August 2010

ENVIRONMENTAL IMPACT STATEMENT

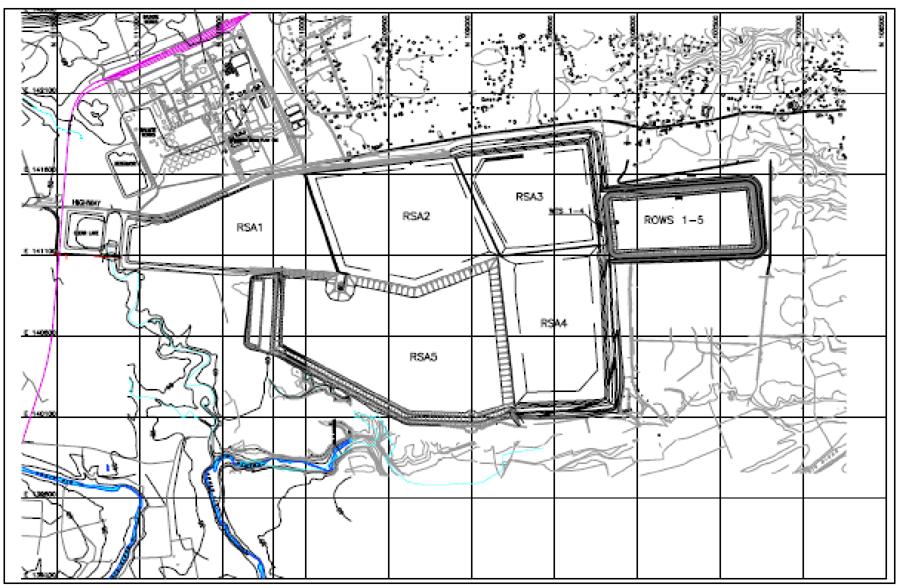
Jamalco Run Off Storage (ROWS) 1-5

CD* PRJ 1098/10

Prepared for:

JAMALCO

Halse Hall, Clarendon



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for

The Construction of

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Prepared for:

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1. EXECUTIVE SUMMARY

1.1. Background

In keeping with its bauxite residue management plan and strategies, Jamalco proposes to construct Run-off Water Storage (ROWS) 1-5 adjacent to the existing residue storage areas numbers 3 and 4 (RSAs 3&4) in its complex of residue disposal areas which are located opposite to its alumina refinery at Halse Hall, Clarendon.

The purpose of the facility is to collect, store and control storm water run-off from the RSAs and recycle the collected water to the alumina refinery for use in the process.

In this regard, it constitutes a major facility in Jamalco's zero discharge plant, thereby ensuring environmental protection while at the same time improving plant economy and contributing to environmental conservation practices by reducing raw material consumption and the demand for fresh make up water.

The proposed storm water lakes represent an integral part of the alumina refinery's environmental management values of maximizing recycling and reuse of useful resources.

An Environmental Impact Statement (EIS) has been prepared for the proposed new ROWS 1-5 based on field and desktop investigations, analyses and assessments.

It is noteworthy that Jamalco has successfully constructed and operated storm water lakes of this kind at this facility for the past 37 years; hence, demonstrating a solid track record and baseline of sound environmental management.

This proposed storm water lake incorporates state-of-the-art technology in civil, structural, chemical engineering and environmental management practices. It is in keeping with the company's policies and values as well as observing the policies, legislation, regulations and standards of the Government of Jamaica.

The following components of the EIS are summarised below:

1.2. Project Description

The ROWS 1-5 will be located to the south of the existing RSAs 3 and 4 requiring the partial diversion of approximately 1.5 km of the existing Dry River Road (Public Road) that presently runs south of RSAs 3 and 4 and to the west of the existing public highway that runs through Hayes. The estimated total plan area of the ROWS pond based on the bulk earthworks footprint is of the order of 21 hectares.

Storage water volumes within ROWS 1-5 is approximately 5.2 million cubic metres. The new ROWS 1-5 will provide storage volume for rainfall runoff from existing RSAs 1, 2, 3 and 4 and 5 and also the clear lake south of RSA1 and the Storm lake located on the refinery.

The system will be gravity drained from the RSAs to the storm lakes insuring that it remains operational even in the event of power outages.

The new ROWS 1-5 would be created by constructing a base layer, incorporating a combined compacted clay and HDPE geomembrane seal, within excavations and embankments.

Design conditions have been modelled to ensure that the proposed earthworks for ROWS 1-5 is satisfactorily safe and meets design standards. The safety factors for long term conditions with no significant build up of groundwater pressure are above 1.5. For the short term condition of construction or rainfall induced groundwater pressure in the embankment, the safety factors are above 1.3. The seismic safety factors are above 1.0 for the design horizontal acceleration of 0.125g. Protection and flood avoidance measures have also been provided at the toes of embankments that are located near the flood plain and approach the 1:100 year flood boundary of the Rio Minho.

Details of the Project Description are provided in the body of the text.

1.3. Environmental Setting

The environmental setting is one of a xerophytic dry area with maritime weather conditions and vegetation and fauna similarly suited and adapted for those conditions. There are no threatened, rare or endangered species of flora or fauna at the proposed project site.

The soil type, hydrology and geology of the area have been investigated and have been found to be alluvium atop limestone. The hydrogeology forms part of the Rio Minho watershed.

Relevant details are provided in the text.

1.4. Impact Identification and Mitigation

Potential negative impacts have been identified and discussed in-depth in the body of the report. These are:

- Water Resources (surface and groundwater)
- Ground (soil) Conditions
- Air Quality
- Noise
- Flora
- Fauna
- Land Use
- Aesthetics

1.5. Regulatory Framework

All relevant policies, regulations and legislations of the Government of Jamaica have been taken into account from the design stage to ensure that the project is constructed and operated compliant with the requirements of the regulatory framework.

Among the laws taken into account are:

- Agenda 21
- Natural Resources Conservation Authority (NRCA) Act, 1991
- Wildlife Protection Act, 1945
- Watershed Protection Act, 1963
- Town & Country Planning Act, 1987
- Forestry Act, 1937
- Water Resources Act/Underground Water Control Act, 1959
- Jamaica National Heritage Trust Act, 1985
- Public Health Act, 1985
- Disaster Preparedness & Emergency Management Act, 1993
- National Solid Waste Management Authority Act, 2001
- Occupational Safety & Health Act, 2003 (DRAFT)
- Clarendon Parish Provisional Development Order, 1982

1.6. Environmental Monitoring Plan

The project will be monitored during the pre-construction, construction and operational phases and the critical parameters will be monitored.

In the event that the project is approved, a detailed monitoring plan will be developed and submitted to NEPA for implementation of the project.

1.7. Conclusions

The proposed ROWS 1-5 storm pond has been optimally designed to ensure that the objectives are effectively met. This uses state-of the art designs, approaches, methodologies and techniques which takes into account the environmental baseline and setting, the need for environmental protection and resource conservation, and the efficient operation of the facility.

1.8. Recommendations

Given the 35 years of successful construction and operation of similar facilities in the same location, the sound concept and design of the proposed ROWS 1-5, the mitigating actions to be taken, the level and detail of assessments conducted and the integral nature of the facilities to the alumina refining process, we recommend that the proposed project be permitted by NEPA with appropriate conditions pertaining to monitoring during all phases of the project.

2. INTRODUCTION

The proposed storm water management and storage project is a necessary development in Jamalco's Residue Management System, as the company prepares to implement Dry Residue Storage methodology. The Storm Water Storage area is proposed to be constructed to the south of existing RSAs 3 and 4 and will receive storm water as it runs off the surface of existing and proposed residue areas, minimising holding of storm water in Jamalco's residue storage areas and maximising the opportunity for consolidation with the associated benefits of increased residue storage over a given area and ease of preparation for rehabilitation. The greatly increased storm water holding capacity of the Jamalco Residue Storage Area that will result from construction of the Run Off Water Storage (ROWS) 1-5 facility will complement the company's policy of zero discharge. The added flexibility in management of water will result in greater reuse from the lakes to the refinery and a reduced consumption of groundwater presently abstracted from wells.

This project will create a new storm water pond with associated water transfer structures. The estimated total plan area of the ROWS pond based on the bulk earthworks footprint is of the order of 21 hectares. The ROWS 1-5 will be located to the south of the existing RSAs 3 and 4 requiring the partial diversion of approximately 1.5 km of the existing Dry River Road (Public Road) that presently runs south of RSAs 3 and 4 and to the west of the existing public highway that runs through Hayes.

