ◆ Maximum Capacity – 69 million m3
  - ◆ Environmental concerns related to surrounding forests
  - ◆ Transport Costs
    - \$4.78/m3 – dredged material
    - \$3.33/m3 – dry material (west banks)
  - ◆ Site prep & restoration - \$48,275/ha
  - ◆ No Value added potential (eco-tourism)
  - ◆ No socio economic impacts
- Slide 6

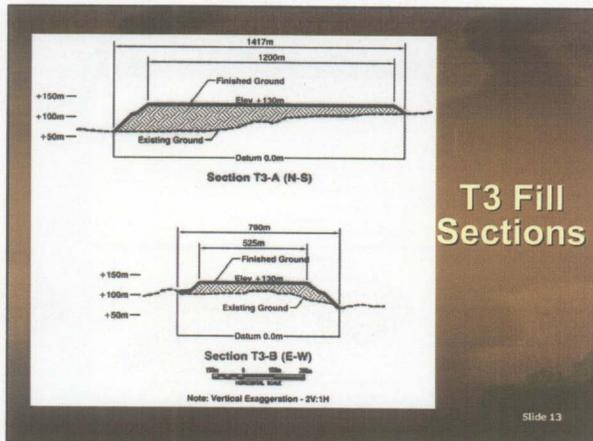


### Site T2 – Development Costs

| Description   | Quantity   | Unit | Unit Cost (US\$) | Amount (US\$)      |
|---|------------|------|------------------|--------------------|
| Preliminaries   |            |      |                  | \$190,000          |
| Site Clearance & Preparation                                      |            |      |                  | \$190,785          |
| Site Restoration  |            |      |                  | \$1,652,480        |
| Environmental Mitigation  |            |      |                  | \$645,782          |
| Sub Total   |            |      |                  | \$2,679,047        |
| Contingencies   |            |      | 10%              | \$267,905          |
| <b>Total Estimated Cost of Site Preparation &amp; Restoration</b> |            |      |                  | <b>\$2,946,951</b> |
| Equivalent Unit cost of Site Development (\$/m3 of capa)          |            | m3   | \$0.18           |                    |
| Equivalent Unit cost of Site Development (\$/ha)                  |            | ha   | \$36,128         |                    |
| <b>Materials Placement</b>  |            |      |                  |                    |
| Wet Materials Transport to Site                                   | 27,616,519 | m3   | 4.06             | \$112,123,067      |
| West bank dry Materials Transport to Site                         | 27,616,519 | m3   | 2.64             | \$72,907,610       |

- ### Summary - Site T2 – Rio Camacho (Modified)
- ◆ Area = 73.5 ha
  - ◆ Maximum Capacity = 28 million m3
  - ◆ Environmental concerns related to surrounding forests
  - ◆ Transport Costs
    - \$4.06/m3 – dredged material
    - \$2.64/m3 – dry material (west banks)
  - ◆ Site prep & restoration - \$36,128/ha
  - ◆ No Value added potential (eco-tourism)
  - ◆ No socio economic impacts
- Slide 11





- US Army Corps of Engineers UXO reports from 1999**
- ◆ 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.
  - ◆ Clearance of approximately 130 ha??
- Slide 15

- Key findings 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
- Slide 16

- UXO Survey & Clearance**
1. Archives Search.
  2. Site Preparation.
  3. Geophysical/Mapping Prove-Out.
  4. Mapping Investigation Plan.
  5. Sampling and/or Mapping.
  6. Analysis & Interpretation.
  7. Risk Analysis
  8. Anomaly Excavation or Treatment.
- Slide 17

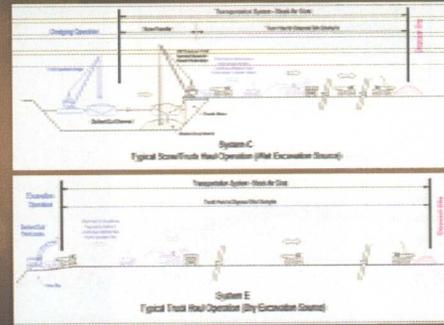
- Estimated Costs of UXO Survey & Clearance (US\$ per hectare)**
- ◆ Site Preparation .....US\$1,000 – 3000
  - ◆ Mapping & Analysis ..... \$3,000 to 15,000
  - ◆ Surface Clearance .....\$10,000 - \$20,000
  - ◆ Clearance to 60 cm .....\$25,000 – 60,000
- Slide 18

## UXO Option for T3, T5 & T6

- ◆ Survey & Analysis
- ◆ Surface Clearance
- ◆ Bury it deep (>10.00 m)
- ◆ How deep is safe?
- ◆ Risk After Filling?
- ◆ Perception of Risk after fill

Slide 19

## T3 Transportation Systems



Slide 20

## Site T3 – Development Costs

| Description   | Quantity   | Unit | Unit Cost (US\$) | Amount (US\$)      |
|---|------------|------|------------------|--------------------|
| Preliminaries   |            |      |                  | \$535,120          |
| UXO Clearance   |            |      |                  | \$4,601,600        |
| Site Clearance & Preparation                                      |            |      |                  | \$207,520          |
| Site Restoration  |            |      |                  | \$2,121,060        |
| Environmental Mitigation  |            |      |                  | \$577,455          |
| Sub Total   |            |      |                  | \$8,042,755        |
| Contingencies   |            |      | 10%              | \$804,276          |
| <b>Total Estimated Cost of Site Development &amp; Restoration</b> |            |      |                  | <b>\$8,847,031</b> |
| Equivalent Unit cost of Site Development (\$/m3 of cap.)          |            | m3   | \$0.33           |                    |
| Equivalent Unit cost of Site Development (\$/ha)                  |            | ha   | \$76,904         |                    |
| <b>Materials Placement</b>  |            |      |                  |                    |
| Wet Materials Transport to Site                                   | 28,132,315 | m3   | 3.52             | \$99,025,749       |
| Dry Materials Transport to Site                                   | 28,132,315 | m3   | 2.08             | \$58,515,215       |

## Site T3 – Gaillard Cut North

- ◆ Area = 115 ha
- ◆ Maximum Capacity = 28 million m3
- ◆ No significant Environmental Concerns
- ◆ Transport Costs
  - \$3.52/m3 - dredged material
  - \$2.08/m3 - dry material (west banks)
- ◆ Site prep & rest. - \$76,904/ha (UXO)
- ◆ No Value added potential
- ◆ Community benefit from UXO clearance?
- ◆ No socio economic impacts

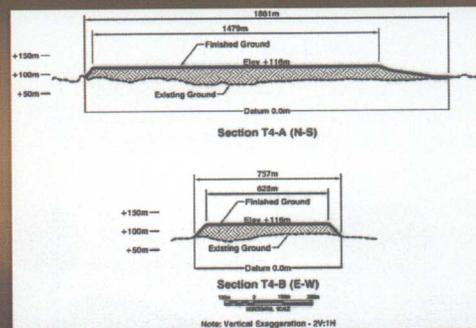
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## Site T4 - Gaillard Cut East Final Configuration



Slide 23

## T4 Fill Sections



Slide 24

## Site T4 – Development Costs

| Description   | Quantity   | Unit | Unit Cost (US\$) | Amount (US\$)      |
|---|------------|------|------------------|--------------------|
| Preliminaries   |            |      |                  | \$80,000           |
| Site Clearance & Preparation                                      |            |      |                  | \$53,334           |
| Site Restoration  |            |      |                  | \$962,000          |
| Environmental Mitigation  |            |      |                  | \$243,996          |
| Sub Total   |            |      |                  | \$1,339,231        |
| Contingencies   |            |      | 10%              | \$133,923          |
| <b>Total Estimated Cost of Site Development &amp; Restoration</b> |            |      |                  | <b>\$1,473,154</b> |
| Equivalent Unit cost of Site Development (\$/m3 of capacity)      |            | m3   | \$0.05           |                    |
| Equivalent Unit cost of Site Development (\$/ha)                  |            | ha   | \$27,910         |                    |
| <b>Materials Transport to Disposal Site</b>                       |            |      |                  |                    |
| Dry Materials Transport to Site                                   | 12,555,399 | m3   | 3.32             | \$41,683,925       |

## Site T4 – Gaillard Cut East

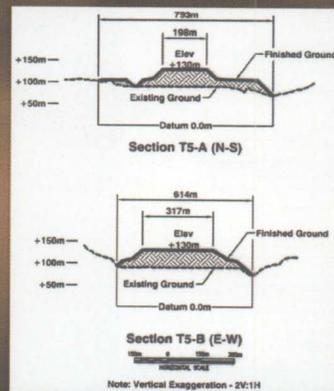
- ◆ Area = 106 ha
- ◆ Maximum Capacity = 31 million m3
- ◆ Reserve - East Bank material – 12.6 M m3
- ◆ No Significant Environmental concerns
- ◆ Transport Costs
  - \$3.32/m3 – dry material (east banks only)
- ◆ Site prep & restoration - \$27,910/ha
- ◆ No Value added potential
- ◆ No socio economic impacts

Slide 26

## Site T5 - Gaillard Cut South Final Configuration



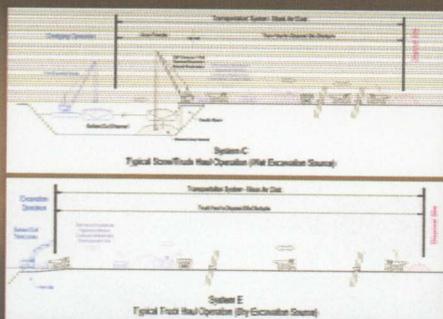
Slide 27



## T5 Fill Sections

Slide 28

## T5 Transportation Systems



Slide 29

## Site T5 – Development Costs

| Description   | Quantity  | Unit | Unit Cost (US\$) | Amount (US\$)      |
|---|-----------|------|------------------|--------------------|
| Preliminaries   |           |      |                  | \$189,301          |
| UXO Clearance & Preparation                                       |           |      |                  | \$1,190,680        |
| Site Clearance & Preparation                                      |           | ha   |                  | \$44,942           |
| Site Restoration  |           |      |                  | \$620,332          |
| Environmental Mitigation  |           |      |                  | \$175,466          |
| Sub Total   |           |      |                  | \$2,220,720        |
| Contingencies   |           |      | 10%              | \$222,072          |
| <b>Total Estimated Cost of Site Development &amp; Restoration</b> |           |      |                  | <b>\$2,442,792</b> |
| Equivalent Unit cost of Site Development (\$/m3 of capacity)      |           |      | \$0.35           |                    |
| Equivalent Unit cost of Site Development (\$/ha)                  |           |      | \$82,064         |                    |
| <b>Materials Placement</b>  |           |      |                  |                    |
| Wet Materials Transport to Site                                   | 7,279,284 | m3   | 4.54             | \$33,047,949       |
| Dry Materials Transport to Site                                   | 7,279,284 | m3   | 3.11             | \$22,638,573       |

## Site T5 – Gaillard Cut South

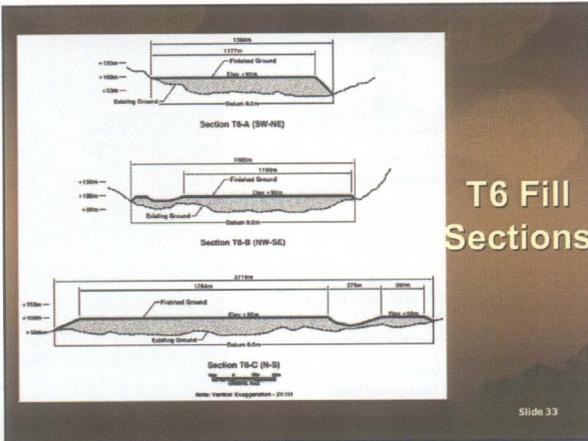
- ◆ Area = 30 ha
- ◆ Maximum Capacity = 7.3 million m<sup>3</sup>
- ◆ No Significant Environmental concerns
- ◆ Critical UXO area
- ◆ Transport Costs
  - \$4.54/m<sup>3</sup> – dredged material
  - \$3.11/m<sup>3</sup> – dry material (west banks)
- ◆ Site prep & restoration - \$82,604/ha
- ◆ No Value added potential
- ◆ No socio economic impacts

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## Site T6 - UXO Area Final Configuration



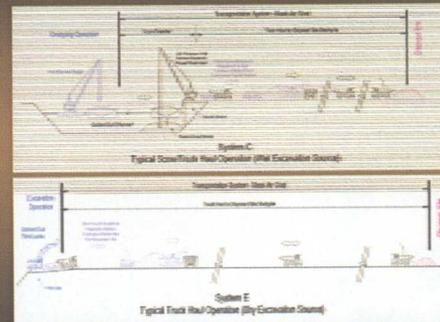
Slide 32



## T6 Fill Sections

Slide 33

## T6 Transportation Systems



Slide 34

## Site T6 – Development Costs

| Description  | Quantity   | Unit           | Unit Cost (US\$) | Amount (US\$)       |
|--|------------|----------------|------------------|---------------------|
| Preliminaries  |            |                |                  | \$1,621,200         |
| UXO Clearance  |            |                |                  | \$10,658,460        |
| Site Clearance & Preparation   |            | ha             |                  | \$527,700           |
| Site Restoration   |            |                |                  | \$6,142,300         |
| Environmental Mitigation   |            |                |                  | \$2,667,772         |
| Sub Total  |            |                |                  | \$21,617,432        |
| Contingencies  |            |                | 10%              | \$2,161,743         |
| <b>Total Estimated cost of Site Development &amp; Restoration</b>        |            |                |                  | <b>\$23,779,175</b> |
| Equivalent Unit cost of Site Development (\$/m <sup>3</sup> of capacity) |            |                |                  | \$0.21              |
| Equivalent Unit cost of Site Development (\$/ha)                         |            |                |                  | \$77,862            |
| <b>Materials Transport &amp; Placement</b>                               |            |                |                  |                     |
| Gaillard Cut Materials   |            |                |                  |                     |
| Wet Materials Transport to Site  | 34,524,112 | m <sup>3</sup> | 6.12             | \$211,287,565       |
| Dry Materials Transport to Site  | 32,900,678 | m <sup>3</sup> | 4.66             | \$153,317,159       |
| Third Locks Material   |            |                |                  |                     |
| Dry Materials Transport to Site  | 90,155,000 | m <sup>3</sup> | 4.12             | \$371,438,800       |