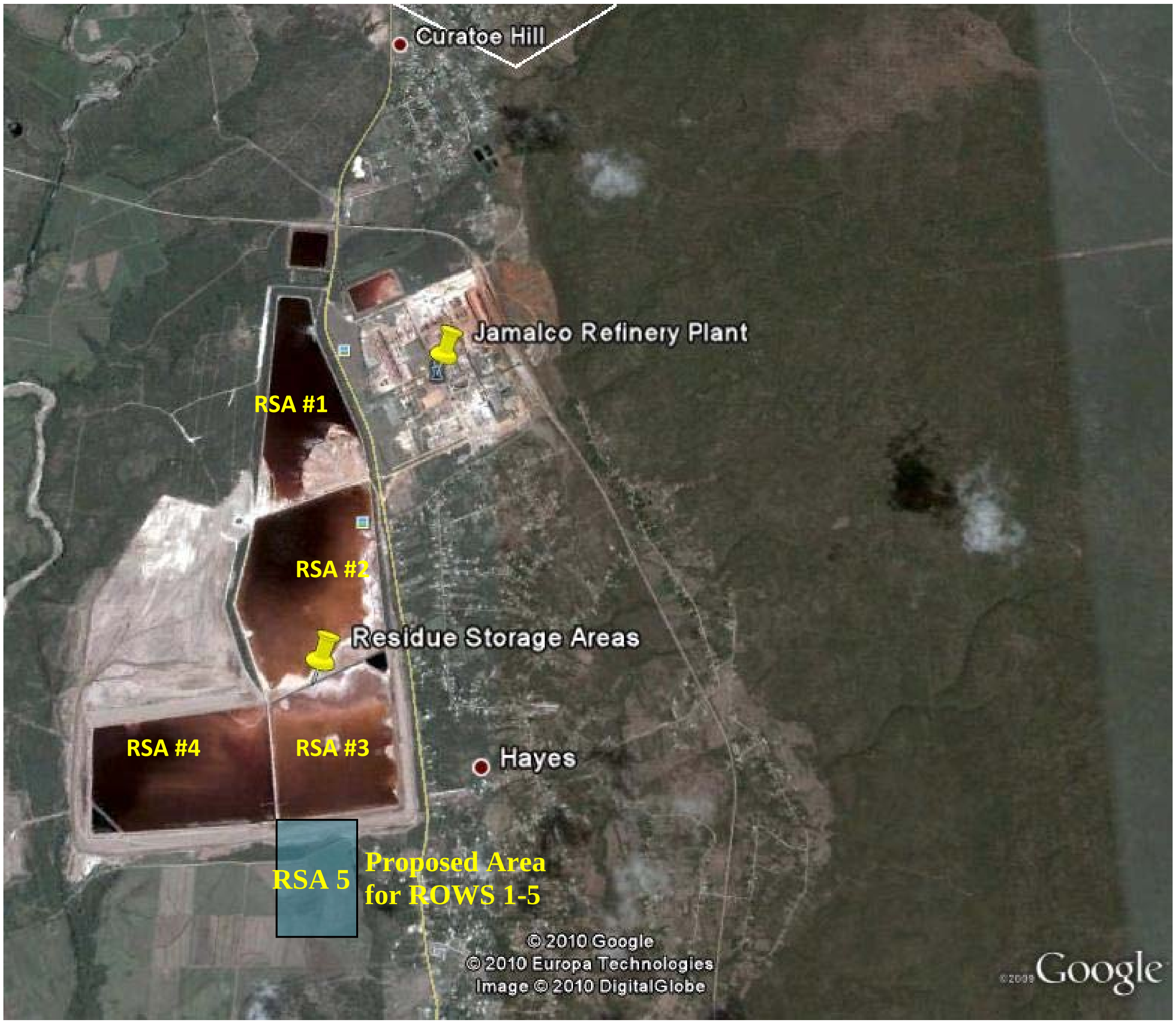

Plate 1: Location of the Red Mud Lakes next to which ROWS pond will be built (south of RSA #3 and 4)

The new ROWS 1-5 will provide storage volume for rainfall runoff from existing RSAs 1, 2, 3 and 4 and 5. Storage water volumes within ROWS 1-5 is approximately 5.2 million cubic metres. The new ROWS 1-5 would be created by constructing a base layer, incorporating a combined compacted clay and HDPE geomembrane seal, within excavations and embankments.

The detailed scope of the ROWS 1-5 project will include the following:

- Construction of elevated earthen berms with a total plan area of about 21 hectares with retention dykes approximately 20m above grade.
- Installation of an HDPE geomembrane liner on top of a 500mm thick compacted clay liner to base and internal sides of excavations and embankments.

- Installation of a baffle chute spillway on the south embankment of RSA 3 to allow gravity transfer of storm water from RSAs 1 to 4 to the lower level storm water ROWS 1-5.
- Installation of floating pump structures and associated M&E equipment for ROWS 1-5 to permit water management between lakes and the Clarendon works
- Partial relocation of the Dry River Road (Public Road) and existing services.
- Provision of access roads.

The General Arrangement Plan of the proposed works is shown in Figure 1.

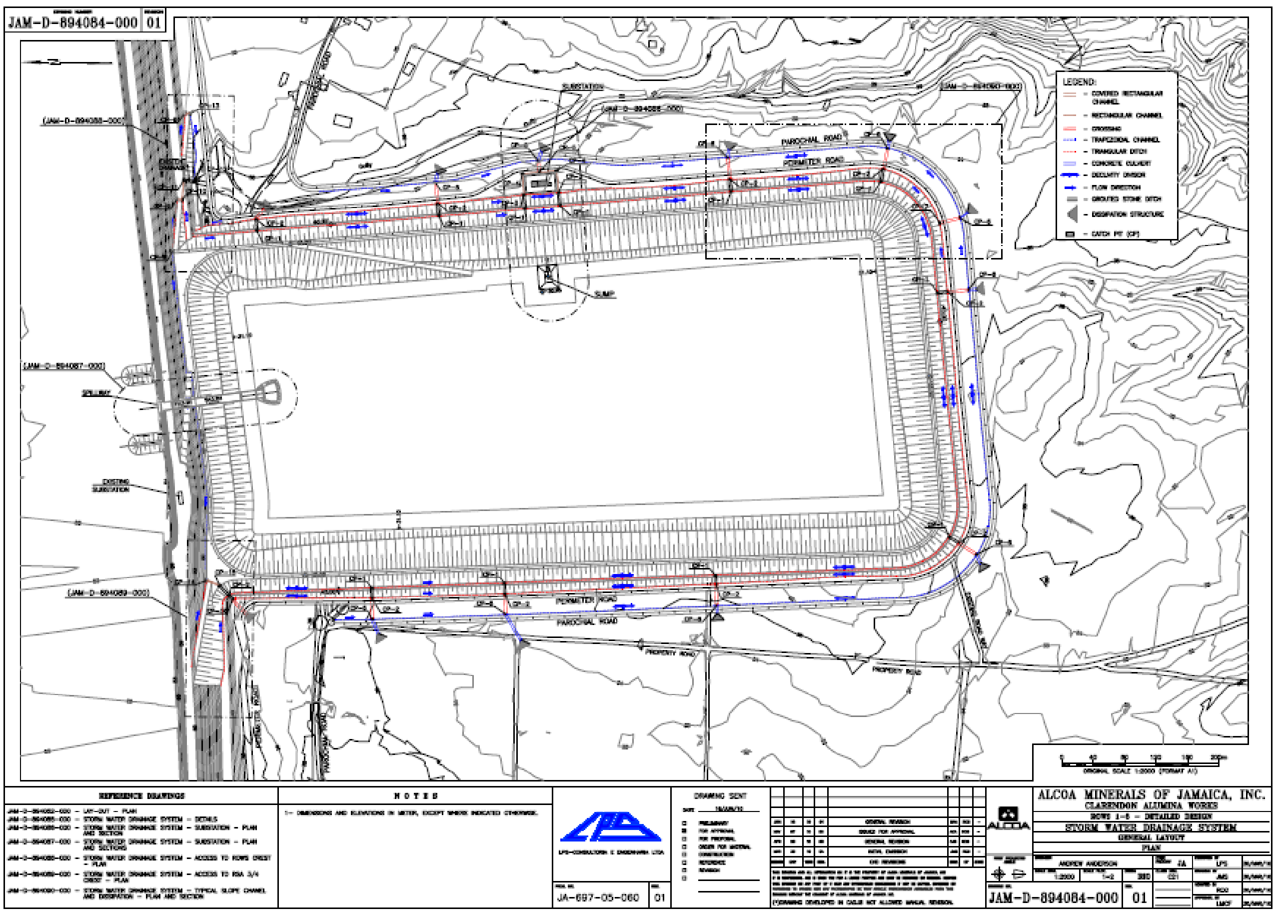

Figure 1: General Arrangement Plan of Storm Water Drainage System

3. PROJECT DESCRIPTION

3.1. Regional Location

The proposed ROWS 1-5 will be annexed to the Residue Storage Area (RSA) of Jamalco's Clarendon Alumina Refinery. The RSA is located immediately to the west of the Clarendon Refinery with the main arterial road bearing traffic to and from May Pen running between them. The town of May Pen is located approximately 5km to the north of the site and the towns of Hayes and Lionel Town are located to the south. To the west the area is bounded by the Rio Minho and Webbers Gully watercourses. Halse Hall Great House is located to the north of the Clarendon Refinery.