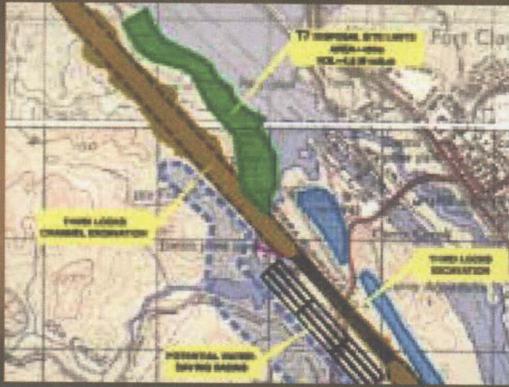
Slide 35

## Site T6 – UXO Area

- ◆ Area = 305 ha
- ◆ Maximum Capacity = 115 million m<sup>3</sup>
- ◆ Environmental Concerns west of site
- ◆ Critical UXO area
- ◆ Transport Costs
  - \$6.12/m<sup>3</sup> – dredged material (Gaillard Cut)
  - \$4.66/m<sup>3</sup> – dry material (Gaillard Cut)
  - \$4.12/m<sup>3</sup> – dry material (New Locks)
- ◆ Site prep & restoration - \$78,916/ha
- ◆ No Value added potential
- ◆ No socio economic impacts

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## Site T7 – Miraflores West shore



## Site T7 – Development Costs

| Description   | Quantity  | Unit | Unit Cost (US\$) | Amount (US\$)    |
|---|-----------|------|------------------|------------------|
| Preliminaries   |           |      |                  | \$100,000        |
| Site Clearance & Preparation                                      |           | ha   |                  | \$60,002         |
| Sub Total   |           |      |                  | \$160,002        |
| Contingencies   |           |      | 10%              | \$16,000         |
| <b>Total Estimated Cost of Site Development &amp; Restoration</b> |           |      |                  | <b>\$176,002</b> |
| Equivalent Unit cost of Site Development (\$/m3 of capacity)      |           |      |                  | \$0.04           |
| Equivalent Unit cost of Site Development (\$/ha)                  |           |      |                  | \$3,911          |
| <b>Materials Placement</b>  |           |      |                  |                  |
| Dry Materials Transport to Site                                   | 4,500,435 | m3   | 2.65             | \$11,926,153     |

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## Site T7 – Miraflores Locks West Bank

- ◆ Area = 45 ha
- ◆ Maximum Capacity = 4.50 million m3
- ◆ Within Locks Construction Zone
- ◆ Transport Costs (from Locks project) - \$2.65/m3 - dry material (New Locks)
- ◆ Site prep & restoration - \$3,911/ha
- ◆ No Value added potential
- ◆ No socio economic impacts

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## Site T8 – Development Costs

| Description   | Quantity  | Unit | Unit Cost (US\$) | Amount (US\$)    |
|---|-----------|------|------------------|------------------|
| Preliminaries   |           |      |                  | \$105,000        |
| <b>Total Estimated Cost of Site Development &amp; Restoration</b> |           |      |                  | <b>\$105,000</b> |
| Equivalent Unit cost of Site Development (\$/m3 of capacity)      |           |      |                  | \$0.02           |
| Equivalent Unit cost of Site Development (\$/ha)                  |           |      |                  | \$2,453          |
| <b>Materials Placement</b>  |           |      |                  |                  |
| Dry Materials Transport to Site                                   | 5,000,100 | m3   | 2.06             | \$10,402,000     |

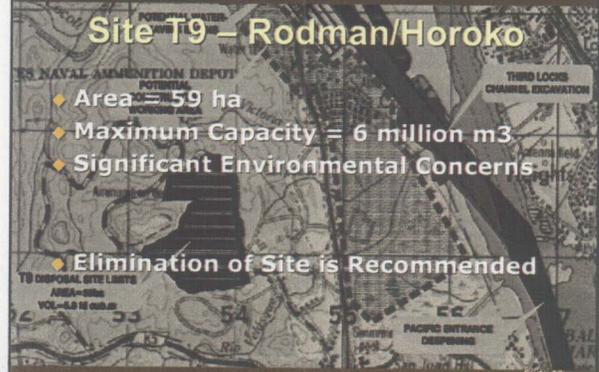
## Site T8 – 1939 Third Locks Lagoons

- ◆ Area = 43 ha (lagoons + entry cut)
- ◆ Maximum Capacity = 5 million m3
- ◆ Within Locks Construction Zone
- ◆ Transport Costs (from Locks project) - \$2.08/m3 - dry material
- ◆ Site prep & restoration - \$2,453/ha
- ◆ No Value added potential
- ◆ No socio economic impacts

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## Site T9 – Rodman/Horoko

- ◆ Area = 59 ha
- ◆ Maximum Capacity = 6 million m3
- ◆ Significant Environmental Concerns
- ◆ Elimination of Site is Recommended



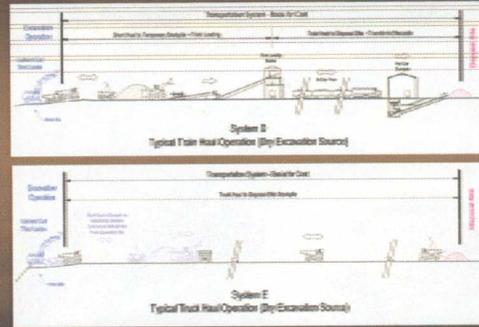
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## Site T10 – El Arado Final Configuration



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## T10 Transportation Systems



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## Site T10 – Development Costs

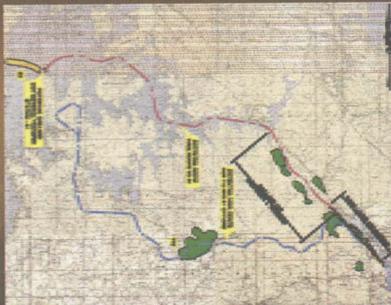
| Description   | Quantity   | Unit | Unit Cost (US\$) | Amount (US\$)       |
|---|------------|------|------------------|---------------------|
| Preliminaries   |            |      |                  | \$49,638,500        |
| Site Clearance & Preparation                                      |            | ha   |                  | \$1,187,785         |
| Site Restoration  |            |      |                  | \$15,577,980        |
| Environmental Mitigation  |            |      |                  | \$8,019,449         |
| Sub Total   |            |      |                  | \$74,423,714        |
| Contingencies   |            |      | 10%              | \$7,442,371         |
| <b>Total Estimated Cost of Site Development &amp; Restoration</b> |            |      |                  | <b>\$81,866,085</b> |
| Equivalent Unit cost of Site Development (\$/m3 of capacity)      |            |      | \$0.78           |                     |
| Equivalent Unit cost of Site Development (\$/ha)                  |            |      | \$93,500         |                     |
| <b>Materials Placement</b>  |            |      |                  |                     |
| 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   | 9.97             | \$898,845,350       |