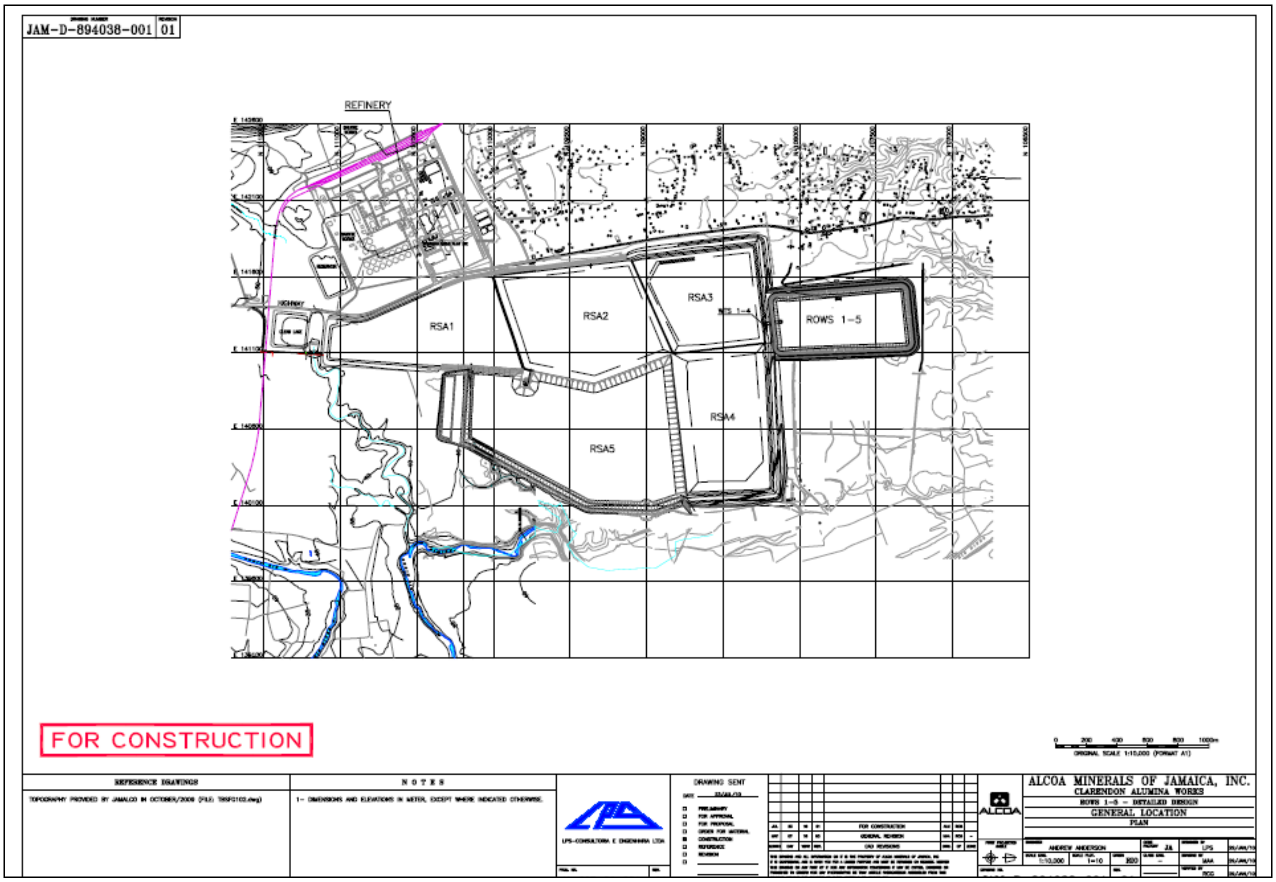

Figure 2: Regional Project Layout (See Appendix for full image)

3.2. Project Location

The proposed ROWS area for RSAs 1 to 5 is to be located to the south of RSAs 3 and 4. The proposed works will require partial diversion of the existing public road. This will be facilitated by new road construction linking to existing roads to the south of the proposed ROWS 1-5. The ROWS 1-5 has an area of about 21 hectares, which together with the access roads etc will total approximately 28 hectares of new development to the south of the existing RSAs. The total area owned by Jamalco for the ROWS 1-5 development is approximately 336 hectares. Approximately 1,375m (1,500 yards) to the west of the ROWS 1-5 area is the Rio Minho. The design will take into account the flooding of the Rio Minho and its flood plain.

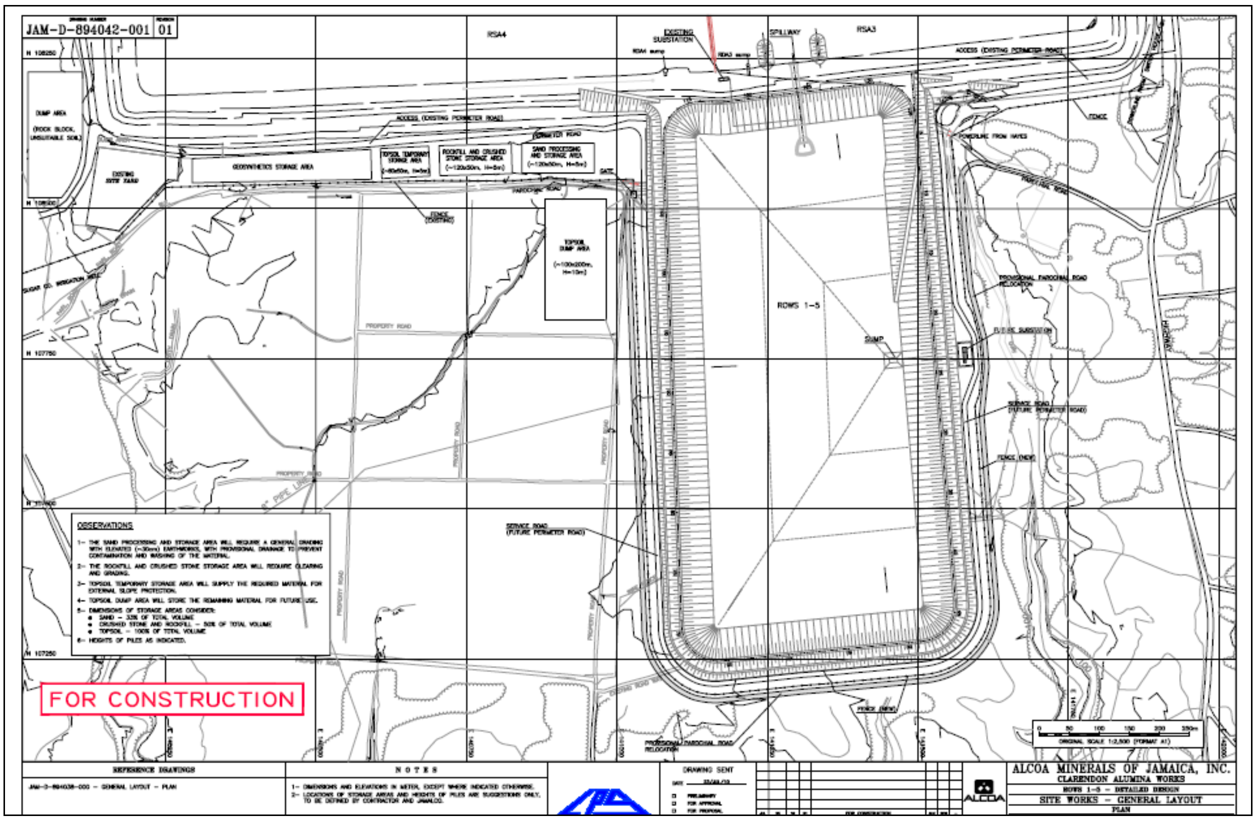

Figure 3: Site Layout Plan (See Appendix 3 for Full Image)

With these measures, the entire proposed permanent structures footprint will not encroach on the 1:100 year flood level as predicted by the most recent flood studies report carried out by Water Resources Authority (2006).

There are screening plantations of trees that separate Hayes New Town, Vere Tech High from the proposed developments. The proposed ROWS 1-5 will not affect the screening trees and will be a minimum of about 219 yards (200m) from these existing developments.

3.3. Project Parameters

3.3.1. Liner System

A liner comprising a 500 mm thick clay layer and geomembrane liner comprising double-sided textured HDPE (High Density Polyethylene) flexible geomembrane is proposed. Most of the clay material will be obtained off site as 115,000 m3 of clay is currently located just west of ROWS 1-5.

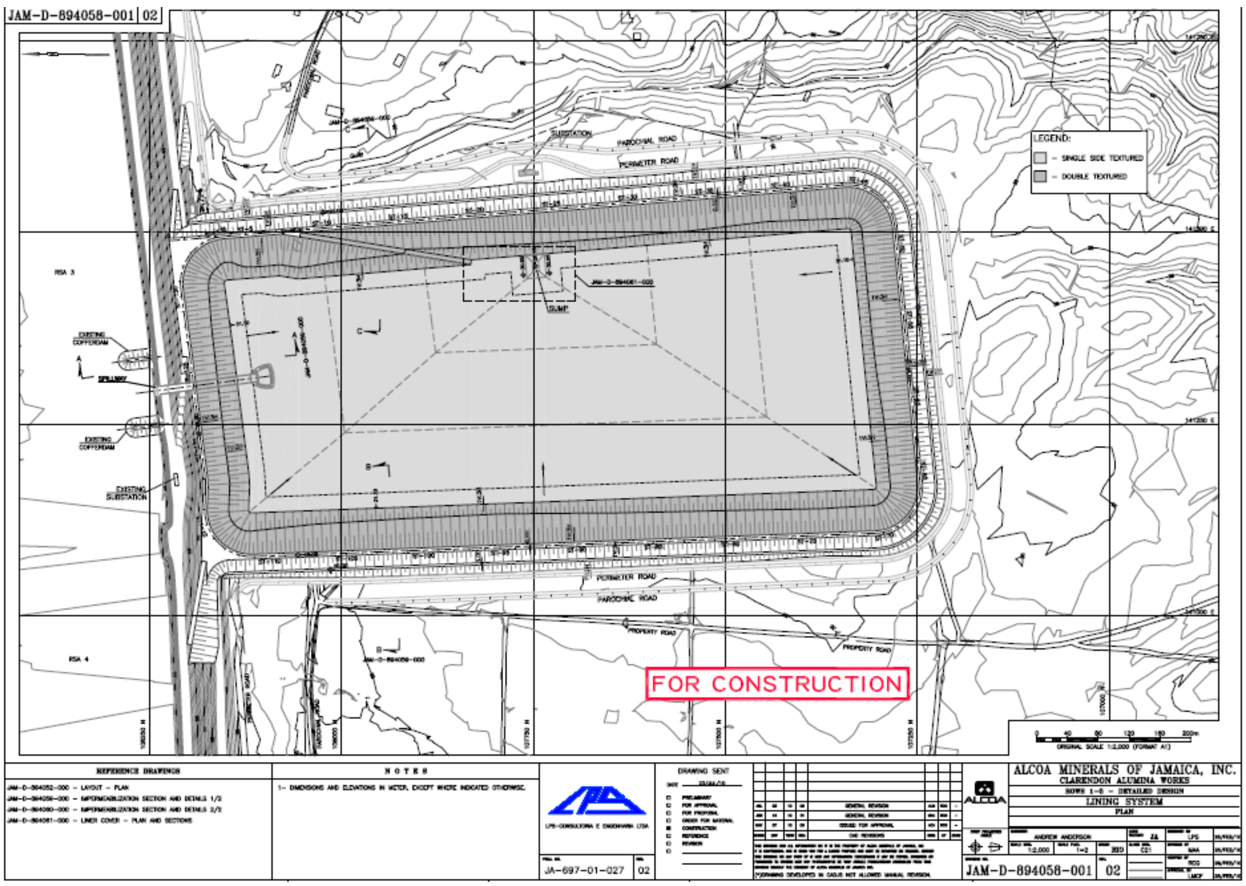

Figure 4: Liner System Plan

3.3.2. Earthworks Profiles and Model Geometry

Earthworks materials for the new embankments will comprise site won material excavated as part of the works. This will comprise predominantly mixed alluvial deposits together with selected suitable limestone arising. The new embankments for the ROWS pond to RSA 3 will be about 40' (12 m) above grade with an external batter of 1:2.5 and internal batter of 1:3. Assuming an overall ground level of about +36mND (118'), they will be constructed to a crest elevation of +47.5mND (156'). The maximum design lake level is +46.5mND. A common embankment will be required at the north end where the new ROWS 1-5 will abut the existing RSA3 embankment.