## Site T10 – El Arado

- ◆ Area = 876 ha
- ◆ Maximum Capacity = 88 million m3
- ◆ Private Ownership
- ◆ Transport Costs (from Locks project)
  - \$5.42/m3 - dry material by train
  - \$9.97/m3 - dry material by truck
- ◆ Acquisition, prep & rest'n = \$93,500/ha
- ◆ Negative Value added potential
- ◆ Potential socio economic impacts
- ◆ Recommend Elimination from Consideration

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## Site A1 – Trinidad Dam Potential Haul Corridors



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## Site A1 – Trinidad Dam Estimated Transport Costs

| Option       | Transport System | Estimated Transport Cost (\$/m3) |       |
|--------------|------------------|----------------------------------|-------|
| Gaillard Cut |                  |                                  |       |
|              | Wet Material     | Barge Haul                       | 5.14  |
|              |                  | Barge/Train                      | 13.86 |
|              |                  | Barge/Truck                      | 31.95 |
| Third Locks  |                  |                                  |       |
|              | Dry Material     | Train Haul                       | 12.72 |
|              |                  | Truck Haul                       | 26.04 |

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## Site M1- Panama Bay Fill



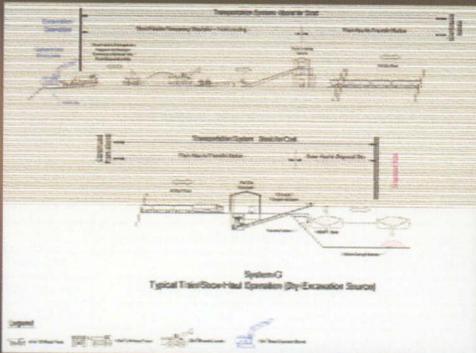
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## M1 Transportation Systems



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## M1 Transportation Systems



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## Site M1 – Panama Bay Fill Estimated Transport Costs

- Barge haul (dredge material only)....\$2.37 per m<sup>3</sup>
- Truck to barge to Dump Site.....\$6.62 per m<sup>3</sup>
- Train to barge to Dump Site .....\$7.49 per m<sup>3</sup>

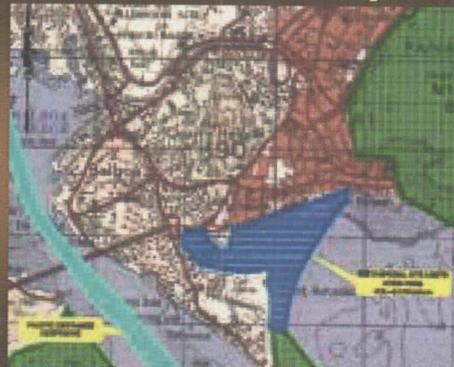
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## Site M1 – Panama Bay Fill

- ◆ Apparent Capacity = 62 million m<sup>3</sup>
- ◆ Jurisdictional Issues
- ◆ Controversial, high cost Project
- ◆ Transport Costs (from Locks project)
  - \$2.37/m<sup>3</sup> – dredged material
  - \$6.62/m<sup>3</sup> – dry material loaded to barges
- ◆ Potential socio economic impacts
- ◆ Approvals unlikely in time for Project

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## Site M2 – Chorrillo Bay Fill



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## Site M2 – Chorrillo Bay Fill Estimated Transport Costs

Barge haul (dredge material only).....\$2.43 per m3  
 Truck to barge to Dump Site.....\$8.09 per m3  
 Train to barge to Dump Site .....\$7.49 per m3

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## Site M2 – Chorrillo Bay Fill

- ◆ Apparent Capacity = 6.6 million m3
- ◆ Jurisdictional Issues
- ◆ Could be a Controversial Project
- ◆ Transport Costs
  - \$2.43/m3 – dredged material - Pac Entrance
  - \$8.09/m3 – dry material from Locks
- ◆ Potential socio economic impacts
- ◆ Approvals unlikely in time for Project

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## Site M3 – Amador Causeway East



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## Site M3 – Amador Causeway East Development Costs

| Description  | Amount (US\$)      |
|--|--------------------|
| Preliminaries and Relocation of Existing Installations       | \$1,050,000        |
| Site Preparation   | \$12,500           |
| Environmental Mitigation                                     | \$258,439          |
| Sub Total  | \$1,320,939        |
| Contingencies  | \$132,094          |
| <b>Total Estimated Cost of Site Preparation</b>              | <b>\$1,453,033</b> |
| Equivalent Unit cost of Site Development (\$/m3 of capacity) | \$0.11             |
| Equivalent Unit cost of Site Development (\$/ha)             | \$13,580           |
| Dredged Material from Pacific Entrance Channel @ \$1.49/m3   | \$21,307,000       |
| Dredged Material from Pacific Locks Expansion @ \$2.42/m3    | \$34,606,000       |

## Site M3 – Amador Causeway East

- ◆ Fill Area = 107 ha
- ◆ Approx. Capacity = 14 million m3
- ◆ Jurisdictional Issues (ARI/IPAT)
- ◆ Transport Costs
  - \$1.49/m3 – dredged material - Pac Entrance
  - \$2.42/m3 – dredged material from Locks
- ◆ Site Preparation costs = \$13,580 /ha
- ◆ Important Community Benefits
- ◆ Unlikely to be controversial?
- ◆ Need to relocate Smithsonian pier
- ◆ Filling already taking place

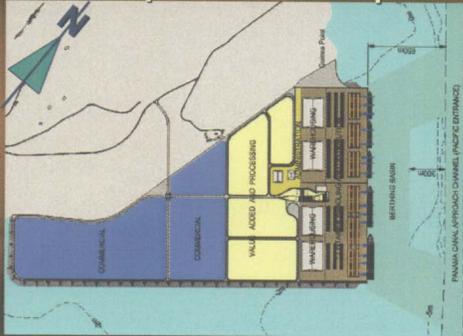
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## Site M4 – Farfan/Palo Seco

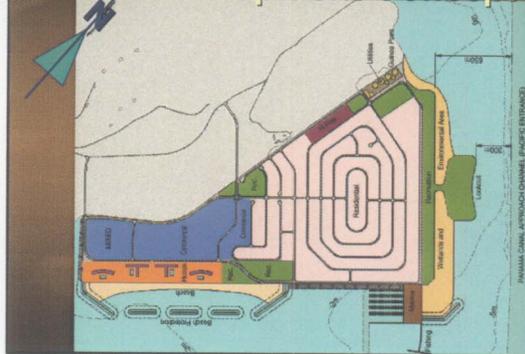


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## Site M4 – Farfan/Palo Seco Development Concept 1



## Site M4 – Farfan/Palo Seco Development Concept 2



## Site M4 – Farfan/Palo Seco Transportation Costs

Barge haul – wet mat'l - Third Locks Excavation.....\$1.49 per m3  
 Barge haul – wet mat'l - Pacific Entrance Dredging.....\$1.49 per m3

Dry Material from Locks excavation by train  
 - stand alone site .....\$7.46 per m3  
 - in conjunction with other site(s) .....\$4.42 per m3