Excavations (see Figure 5) typically of the order of 1m increasing up to 4m depth below existing ground level at the northern end will be required to form the proposed lake floor levels. An 8m wide access road at the crest of the embankment is proposed.

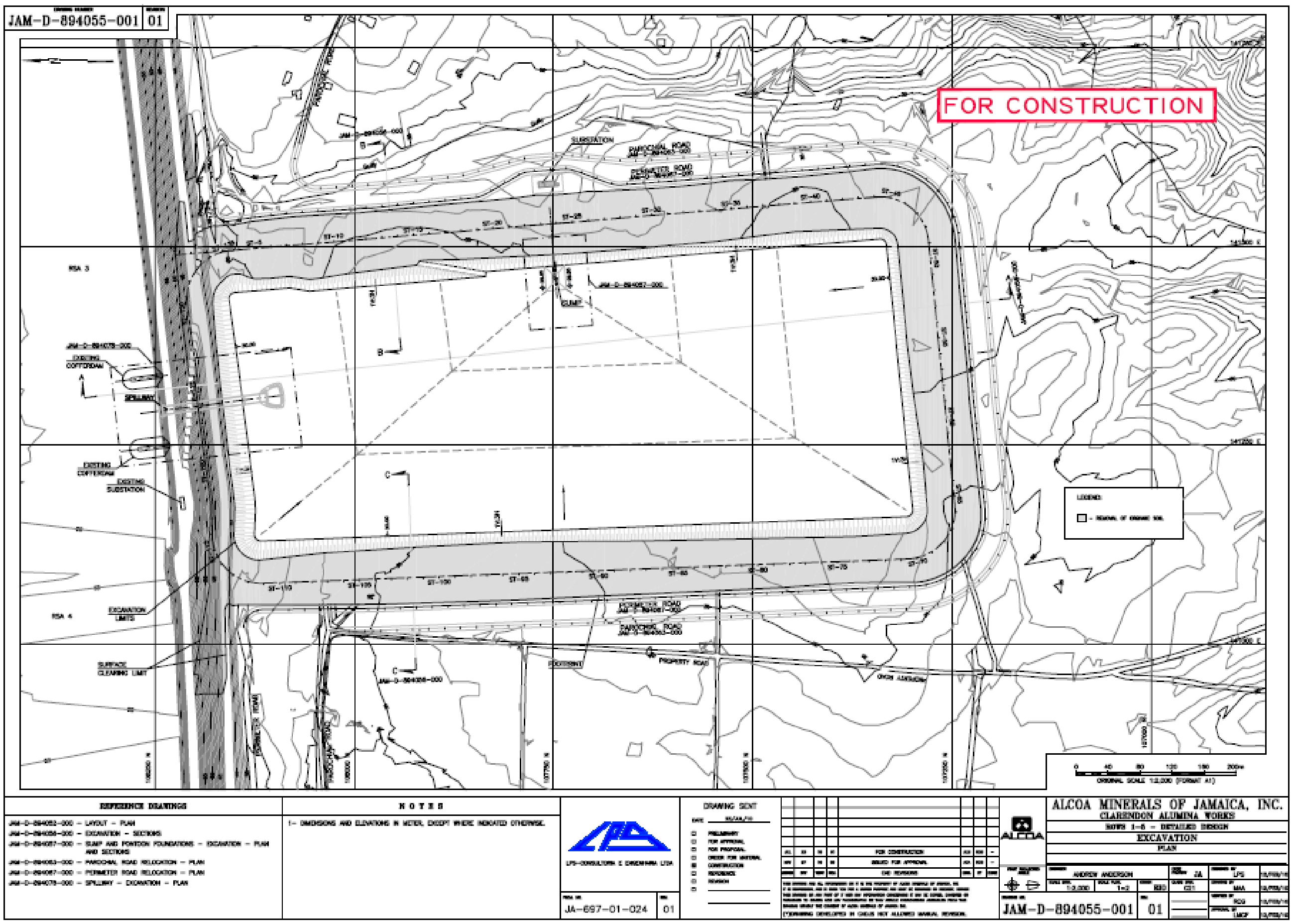

Figure 5: Excavation Plan

The water transfer structure will be formed in open channel approximately 4m deep through the crest of the existing RSA3 embankment and then comprise a concrete baffle chute spillway at approximate grade 1V:3H discharging into ROWS 1-5. The layout of the water transfer structure is shown in Figure 6 and Figure 7. Local earthworks will be required to support the spillway structure on the south face of RSA3.

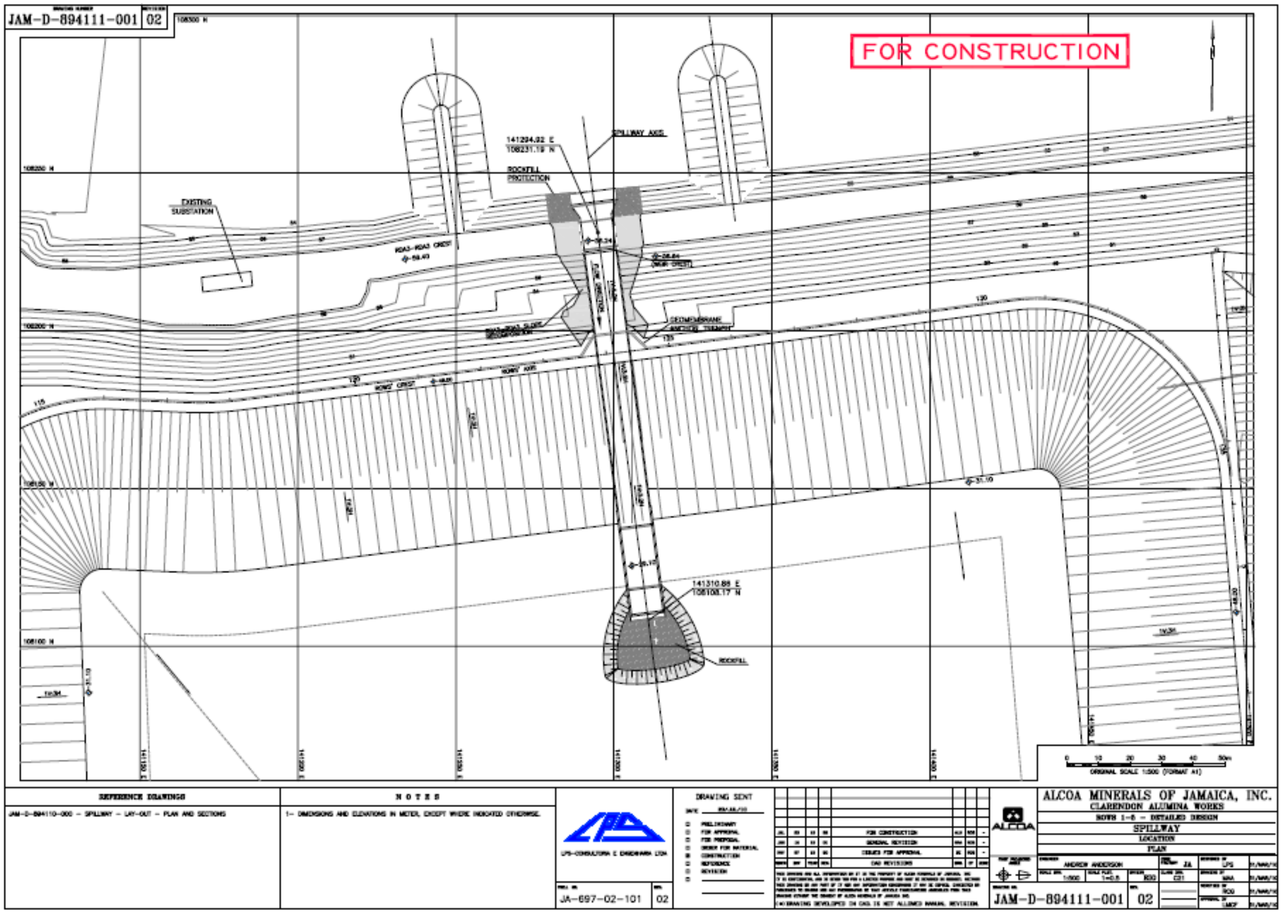

Figure 6: Spillway Location Plan

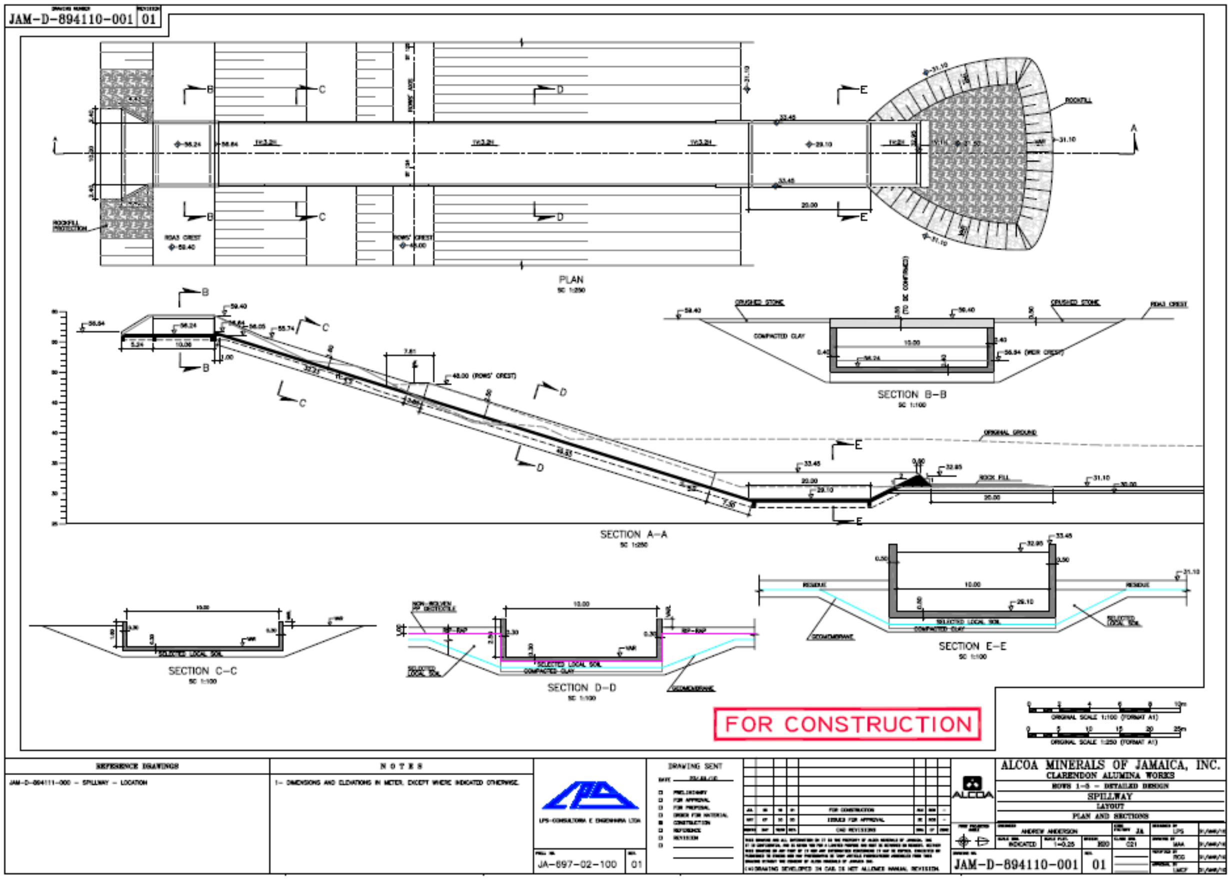

Figure 7: Spillway Layout Plan

3.3.3. Liner Cover

The HDPE liner in the ROWS 1-5 will be covered with a layer of sand covered with a layer of geotextile fabric and a third layer of rock material.

3.3.3.1. Earthwork Design and Analysis

3.3.3.1.1. Ground Conditions

Extensive geotechnical investigations have been undertaken as part of the design studies and these are discussed in Section 1.8 below.

The ground model for the ROWS 1-5s site is summarised below:

Table 1: Summary of Ground Conditions

Strata	Elevation to Top of Strata (m ND)	Proven Thickness of Strata (m)	Average Thickness of Strata (m)
Topsoil	37.5 to 30.2	0.1 to 0.5	0.3
Alluvial Deposits (granular and cohesive soils)	37.4 to 30.5	0.3 to 23.2	9
Limestone (weathered and competent Limestone)	35.7 to 10.6	Not proven. (Proven to at least 8.4 in all rotary drill holes)	-

3.3.3.2. Design Method and Criteria

Stability analyses have been undertaken to consider the short term construction condition as well as long term stability conditions. In addition, in accordance with local building requirements, analyses have been carried out to consider earthworks stability under seismic conditions by means of a pseudo-static method of analysis.

The embankment design was undertaken in accordance with the Minimum Factor of Safety failure criteria summarised below. These adopted minimum required factors of safety against slope instability are based on Alcoa's "Bauxite Residue Management Standards & Guidelines" (2004) and generally accepted US/UK geotechnical engineering practice.

Table 2: Summary of Adopted Slope Stability Design Criteria

Design Loading Case	Seismic/Dynamic Condition	Minimum Factor of Safety
Short Term (i.e. End of construction or rainfall events)	Static	1.3
Long Term (i.e. Operational,)	Static	1.5
Earthquake	Pseudo-static	1.0

The calculations were performed using the SLOPE/W computer program (version 6.14) developed by GEO-SLOPE International Ltd, Canada which employs the two-dimensional limit equilibrium method of slices. The minimum factors of safety for the most critical circular slip surface were computed by the Morgenstern-Price (M-P) method that satisfies both moment and force equilibrium static conditions. A half-sine force function was also defined for characterising the normal and shear interslice forces used by the M-P method.

In general, the M-P method tends to produce slightly less conservative results compared with the different analysis methods used by others during the previous stability studies (namely, Bishops modified and Janbu methods).

For assessment of the seismic stability, the horizontal and vertical inertial forces created by earthquake ground shaking were defined as:

F = Aw/g = Kw, where

a = pseudostatic accelerations

g = gravitational acceleration constant

W = weight of failure mass or interslice

k = seismic coefficient of acceleration

The dynamic loading conditions applied was a horizontal inertial force (Fhh) acting upstream and positive vertical inertial force (Fvv) acting downwards in the direction of gravity, to reduce the embankment's mass and stability. In addition, the vertical seismic coefficient (kvv) was taken as 50% or 0% of the horizontal seismic coefficient (khh).

3.3.3.3. Material Design Parameters

To reflect the observed variability in the Alluvial Deposits and the fill materials derived from the Alluvial Deposits, recognised in the geotechnical investigations, moderately conservative material design parameters were adopted and analyses based on the more critical design case of embankment foundation or cut slope formation in predominantly cohesive Alluvial Deposits. Strength parameters for the predominantly cohesive deposits are lower than for the more granular materials. The material parameters used in the stability analyses are summarised below. The effective shear strength parameters adopted are unfactored values.

Table 3: Summary of Adopted Stability Design Soil Parameters

Soil Model	Material Type	Material Properties Adopted		
		Bulk Unit Weight, γ (kN/m3)	Effective Cohesion, c' (kN/m2)	Effective Angle of Friction, ϕ' (°)
Embankment FILL	Type B	20.0	5	28
Foundation	Cohesive Alluvial Deposits	20.0	0	28

3.4. Materials of Construction

The following bulk earthworks materials will be required for construction of the ROWS 1-5.

Table 4: Key Quantities

Item	Location	Unit	Quantity
Clay	Seal layer	m3	185,000
Soil	Embankments	m3	1,420,000
Geomembrane liner	Seal layer	m2	406,612
Import Cover (sand & Crushed limestone)	Lake Liner Cover	m3	260,000

It is anticipated that earthworks for the ROWS 1-5 will result in an overall balance of material. Surplus material arising will be used for remediation purposes. It is anticipated that cover materials for the lake liner will be imported from local quarries.

3.5. Flood Risk

The overall topography of the storm lake site indicate the ground levels to generally slope south westwards with minor depressions and irrigation gullies within the central areas of the sugarcane fields. The ground levels based on the recent surveys vary between approximately 32m ND and 36m ND. Typically, existing ground levels fall towards local gullies to the south west of ROWS 1-5 as well as westwards towards the Rio Minho flood plain. The eastern edge of the Rio Minho flood plain is marked by a distinct topographical rise from 24 to 25m in the flood plain itself to the higher ground currently occupied by the sugar plantations where ROWS 1-5 is to be located.

The Report, Flood Study for the Proposed RDA6 Development Area (HBIV-9), July 2006, prepared by Water Resources Authority (WRA) for Jamalco has been referenced to provide information on the flood risk in the area of the site. The report provides modelled flood levels for selected return events at two sections across the Rio Minho floodplain relevant to the storm lakes site.

1. northern section of the site (i.e. south west corner of RDA4), and
2. southern section (approximately 1km south of the ROWS 1-5).

The following flood levels are given in the report (see report for more detailed information).

Section	**Period Flood Water Elevation (m) corresponding to Return**			
	10 year	25 year	50 year	100 year
Northern Section	22.1	23.9	25.3	26.7
Southern Section	19.2	20.9	22.2	23.5

The proposed ROWS 1-5 excavation is located approximately 600m to the east of the Rio Minho flood plain and between 1050m and 1350m from the 'normal' course of the Rio Minho.

On the basis of the flood levels predicted above, it is noted that 1 in 100 year flood levels (and more frequent return events) will not affect surface water conditions in the area of the storm lakes. This is supported by data from monitoring of piezometers that confirms there is no indication of hydraulic connectivity between storm events in the Rio Minho and the groundwater regime over the ROWS 1-5 area.

3.6. Design Groundwater Conditions

The main groundwater table is present at depth in the Limestone. A design piezometric surface at approximately 23 m (75 ft) depth was generally used in the analyses to represent the regional ground water table in the underlying limestone aquifer.

A typical range of pore water pressure coefficients (ru values) from 0.05 to 0.2 were applied to model the sensitivity of the design to temporary, short term changes in pore water pressures:

- Within saturated cohesive embankment fill due to construction processes;
- Within near surface embankment fill, as a result of extreme seasonal precipitation effects.
- Within near surface saturated embankment foundation soils

Low ru values are representative of conditions of low porewater pressures.

No specific additional allowance for live loading is included in the stability analyses as these are not expected to be significant owing to their transitory nature.

3.6.1. Design Seismic Conditions

A site-specific probabilistic seismic hazard analysis was performed and results are reported in ‘Technical Memorandum No. 5’ Phase II – Probabilistic Seismic Hazards Study, Dames and Moore, 20 November 2000. From this analysis, the peak ground accelerations are found to be 0.09g (100-years return period) and 0.21g (500 years return period), corresponding to estimated magnitudes of M 6.5 and M 7.0 respectively.