Dry Material from Locks excavation by truck haul.....\$6.92 per m3

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## Site M4 – Farfan/Palo Seco Development Costs

| Description   | Quantity   | Unit Cost (US\$) | Amount (US\$)      |
|---|------------|------------------|--------------------|
| <b>Preliminaries</b>  |            |                  | <b>\$3,400,000</b> |
| Mobilization  | 1          | 150,000.00       | \$150,000          |
| Relocate long term stay hospital                                    | 1          | 3,250,000.00     | \$3,250,000        |
| <b>Site Preparation</b>   |            |                  | <b>\$17,500</b>    |
| <b>Environmental Mitigation</b>                                     |            |                  | <b>\$1,898,536</b> |
| Sub Total   |            |                  | \$5,116,036        |
| Contingencies   |            | 10%              | \$511,604          |
| <b>Total Estimated Cost of Site Preparation</b>                     |            |                  | <b>\$5,627,640</b> |
| <b>Equivalent Unit cost of Site Development (\$/m3 of capacity)</b> |            |                  | <b>\$0.19</b>      |
| <b>Equivalent Unit cost of Site Development (\$/ha)</b>             |            |                  | <b>\$18,822</b>    |
| <b>Materials Placement</b>  |            |                  |                    |
| Dry Materials Transport to Site                                     | 29,900,000 | 7.46             | \$223,054,000      |
| Wet Materials Transport to Site                                     | 14,315,000 | 1.49             | \$21,329,350       |

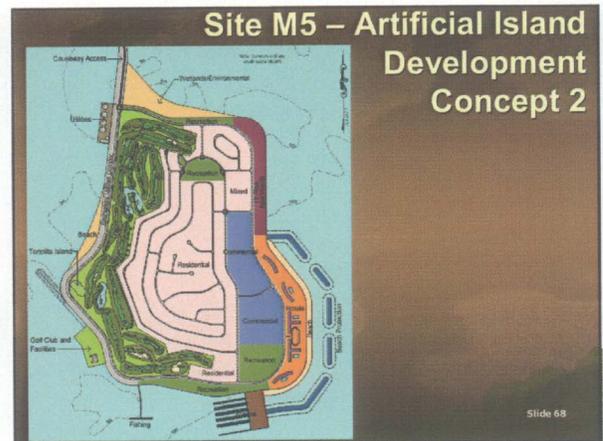
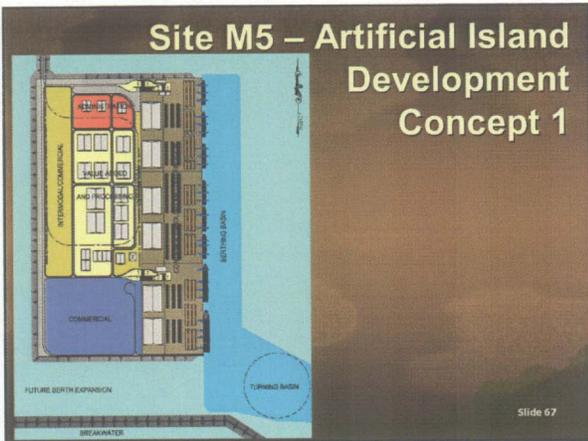
## Site M4 – Farfan/Palo Seco

- ◆ Fill Area = 324 ha (recommended)
- ◆ Capacity = 32.4 million m3
- ◆ Environmental Concerns on landside
- ◆ Transport Costs
  - \$1.49/m3 – dredged material - Pac Entrance
  - \$4.42-6.92/m3 – dry material from Locks
- ◆ Site Preparation costs = \$18,822 /ha
- ◆ Likely to be controversial
- ◆ Need to relocate Hospital
- ◆ Good Potential for Added Value

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## Site M5 – Artificial Island

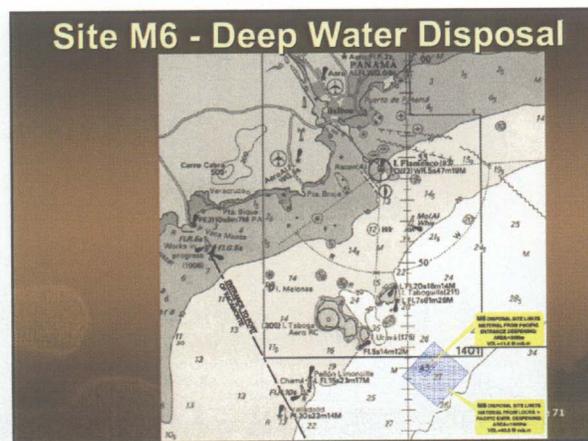




### Site M5 – Artificial Island Development Costs

| Description   | Quantity   | Unit | Unit Cost (US\$) | Amount (US\$)      |
|---|------------|------|------------------|--------------------|
| Preliminaries   |            |      |                  | \$290,000          |
| Site Preparation  |            |      |                  | \$3,750,000        |
| Environmental Mitigation  |            |      |                  | \$2,870,108        |
| Sub Total   |            |      |                  | \$6,900,108        |
| Contingencies   |            |      | 10%              | \$690,011          |
| <b>Total Estimated Cost of Site Preparation</b>                     |            |      |                  | <b>\$7,590,118</b> |
| <b>Equivalent Unit cost of Site Development (\$/m3 of capacity)</b> |            |      | <b>\$0.07</b>    |                    |
| <b>Equivalent Unit cost of Site Development (\$/ha)</b>             |            |      | <b>\$27,600</b>  |                    |
| <b>Materials Placement</b>  |            |      |                  |                    |
| Dry Materials Transport to Site                                     | 90,155,000 | m3   | 4.20             | \$378,651,000      |
| Wet materials from Pac channel                                      | 14,315,000 | m3   | 2.37             | \$33,926,550       |

- ### Site M5 – Artificial Island
- ◆ Fill Area = >350 ha
  - ◆ Capacity = >90 million m3
  - ◆ Possible Environmental Concerns
  - ◆ Transport Costs
    - \$6.35/m3 - dry material from Locks
  - ◆ Site Preparation = \$27,600/ha
  - ◆ Likely to be Controversial
  - ◆ Excellent Potential for Added Value
  - ◆ Study ongoing
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- ### Site M6 – Open Water Disposal Transportation Costs
- Barge haul – Pacific Entrance Dredging.....\$2.57 per m3
  - Dry Material from Locks excavation by train/barge
    - stand alone site.....\$6.35 per m3
    - in conjunction with other site(s).....\$4.42 per m3
  - Dry Material from Locks excavation by truck/barge.....\$7.25 per m3
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## Site M6 – Open Water Disposal

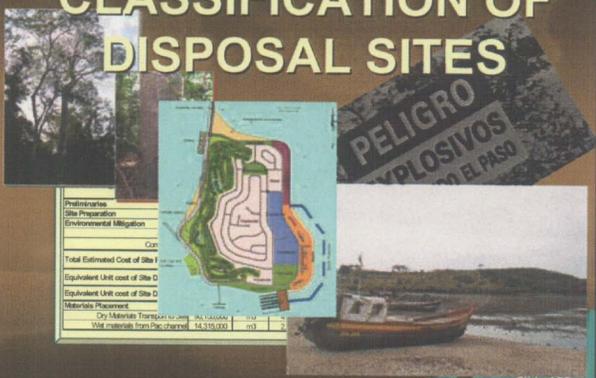
- ◆ \$4.42 -> \$7.25/m<sup>3</sup> – dry material from Locks
- ◆ \$2.57 – dredged material from Pacific Entrance Channel
- ◆ No Added Value

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**PRESENTATION # 4**

**CLASSIFICATION OF DISPOSAL SITES AND SUMMARY OF  
FINDINGS**

# CLASSIFICATION OF DISPOSAL SITES



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EACH GROUP OF SITES IS CLASSIFIED INDEPENDENTLY, BASED ON:

- Environmental Impacts
- Socio Economic Impacts
- Development & Transport Costs
- Value Added Potential
- Institutional or Approval Issues
- (Site Holding Capacity)?????

{ Gaillard Cut }  
 { Locks Project }  
 { Pac. Channel Dredging }

## Site Capacities – Gaillard Cut Group

| Site Ref.                       | Designation  | Generated Excavation Volume (million m3) | Estimated Maximum Capacity (million m3) |
|---------------------------------|--|--|---|
| Gaillard Cut Materials Sites    |  | 79.98                                    |   |
| T1                              | Rio Mandinga   |  | 68.38                                   |
| T2                              | Rio Camacho  |  | 27.62                                   |
| T3                              | Gaillard Cut North                                   |  | 28.13                                   |
| T4                              | Gaillard Cut East (cap limited to west bank dry mat) | 12.56                                    | 12.56                                   |
| T5                              | Gaillard Cut South                                   |  | 7.29                                    |
| T6                              | UXO Area   |  | 115.24                                  |
| A1                              | Trinidad Dam Project                                 |  | 33.50                                   |
| Total Volume Available in Group |  |  | 292.72                                  |

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## Site Capacities – New Locks Group

| Site Ref.                       | Designation                 | Generated Excavation Volume (million m3) | Estimated Maximum Capacity (million m3) |
|---------------------------------|-----------------------------|--|---|
| Third Locks Excavation Sites    |                             | 99.17                                    |   |
| T6                              | UXO Area                    |  | 115.24                                  |
| T7                              | Miraflores West Bank        |  | 4.50                                    |
| T8                              | 1939 Third Locks Excavation |  | 5.00                                    |
| T9                              | Rodman/Horoko               |  | 0.00                                    |
| T10                             | El Arado                    |  | 87.56                                   |
| M1                              | Panama Bay Fill             |  | 61.68                                   |
| M2                              | Chorrillo Bay Fill          |  | 6.56                                    |
| M3                              | Amador East                 |  | 11.23                                   |
| M4                              | Farfan/Palo Seco            |  | 32.49                                   |
| M5                              | Artificial Island           |  | 110.40                                  |
| Total Volume Available in Group |                             |  | 434.66                                  |

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## Site Capacities – Pacific Entrance Dredging

| Site Ref.                               | Designation        | Generated Excavation Volume (million m3) | Estimated Maximum Capacity (million m3) |
|---|--------------------|--|---|
| Pacific Entrance Channel Dredging Sites |                    | 14.30                                    |   |
| M1                                      | Panama Bay Fill    |  | 61.68                                   |
| M2                                      | Chorrillo Bay Fill |  | 6.56                                    |
| M3                                      | Amador East        |  | 13.90                                   |
| M4                                      | Farfan/Palo Seco   |  | 32.49                                   |
| M5                                      | Artificial Island  |  | 110.40                                  |
| Total Volume Available in Group         |                    |  | 225.03                                  |

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## Environmental Classifications Gaillard Cut Sites

| Site Ref. | Site                 | Classification |
|-----------|----------------------|----------------|
| T1        | Rio Mandinga         | 6              |
| T2        | Rio Camacho          | 5              |
| T3        | Gaillard Cut North   | 2              |
| T4        | Gaillard Cut East    | 1              |
| T5        | Gaillard Cut South   | 2              |
| T6        | UXO Area             | 4              |
| A1        | Trinidad Dam Project |                |

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## Environmental Classifications Locks Project Sites

| Site Ref. | Designation                 | Socio Economics | Environmental Impact |
|-----------|-----------------------------|-----------------|----------------------|
| A1        | Trinidad Dam Project        |                 |                      |
| T6        | UXO Area                    | 1               | 3                    |
| T7        | Miraflores West Bank        | 1               | 1                    |
| T8        | 1939 Third Locks Excavation | 1               | 1                    |
| T9        | Rodman/Horoko               | 1               | 9                    |
| T10       | El Arado                    | 8               | 4                    |
| M1        | Panama Bay Fill             | n/a             |                      |
| M2        | Chorrillo Bay Fill          | 7               | 5                    |
| M3        | Amador East                 | 1               | 6                    |
| M4        | Farfan/Palo Seco            | 10              | 7                    |
| M5        | Artificial Island           | 9               | 7                    |

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## Environmental Classifications Pacific Entrance Dredging Sites

| Site Ref. | Designation         | Socio Economic | Environmental |
|-----------|---------------------|----------------|---------------|
| M1        | Panama Bay Fill     | 1              |               |
| M2        | Chorrillo Bay Fill  | 3              | 2             |
| M3        | Amador East         | 1              | 2             |
| M4        | Farfan/Palo Seco    | 5              | 5             |
| M5        | Artificial Island   | 4              | 4             |
| M6        | Open Water Disposal | n/a            | 1             |

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## Cost Classifications Gaillard Cut Sites

| Site | Description          | Site Preparation & Restoration |        | Transport Costs (\$/m3) |              | Total Cost (\$/m3) at max capacity |              | Classification based on Total Cost /# |              |
|------|----------------------|--------------------------------|--------|-------------------------|--------------|------------------------------------|--------------|---------------------------------------|--------------|
|      |                      | \$/ha                          | \$/m3  | Dry Material            | Wet Material | Dry Material                       | Wet Material | Dry Material                          | Wet Material |
|      |                      |                                |        |                         |              |                                    |              |                                       |              |
| T1   | Rio Mandinga         | \$48,275                       | \$0.09 | \$3.33                  | \$4.78       | \$3.42                             | \$4.87       | 4                                     | 3            |
| T2   | Rio Camacho          | \$36,128                       | \$0.17 | \$2.64                  | \$4.06       | \$2.81                             | \$4.23       | 2                                     | 2            |
| T3   | Gaillard Cut North   | \$76,904                       | \$0.32 | \$2.08                  | \$3.52       | \$2.40                             | \$3.84       | 1                                     | 1            |
| T4   | Gaillard Cut East #1 | \$27,910                       | \$0.05 | \$3.32                  |              | \$3.37                             |              | 3                                     |              |
| T5   | Gaillard Cut South   | \$52,064                       | \$0.35 | \$3.11                  | \$4.54       | \$3.46                             | \$4.89       | 5                                     | 4            |
| T6   | UXO Sites            | \$77,862                       | \$0.21 | \$4.66                  | \$6.12       | \$4.87                             | \$6.33       | 6                                     | 6            |
| A1   | Trinidad Dam #3      |                                |        |                         | \$5.14       |                                    | \$5.14       |                                       | 5            |