From the seismicity chart presented in Figure 8 (from the website of the OAS), it can be seen that the horizontal peak ground acceleration (PGA) at the site, which is just south of May Pen, is 245 gals or 0.25g for a 10% probability of exceedance in 50 years (corresponding to a 475-year return period). The return periods commonly used are 72-year, 475-year, and 975-year periods. These return periods correspond to 50, 10, and 5 percent probability of exceedance for a 50-year period. The 475-year return period (or 10 percent probability of exceedance in 50 years) event is the most common standard used in the industry for assessing seismic risk, and it is also the basis for most building codes for seismic design.

The pseudostatic approach has been used to analyse the seismic stability of the embankments. In these limit equilibrium type of analyses, seismic coefficients kh and kv are applied to model the effect of the earthquake.

Seismic coefficients used in pseudo static analyses are based on the Peak Ground Acceleration (PGA) corrected to account for the dynamic response of the embankment. Typical values of horizontal seismic coefficients (kh) adopted in practice vary from 1/3 PGA to ½ PGA (Geotechnical Earthquake Engineering, Prentice-Hall, 1996, Steven Kramer). In the analyses performed here, kh = ½ PGA is applied. It is furthermore reported that earth dams with pseudostatic factors of safety greater than 1.0 using kh=0.5amax/g would not develop dangerously large deformations (Research by Hynes-Griffin and Franklin, from Kramer).

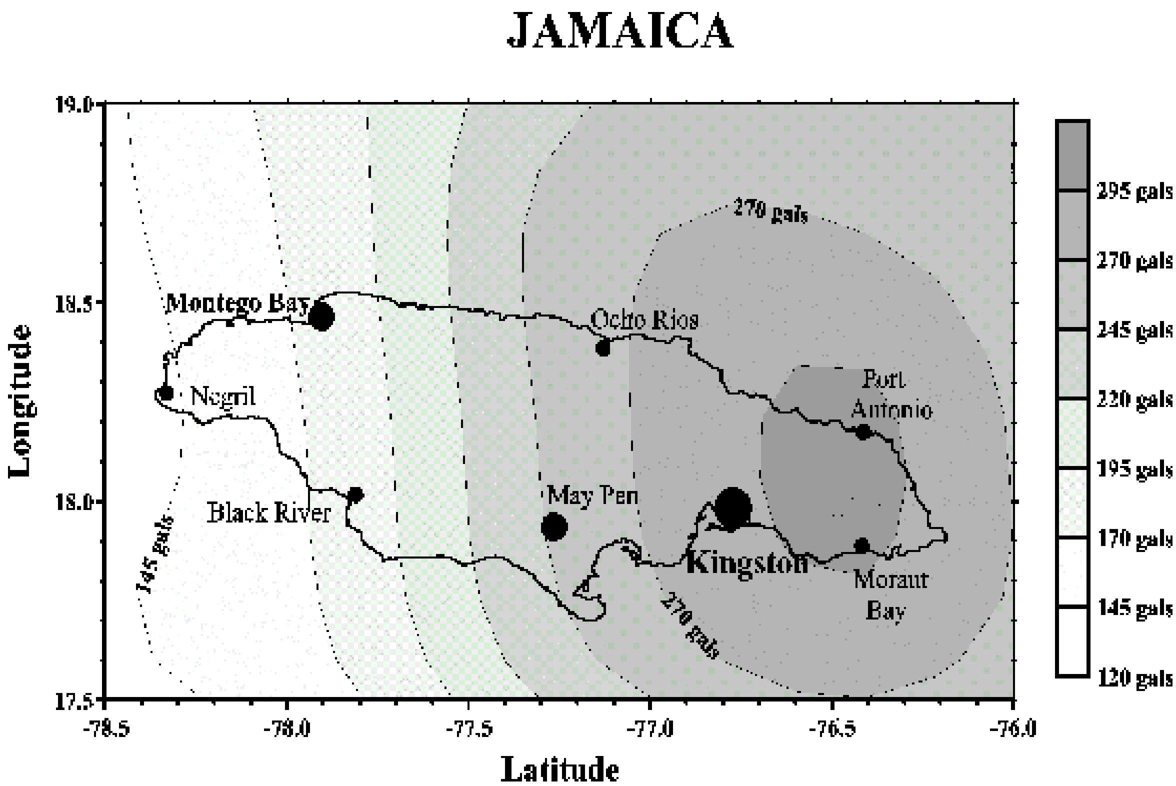

Figure 8: Seismicity Chart - Jamaica

A comparison between the site specific analysis and the seismicity chart shows that the peak ground acceleration is found to be 0.21g for a 500 year return period and 0.25g (at the site) for a 475 years return period respectively.

For reasons given above, a horizontal pseudostatic acceleration of 0.5*0.25g = 0.125g is a conservative and most applicable value for this site.

As per Alcoa standards, a minimum factor of safety of 1.0 is required for a seismic stability analysis. In reality, the factor of safety varies both above and below the static factor of safety and may even fall momentarily below 1.0.

3.6.2. Other Design Considerations

The following temporary or permanent conditions have been considered:

- Live loading, due the passage of trucks and other equipment along the embankment crests has not been analysed, as the absolute mass of such equipment is small in comparison to the size of the embankments. The effect on factor of safety would not be significant.
- Settlement and deformation should not affect embankment serviceability performance, as the Alluvium was found in the geotechnical investigation to be a competent foundation of

low compressibility. Failure surfaces with the minimum safety factors for most of the cases analysed were not through the foundation but contained within the embankment.

- Interfaces with other existing RSA earthworks structures and access ramps are considered to have been covered by the design cases assessed in the calculations.
- Liquefaction potential – the nature of the Alluvial deposits and deep groundwater mean that the potential for liquefaction of materials on the site under seismic conditions is considered to be very low.

Implications of common RSA 3 embankment retaining residue to the north and storm water storage to the south.

3.6.3. Analysis Results and Conclusions

For the design conditions modelled, the proposed earthworks for ROWS 1-5 has satisfactory factors of safety. The safety factors for long term conditions with no significant build up of groundwater pressure are above 1.5. For the short term condition of construction or rainfall induced groundwater pressure in the embankment, the safety factors are above 1.3. The seismic safety factors are above 1.0 for the design horizontal acceleration of 0.125g. Protection and flood avoidance measures have also been provided at the toes of embankments that are located near the flood plain and approach the 1:100 year flood boundary of the Rio Minho.

3.6.4. Surface Water

Water will be transferred by gravity flow from the residue disposal areas. Stormwater from RSAs 1 to 4 will be transferred by means of a broad crested weir and open channel spillway discharging south of the embankment of RSA 3 into ROWS 1-5.

Additional surface water interceptor and carrier drainage is proposed on and surrounding the proposed earthworks structures. Collected surface water will be discharged to existing gully features.

3.7. Pre-Construction Investigations

3.7.1. Ground Investigation and Resource Survey

Comprehensive ground investigations and materials resources surveys have been undertaken as explained in the sections below. These studies have provided information for geotechnical design and on quantities and location of suitable embankment fill and clay liner materials.

3.7.1.1. Ground Investigation

3.7.1.1.1. Mapping the Depth and Nature of the Limestone Subcrop

Geophysics / Resistivity imaging methods (by Fugro Engineering Services, UK) have been used to perform this task. The survey comprised 5 (no.) profiles orientated north-south over the survey area, with 4 (no.) traverses orientated east-west in the area of the ROWS 1-5 at approximately 200 m to 300 m centres. The analysis of the results is presented as cross-sections along each resistivity line, which would highlight the vertical and lateral changes in the subsurface layering. Depth to the Limestone subcrop is highlighted in the sections as a continuous layer at depth, which would be transferred into a contour map over the survey areas. In order to calibrate and to refine the geophysical interpretation an intrusive ground investigation comprising a series of boreholes and trial pits have been carried out in conjunction over the various survey areas.

The detailed findings and interpretations of the Electrical Resistivity sections are presented in the final report entitled "Geophysical Survey – Jamalco RDA's 1-4", Report No. OVS069501-01 (02) dated 1st August 2006.

3.7.1.1.2. Ground Investigation Boreholes and Test pits

The main purpose of the phased intrusive ground investigations contract (by Soil Management Ltd, UK) was to carry out the following activities which facilitated the design and construction of the permanent works of the previously design storm lake, water transfer structures and associated infrastructure:

- Determine the nature, depth and variability of the overburden and limestone strata and the groundwater levels present within the ROWS 1-5 sites. To locate the presence of fissures, possible cavities and evidence of collapse features within the rock formations.
- Obtain good quality, representative samples of all strata encountered for geotechnical and chemical laboratory testing. Including continuous rock core samples of the limestone stratum, where necessary.
- Determine the appropriate geotechnical properties of all strata encountered for deep excavation/embankment slope stability analysis, embankment foundation analysis, lining and cover design materials reuse assessment.
- Monitor the quality and level of any groundwater regime and the potential for migration of contaminants within the ground.
- Enable the formulation of management strategies for re-development/disposal activities and groundwater discharge.
- Obtain sufficient information to assist in the production of Health and Safety hazard/risk assessments for the construction works and site end use.

3.7.1.1.3. Fieldworks

A phased fieldworks approach was adopted as part of the Ground Investigation (GI) strategy to enable adequate information to be obtained during various stages of the storm lake and water transfer structures design. The fieldworks main phases of investigation are summarised below.