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## Cost Classifications New Locks Sites

| Site                                  | Description                   | Site Preparation & Restoration |        | Transport Costs (\$/m3) |              | Total Cost (\$/m3) at max capacity |              | Classification based on Total Cost /# |              |
|---------------------------------------|-------------------------------|--------------------------------|--------|-------------------------|--------------|------------------------------------|--------------|---------------------------------------|--------------|
|                                       |                               | \$/ha                          | \$/m3  | Dry Material            | Wet Material | Dry Material                       | Wet Material | Dry Material                          | Wet Material |
|                                       |                               |                                |        |                         |              |                                    |              |                                       |              |
| Third Locks Excavation Disposal Sites |                               |                                |        |                         |              |                                    |              |                                       |              |
| T6                                    | UXO Sites                     | \$77,862                       | \$0.21 | \$4.12                  |              | \$4.33                             |              |                                       | 4            |
| T7                                    | Miraflores Locks West Bank    | \$3,911                        | \$0.04 | \$2.65                  |              | \$2.69                             |              |                                       | 2            |
| T8                                    | 1939 Locks Excavation Lagoons | \$2,453                        | \$0.02 | \$2.68                  |              | \$2.70                             |              |                                       | 1            |
| T9                                    | Rodman/Horoko /2              |                                |        |                         |              |                                    |              |                                       | n/a          |
| T10                                   | El Arado                      | \$93,500                       | \$0.18 | \$5.42                  |              | \$5.20                             |              |                                       | 5            |
| M1                                    | Panama Bay Fill #2            |                                |        | \$3.24                  |              | \$3.24                             |              |                                       | 8            |
| M2                                    | Chorrillo Bay #2              |                                |        | \$5.91                  |              | \$5.91                             |              |                                       | 9            |
| M3                                    | Amador Causeway East Expans   | \$13,580                       | \$0.11 | \$5.91                  |              | \$9.02                             |              |                                       | 10           |
| M4                                    | Farfan/Palo Seco Reclamation  | \$18,822                       | \$0.19 | \$7.46                  |              | \$7.65                             |              |                                       | 7            |
| M5                                    | Artificial Island             | \$27,600                       | \$0.07 | \$4.20                  |              | \$4.27                             |              |                                       | 3            |
| M6                                    | Open Water Disposal           | \$228                          | \$0.00 | \$6.35                  |              | \$6.35                             |              |                                       | 6            |

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## Cost Classifications Pacific Entrance Dredging Sites

| Site | Description                    | Site Preparation & Restoration |        | Transport Costs (\$/m3) |              | Total Cost (\$/m3) at max capacity |              | Classification based on Total Cost /# |              |
|------|--------------------------------|--------------------------------|--------|-------------------------|--------------|------------------------------------|--------------|---------------------------------------|--------------|
|      |                                | \$/ha                          | \$/m3  | Dry Material            | Wet Material | Dry Material                       | Wet Material | Dry Material                          | Wet Material |
|      |                                |                                |        |                         |              |                                    |              |                                       |              |
| M1   | Panama Bay Fill #2             |                                |        |                         | \$2.63       |                                    | \$2.63       |                                       | 5            |
| M2   | Chorrillo Bay #2               |                                |        |                         | \$2.70       |                                    | \$2.70       |                                       | 6            |
| M3   | Amador Causeway East Expansion | \$13,580                       | \$0.11 |                         | \$1.49       |                                    | \$1.60       |                                       | 1            |
| M4   | Farfan/Palo Seco Reclamation   | \$18,822                       | \$0.19 |                         | \$1.49       |                                    | \$1.68       |                                       | 2            |
| M5   | Artificial Island              | \$27,600                       | \$0.07 |                         | \$2.37       |                                    | \$2.44       |                                       | 3            |
| M6   | Open Water Disposal            | \$228                          | \$0.00 |                         | \$2.57       |                                    | \$2.57       |                                       | 4            |

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## Value Added Potential Classification Criteria (Score)

- 4 - Significant Financial Added Value (ie land sale or rental)
- 3 - Significant Community and/or Economic Benefits
- 2 - Potential Economic or Intrinsic Benefits to Panama
- 1 - Nominal or modest financial or economic benefits
- 0 - No Added Value or Benefits

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## Value Added Classifications Gaillard Cut Sites

| Site Ref.                    | Designation          | Value Added Potential | Classification |
|------------------------------|----------------------|-----------------------|----------------|
| Gaillard Cut Materials Sites |                      |                       |                |
| T1                           | Rio Mandinga         | 0                     | 4              |
| T2                           | Rio Camacho          | 0                     | 4              |
| T3                           | Gaillard Cut North   | 0                     | 4              |
| T4                           | Gaillard Cut East    | 1                     | 1              |
| T5                           | Gaillard Cut South   | 0                     | 4              |
| T6                           | UXO Area             | 1                     | 1              |
| A1                           | Trinidad Dam Project | 1                     | 1              |

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## Value Added Classifications New Locks Sites

| Site Ref.                    | Designation                 | Value Added Potential | Classification |
|------------------------------|-----------------------------|-----------------------|----------------|
| Third Locks Excavation Sites |                             |                       |                |
| T6                           | UXO Area                    | 2                     | 6              |
| T7                           | Miraflores West Bank        | 0                     | 7              |
| T8                           | 1939 Third Locks Excavation | 0                     | 7              |
| T9                           | Rodman/Horoko               | 0                     | 7              |
| T10                          | El Arado                    | 0                     | 7              |
| M1                           | Panama Bay Fill             | 4                     | 1              |
| M2                           | Chorrillo Bay Fill          | 3                     | 4              |
| M3                           | Amador East                 | 3                     | 4              |
| M4                           | Farfan/Palo Seco            | 4                     | 1              |
| M5                           | Artificial Island           | 4                     | 1              |

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## Value Added Classifications Pacific Entrance Channel Sites

| Site Ref.                               | Designation        | Value Added Potential | Classification |
|---|--------------------|-----------------------|----------------|
| Pacific Entrance Channel Dredging Sites |                    |                       |                |
| M1                                      | Panama Bay Fill    | 4                     | 1              |
| M2                                      | Chorrillo Bay Fill | 3                     | 4              |
| M3                                      | Amador East        | 3                     | 4              |
| M4                                      | Farfan/Palo Seco   | 4                     | 1              |
| M5                                      | Artificial Island  | 4                     | 1              |

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## Institutional or Approval Issues Evaluation Criteria (Score)

- 3 - No Significant Issues
- 2 - Moderate to Significant Issues
- 1 - Significant Issues
- 0 - Expectation of Strong Resistance

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## Institutional or Approval Issues Gaillard Cut Sites

| Site Ref.                    | Designation          | Institutional Factor | Classification |
|------------------------------|----------------------|----------------------|----------------|
| Gaillard Cut Materials Sites |                      |                      |                |
| T1                           | Rio Mandinga         | 3                    | 1              |
| T2                           | Rio Camacho          | 3                    | 1              |
| T3                           | Gaillard Cut North   | 3                    | 1              |
| T4                           | Gaillard Cut East    | 2                    | 5              |
| T5                           | Gaillard Cut South   | 3                    | 1              |
| T6                           | UXO Area             | 1                    | 7              |
| A1                           | Trinidad Dam Project | 2                    | 5              |

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## Institutional or Approval Issues New Locks Sites

| Site Ref.                    | Designation                 | Institutional Factor | Classification |
|------------------------------|-----------------------------|----------------------|----------------|
| Third Locks Excavation Sites |                             |                      |                |
| T6                           | UXO Area                    | 2                    | 3              |
| T7                           | Miraflores West Bank        | 3                    | 1              |
| T8                           | 1939 Third Locks Excavation | 3                    | 1              |
| T9                           | Rodman/Horoko               | 2                    | 3              |
| T10                          | El Arado                    | 1                    | 7              |
| M1                           | Panama Bay Fill             | 0                    | 10             |
| M2                           | Chorrillo Bay Fill          | 1                    | 7              |
| M3                           | Amador East                 | 2                    | 3              |
| M4                           | Farfan/Palo Seco            | 0                    | 9              |
| M5                           | Artificial Island           | 1                    | 7              |
| M6                           | Open Water Disposal         | 1                    | 6              |

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## Institutional or Approval Issues Pacific Entrance Dredging Sites

| Site Ref                                | Designation        | Institutional Factor | Classification |
|---|--------------------|----------------------|----------------|
| Pacific Entrance Channel Dredging Sites |                    |                      |                |
| M1                                      | Panama Bay Fill    | 0                    | 4              |
| M2                                      | Chorrillo Bay Fill | 1                    | 2              |
| M3                                      | Amador East        | 2                    | 1              |
| M4                                      | Farfan/Palo Seco   | 0                    | 4              |
| M5                                      | Artificial Island  | 1                    | 2              |

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## Classifications Gaillard Cut Sites

| Site Ref. | Designation          | Classification Category |               |       |             |               |
|-----------|----------------------|-------------------------|---------------|-------|-------------|---------------|
|           |                      | Socio Economic          | Environmental | Costs | Value Added | Institutional |
| T1        | Rio Mandinga         | 1                       | 6             | 4     | 3           | 1             |
| T2        | Rio Camacho          | 1                       | 5             | 3     | 3           | 1             |
| T3        | Gaillard Cut North   | 1                       | 2             | 1     | 3           | 1             |
| T4        | Gaillard Cut East    | 1                       | 1             | 2     | 1           | 5             |
| T5        | Gaillard Cut South   | 1                       | 2             | 5     | 3           | 1             |
| T6        | UXO Area             | 1                       | 4             | 6     | 1           | 7             |
| A1        | Trinidad Dam Project |                         |               |       |             | 5             |

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## Classifications New Locks Sites

| Site Ref. | Designation                 | Classification Category |               |       |             |               |
|-----------|-----------------------------|-------------------------|---------------|-------|-------------|---------------|
|           |                             | Socio Economic          | Environmental | Costs | Value Added | Institutional |
| T6        | UXO Area                    | 1                       | 3             | 4     | 6           | 3             |
| T7        | Miraflores West Bank        | 1                       | 1             | 2     | 7           | 1             |
| T8        | 1939 Third Locks Excavation | 1                       | 1             | 1     | 7           | 1             |
| T9        | Rodman/Horoko               | 1                       | 9             |       | 7           | 3             |
| T10       | El Arado                    | 8                       | 4             | 5     | 7           | 7             |
| M1        | Panama Bay Fill             | 0                       |               | 8     | 1           | 10            |
| M2        | Chorrillo Bay Fill          | 7                       | 5             | 9     | 4           | 7             |
| M3        | Amador East                 | 1                       | 6             | 10    | 4           | 3             |
| M4        | Farfan/Palo Seco            | 10                      | 7             | 7     | 1           | 9             |
| M5        | Artificial Island           | 9                       | 7             | 3     | 1           | 7             |
| M6        | Open Water Disposal         |                         |               | 6     | 6           | 6             |

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## Classification Pacific Entrance Dredging Sites

| Site Ref. | Designation         | Classification Category |               |       |             |               |
|-----------|---------------------|-------------------------|---------------|-------|-------------|---------------|
|           |                     | Socio Economic          | Environmental | Costs | Value Added | Institutional |
| M1        | Panama Bay Fill     | 1                       |               | 5     | 1           | 6             |
| M2        | Chorrillo Bay Fill  | 3                       | 2             | 6     | 4           | 3             |
| M3        | Amador East         | 1                       | 2             | 1     | 4           | 2             |
| M4        | Farfan/Palo Seco    | 5                       | 5             | 2     | 1           | 5             |
| M5        | Artificial Island   | 4                       | 4             | 3     | 1           | 4             |
| M6        | Open Water Disposal | n/a                     | 1             | 4     | 6           | 1             |

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## SUMMARY & CONCLUSIONS Gaillard Cut project (80 M m3):

Appropriate for immediate use:

- ✓ T1 - Rio Mandinga (68 M m3)
- ✓ T2 - Rio Camacho (28 M m3)
- ✓ T4 - Gaillard Cut East (13 M m3)

Not essential to Project:

- ✓ T3 - Gaillard Cut North (UXO issues)
- ✓ T5 - Gaillard Cut South (UXO issues)
- ✓ T6 - UXO site (UXO & costs)

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## SUMMARY & CONCLUSIONS New Locks Project (90 M m3):

No significant Issues:

- ✓ T7 - Miraflores West Bank (4.58 M m3)
- ✓ T8 - 1939 Lagoons (5.0 M m3)

High Capacity Terrestrial Sites:

- ✓ T6 - UXO site (115 M m3 - costs + institutional issues)

Good Potential for Value Added Opportunities :

- ✓ M3 - Amador Causeway East (14 M m3)
- ✓ M4 - Farfan/Palo Seco (32 M m3 - Env. Issues)
- ✓ M5 - Artificial Island (110 M m3 - Environmental Issues)

Not Recommended for Serious Consideration:

- ✓ T9 - Rodman/Horoko (Env. Impacts)
- ✓ T10 - El Arado (Socio Economic impact + Costs)
- ✓ M1 - Panama Bay Fill (Timing + controversial)
- ✓ M2 - Chorrillo Bay Fill (Timing + capacity)

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## SUMMARY & CONCLUSIONS

### Pacific Entrance Project (14 M m3)

Good Potential for Value Added Opportunities or Community Benefits :

- ✓ M3 – Amador Causeway East (13 M m3)
- ✓ M4 – Farfan/Palo Seco (32 M m3 - Env. Issues)

Possible Alternates :

- ✓ M5 – Artificial Island (110 M m3)
- ✓ M4 – Farfan/Palo Seco (32 M m3 - Env. Issues)
- ✓ M2 – Chorrillo Bay Fill (6.56 M m3)

**Not Recommended:**

- ✓ M1 – Panama Bay Fill (Timing + controversial)

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## APPENDIX I - BIBLIOGRAPHY

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