Table 5: Summary of Geotechnical Investigations

GI Phase	**Fieldworks Period**	**Fieldworks Scope**	**Comments**
Phase 1	February – March 2006	• 10 No. boreholes to a maximum depth of 25.4m (83 ft) BGL • 31No. trial pits to a maximum depth of 6.3m (21 ft) BGL • n situ field testing comprising Standard Penetration Tests (SPTs) in boreholes and soak away tests and shear vane tests in trial pits.	Phase 1 GI intended to obtain overview ground conditions information within the known current site boundary.
Phase 2	April 2006 – May 2006	• 13No. boreholes to a maximum depth of 33.2m (109 ft) BGL • 9No. trial pits to a maximum depth of 6.2m (21 ft) BGL • In situ field testing comprising Standard Penetration Tests (SPTs) and variable head permeability tests in boreholes and shear vane tests in trial pits.	Phase 2 GI intended to build on ground conditions information from Phase 1 GI and geophysical resistivity survey. Target areas include “clay rich” areas and shallow Limestone.
Additional GI for south east of ROWS 1-5 and water transfer structure 5	August 2006	• 14No. trial pits to a maximum depth of 6.2m (21 ft) BGL	Additional GI for ground conditions information within south of Bog III Estate development for ROWS 1-5 design and south of plant yard for water transfer structure 5 route optioneering.
Clay Proofing	August	• 5No. boreholes to a	Clay Proofing GI to refine

GI Phase	Fieldworks Period	Fieldworks Scope	Comments
within Stormlakes 1-4 and 5	2006	maximum depth of 13.5m (44 ft) BGL • 31No. trial pits to a maximum depth of 6.4m (21 ft) BGL • In situ field testing comprising Standard Penetration Tests (SPTs) in boreholes and shear vane tests in trial pits.	earthworks estimates prepared during Concept Design. In particular to assess the quantity and quality of Type A material likely to be available within excavation footprint of ROWS 1-5 during construction.
GI for Option 5 Stormlake 1-4 and associated spillway structure along the southern embankment of RSA3 and south of RSA3	December 2006	• 6No. boreholes to a maximum depth of 24.0m (79 ft) BGL • 12No, trial pits to a maximum depth of 6.3m (21 ft) BGL	Option 5 stormlake 1-4 and spillway structure GI along RSA3 carried out to obtain information of the existing RSA3 southern embankment, ground conditions underlying the existing embankment and areas south of RSA3 for slope stability analyses and materials reuse assessment.

In addition to the above fieldworks, soil and groundwater sampling was carried out to obtain representative samples for geotechnical and chemical laboratory testing. In selected boreholes groundwater monitoring instruments were installed to monitoring the groundwater regime within the superficial deposits and in the Limestone for the general stormlakes site area.

3.7.1.1.4. Laboratory Testing

Selected soil and groundwater samples were scheduled for geotechnical and chemical laboratory testing. The laboratory tests scheduled are summarised as follows:

Table 6: Summary of Laboratory Testing

Material Type	Laboratory Testing	Comments
Soil	• Soil State Testing • (Moisture Content, Atterberg Limits, Particle Size Distribution, Bulk Density)	• For earthworks design and suitability of materials assessment • Slope stability and settlement analysis

Material Type	**Laboratory Testing**	**Comments**
	• Soil Strength Testing • (Undrained Triaxial Compression Tests, Drained Triaxial Conpression Tests, Shear Box Tests) • Permeability Testing • (Oedometer Tests and Triaxial permeability Tests) • Earthworks Design Testing • (Light Weight Compaction Testing)	analyses
Soil	• Chemical Testing • (Sulphates, Chlorides, Nitrates, Carbonates, Organic Content and pH)	• For concrete design recommendations • Organic Content assessment of type A Clay for suitability of material in accordance with RSA5 Earthworks specification requirements (Rev05), August 2006.
Rock	• Rock Strength Testing • (Point Load Tests, Uniaxial Compression Tests)	• For Limestone excavatibility assessment • Earthworks design and suitability of materials assessment
Groundwater	• Chemical Testing • (BH specific chemical determinants suite for Groundwater quality testing)	• For groundwater quality monitoring and obtaining baseline groundwater quality information for ROWS 1-5 site

Refer to Soil Management’s Final Factual Report titled “JAMALCO RDA’s 1-4 and DRDA5 Stormlakes Ground Investigation Factual Report Version B – Final” dated January 2007 for detailed findings of the GIs.

3.7.2. Material Resource Surveys

The site investigation works focuses on the identification of sources of earthworks materials for the construction of the ROWS 1-5 at the Clarendon Works site in Jamaica. It is anticipated that all the embankment fill material will be derived from the excavations for the ROWS 1-5.

The clay Proofing GI carried out in July 2006 indicate that the "clay rich" area within the excavation footprint of ROWS 1-5 may be considered for sourcing suitable clay for the construction of the ROWS 1-5. Based on findings of the geophysical and the phased intrusive investigations a materials suitability assessment has been carried out. Additional clay required will be obtained from a clay source located in Salt River, and nearby community.

It is anticipated that materials for dike construction for the ROWS 1-5 will result in an overall balance of suitable material. Surplus suitable and unsuitable material arising will remain on the Jamalco site. It is anticipated that cover materials for the lake liner will be imported from local quarries.

3.7.2.1. Topographical and Hydrological Surveys and Studies

To establish existing ground levels and impact of flooding events, a topographic survey by a commissioned land surveyor has been undertaken.

In view of the proximity of the Rio Minho flood plain, the Water Resources Authority (WRA) was commissioned to undertake a revision of their existing Flood Plain Study for the area (2006). This includes mapping of the 1 in 25, 1 in 50 year, and 1 in 100 year flood events. An assessment has been carried out to determine the possible impacts of flooding on the earthworks structures. All structures are located outside the 1:100 year flood boundary and flood protection measures have been provided at the toe of earthworks structures that approach the 1:100 year flood boundary. All surface water flow will be intercepted and positively discharged to the Rio Minho.

Discussions with the WRA have taken place regarding the location of additional groundwater monitoring wells around ROWS 1-5. A revised groundwater monitoring schedule will be supplied to the WRA.

3.7.2.2. Geotechnical and Civil Engineering

Major components of the design will be:

- Embankments,
- Excavation,
- Seal / liner.
- Access Roads

Outlet Structures such as spillways, baffle blocks and aprons will be constructed with good civil engineering practice so no risk of dike failure will result. Risks associated with flooding, hurricanes and earthquakes have been addressed in this design activity. Bearing capacity of underlying strata has been ascertained to be stable for the intended design configurations and in service conditions.

3.7.2.3. Identification of any major risks

Major risks that have been investigated are listed on the appended Environmental Risk Assessment. This details the nature of mitigations proposed to manage the identified risks.

4. PROJECT JUSTIFICATION AND CONSIDERATION OF ALTERNATIVES

4.1. Justification

Given the need to convert from current wet residue disposal methods to 'dry-stacking' as required by NEPA, separate storm water storage is required. To eliminate risk and operate under all conditions including total loss of power under severe weather conditions, gravity drainage and containment systems have been designed. Because of the natural slope of the ground, the ROWS pond must therefore be constructed in the proposed location. In addition to the gravity flow requirement, any alternative location of these ROWS 1-5 on lands owned by Jamalco would compromise the continued operation of the Jamalco facility.

Jamalco has also identified the urgent need for storm water storage prior to the on-coming and for future hurricane seasons. This is considered critical, as the capacity of the existing RSAs to hold storm water is limited. Given that high rainfall activity has occurred in 2004 and 2005, and the unpredictability of the hurricane season, Jamalco considers it critical to provide storm water storage capacity to contain storm water in larger events.

4.2. Alternatives

Jamalco has considered a number of alternatives in relation to increasing residue storage capacity and management of storm water. These include:

- Take no action; and
- Treat and discharge to the Rio Minho.
- Site lakes elsewhere

The 'no action' option was considered unacceptable given the identified risk of storm water overflow during a large storm event. If adequate capacity for storm water is not provided, this may result in overflow of untreated storm water to the Rio Minho.

The option of treating storm water and discharging to the Rio Minho was also considered. This option was considered as a last resort as Jamalco aims to remain a zero discharge facility.

As indicated in the previous section, the alternative of siting the lakes elsewhere did not meet the required criteria of operating under all conditions.

4.3. Timing

The timing has already passed to complete ROWS 1-5 in advance of the up-coming hurricane season. Jamalco had previously submitted an application which was returned pending the presentation of Jamalco's 25 year residue storage strategy. As soon as Jamalco resubmits the application, Jamalco needs prompt approval to complete construction as the temporary run off water storage area will become full by Q2 2012.

The anticipated timing for construction of the ROWS 1-5 is shown below. Construction of the ROWS 1-5 in advance of the up-coming hurricane season is considered critical to ensure adequate storm water storage capacity. The design of the ROWS 1-5 will be completed by the end of Q2 2010. The construction start date will begin immediately upon receipt of environmental approval.

Table 7: Construction Timing

Project	**Construction Phase**		
	Tentative Start (dependent on approval)	Tentative Complete	Duration
ROWS 1-5	November 2010	April 2012	18 months

The transfer structure from RSA 1-4 is to be completed under another project and will be completed in time to facilitate the commissioning of the ROWS pond.

5. POLICY, LEGISLATION, STANDARDS AND REGULATORY FRAMEWORK

5.1. Introduction

This section provides a background on Alcoa's (Jamalco) Environmental Policy and International & National Policies, Legislation and Regulations applicable to the proposed construction of Jamalco's Run off Water Storage (ROWS) 1-5.

5.2. Alcoa's Policies, Principles and Guidelines

5.2.1. Alcoa's Environmental Policy

The Jamalco facility, under the management of Alcoa, strives to meet or exceed all environmental policies and regulations locally and within its corporate structure. As such, the facility is operated under strict guidance and guidelines to insure compliance at all levels of operation. For detailed information on Alcoa's Policies, Principles and Guidelines, reference can be made to the Jamalco Environmental Policy Document.

5.3. Local Policies, Legislation and Regulations

The following represents the applicable legislative requirements with which the proposed ROWS 1-5 construction must comply:

- Agenda 21
- Natural Resources Conservation Authority (NRCA) Act, 1991
- Wildlife Protection Act, 1945
- Watershed Protection Act, 1963
- Town & Country Planning Act, 1987
- Forestry Act, 1937
- Water Resources Act/Underground Water Control Act, 1959
- Jamaica National Heritage Trust Act, 1985
- Public Health Act, 1985
- Disaster Preparedness & Emergency Management Act, 1993
- National Solid Waste Management Authority Act, 2001
- Occupational Safety & Health Act, 2003 (DRAFT)
- Clarendon Parish Provisional Development Order, 1982

Further details of the legislative requirements can be found NEPA website: www.nepa.gov.jm. For specific information in respect of the project, please see the EIA for the construction of a new Dry Residue Disposal Area (DRDA 6) under Policy, Legislation, Standard and Regulatory Framework.

The Agencies responsible for the legislative requirements outlined are shown in Table 8

Table 8: National Legilsation and Responsible Agencies

LEGISLATION	INSTITUTION RESPONSIBLE
1. NRCA Act, 1991	Natural Resources Conservation Authority
2. Wildlife Protection Act, 1945	Natural Resources Conservation Authority
3. Watershed Protection Act, 1963	Natural Resources Conservation
4. Town & Country Planning Act, 1987	Town Planning Department
5. Forestry Act, 1937	Forestry Department
6. The Water Resources Act/UWC Act, 1959	Water Resources Authority
7. Ja. National Heritage Trust Act, 1985	Jamaica National Heritage Trust
8. Public Health Act, 1985	Ministry of Health/Environmental Control Division
9. Disaster Preparation & Emergency Management Act, 1993	Office of Disaster Preparedness and Emergency Management
10. National Solid Waste Management Authority Act, 2001	National Solid Waste Management Authority
11. Clarendon Parish Provisional Development Order, 1982	Town Planning Department

6. EXISTING ENVIRONMENT

6.1. Water Resources

6.1.1. Ground and Surface Water Regime

Surface water features comprise a network of surface water channels that cross the site and pumps that provide irrigation water to the sugar cane fields. A number of gullies provide major natural drainage courses notably one west towards the Rio Minho and another that runs east of the site in approximately north to south direction beyond the toe of ROWS 1-5 embankment. The latest flood studies report produced by WRA (2006) indicates the 1:100 year flood event is confined to Rio Minho channel to a level of approximately 27.9mND and does not extend to the major gullies described above.

Excavations undertaken during the recent (2006) investigation within the upper alluvial deposits confirmed that other than localised perched water in some excavations (probably associated with field irrigation activities) conditions are generally dry. More extensive perched water within the alluvial deposits may be expected in response to seasonal rainfall events.

In contrast, groundwater monitoring standpipes within the upper Alluvial Deposits generally indicate more or less dry conditions. Groundwater monitoring of the upper Alluvial Deposits have shown evidence of dry conditions, however, it should be noted that there is insufficient data to demonstrate conclusively that the groundwater behaviour in response to rainfall or flooding events because of the limited frequency and duration of the monitoring. There is a risk that storm rainfall events may cause significant perched water on the less pervious cohesive layers and this could contribute to significant water flows into temporary excavations. The recent readings of 7 September 2006 were taken following heavy rain the previous day. .

The present groundwater regime has been confirmed by monitoring instrumentation during and post investigation fieldworks. The monitoring is ongoing, and results indicate that the standing groundwater level occurs within the main Limestone aquifer and is typically between 24m to 29m below existing ground level, i.e. typically +7mA. The plots indicate little response in groundwater level. Groundwater levels from standpipes from the nearby RSA5 suggests that typical fluctuations of groundwater level in the limestone of the order 1m could be anticipated.

6.1.1.1. Surface Water

"The Rio Minho and Webbers Gully are the main constituents of the surface water hydrologic system in the Halse Hall area. The Webbers Gully has a sub-basin that covers an area of approximately 17.8km2.

The Rio Minho, located west of the proposed ROWS 1-5, flows in a north-south direction. Webbers Gully, a tributary of the Rio Minho, drains the area between New Bowens and the Jamalco Refinery site. The alluvium filled Webbers Gully joins the Rio Minho Valley through Palmers Cross at the Barrel Hole sink west of Chateau, May Pen. It joins the Rio Minho at Old Bowens.

The Rio Minho and Webbers Gully are seasonal in flow. The Rio Minho is seasonal between May Pen and Alley. The river loses its flow-an average of 20 million cubic metres per year (MCM/yr) just north of May Pen to the limestone aquifer. At Alley the river becomes perennial and is sustained by wet season surface water throughflow from the Upper Rio Minho sub-basin (111 MCM/yr) and perennial inflow of irrigation return water (22 MCM/yr), totalling 133 MCM/yr average discharge to the sea. There is no significant contribution to the Rio Minho throughout its passage across the Clarendon Plains sub-basin to the sea.

Ponding of water occurs along the course of both surface water systems. The ponding indicates the effectiveness of the basal clay layer in preventing vertical movement of water through the alluvium to the limestone aquifer. However along Webbers Gully in the vicinity of the clear lake there are outcroppings of limestone. Surface flow as well as any contaminant can enter the limestone aquifer through these surface exposures of limestone".

6.1.1.2. Ground Water

The two main hydrostratigraphic units within the project area are the limestone and the alluvium aquifers. The alluvium is unsaturated and overlies and may partly confine the limestone aquifer.

Ground water can pond within the karstic Clarendon Plains limestone aquifer by clayey alluvium on the downfaulted southern block of the South Coastal Fault. Along its southeastern boundary alluvium and underlying coastal aquicludes act as a barrier to direct outflow to the sea.

Further details of baseline ground water conditions in the vicinity of the ROWS 1-5 have been determined during recent ground investigation surveys.

There are no hydraulic structures on the Rio Minho River in the vicinity of the proposed site for the development of additional RSAs.

The seasonal character of the main rivers in the Basin combined with the high agricultural demand account for the heavy reliance on ground water. Wells tapping the limestone aquifer produce water for agricultural, domestic and industrial uses. At present over 80% of the water supplied in the basin is from ground water.

There are 26 production wells tapping the limestone aquifer, located east of the Rio Minho River within the Clarendon Plains sub-division and to the north (from Halse Hall Great House) and south (to Raymonds) of the Refinery. Ten accessible groundwater monitoring wells are located around the Refinery (two are currently inaccessible. Groundwater levels (elevation of water table above the sea level) and water quality (physico-chemical parameters) are routinely monitored at these locations.

6.2. Ground Conditions

6.2.1. Baseline Conditions

"The area under consideration is in the district of Halse Hall, in southern Clarendon. Geomorphologically, the area lies on the gently sloping alluvial fan of the Rio Minho. The apex of the fan, at May Pen, lies at an altitude of about 70 m above sea level (asl), although the present river bed is incised into the fan, being at about 50 m asl at May Pen. From May Pen the river flows over a straight line distance of about 20 km to the sea. In the vicinity of Hayes, at the confluence with Webbers Gully, the river bed lies at an altitude of 38 m asl, while the plant and RSAs at Hayes, east of the river, lie on an old, dissected terrace remnant at elevations of 45 to 50 m asl with flat to gently undulating topography. The terrace remnant forms a high spot between Webbers Gully, which borders the site on the north and northwest before entering the Rio Minho, and Cannons Gully which extends along the eastern side of the site, draining to the south at Bog and separating the site from the limestone plateau of Harris Savannah.

South of Hayes the alluvial fan flattens out to form what have been called the Vere Plains. Elevations over this area are low and the water table is relatively high, so that settlements such as Lionel Town and Alley are frequently flooded.

The rocks of the area consist of two main units. The various unconsolidated alluvial sediments, part of the Rio Minho fan complex, rest on limestone bedrock with a highly irregular surface".

6.3. Flora

6.3.1. Baseline Conditions

"The area proposed for construction of the ROWS pond is agricultural land supporting sugar cane farming. Some natural vegetation exists to the south of this area. The following description of the vegetation of the broader area surrounding the site is extracted from the EIA for RSA5.

The circular perimeter of 5 km radius around the Hayes factory is subdivided into a western agricultural and eastern woodland area, the latter forming a part of Harris Savanna. Residential areas mainly stretch along the main road that runs southwards from Curatoe Hill through Hayes and towards Lionel Town. To the east of the road, the bed of Rio Minho meanders southward.

Growing on top of flat though often rugged limestone, the woodland consists of a mosaic of secondary scrub dominated by exotic plants and degraded dry limestone forest of varying quality. Secondary scrubs are most common in the most northern section of the area and along drive roads. The least disturbed dry forest is found away from drive roads and footpaths. Shallow depressions filled with alluvial deposits intersect the limestone. These soil rich areas are mostly clear cut and covered with grassy plants. Prone to flooding, they contain a series of seasonal wetlands that support a unique flora.

The agricultural and residential areas are located on the Clarendon alluvial plain. They have lost their natural vegetation in the past and are dominated by exotic plants. The major crop species is sugar cane".

6.3.2. Habitat Types

"The ecology of this site and the areas along the railway leading to the Alumina Refinery reflects plant species exposed to dry and hot conditions which may be generally described as Thorny scrub. Many of the water conservation measures employed by species in the coastal areas, described below, were noted here. The dominant species was Wild poponax (Acacia tortusa) which had an even distribution. Specimens were found to be of an average height of 3 m (9ft). The plants were highly branched with deep canopies, accounting for an estimated 60% of the plants height. However, the plants did not form a continuous canopy. An herb or sub-canopy was not represented in the scrub area. However, Seymour grass (Andropogon pertusus) was quite common.

The Rio Minho River runs through a section of the study area. Vegetation flanking the river showed a marked difference to that found on the plains. The height, diversity and density of the plant species were much greater and the proximity to water resources is undoubtedly a contributing factor. Aquatic and hydrophilic plants represented the only variation from xerophytic vegetation and naturally their distribution was limited to the waterbodies and waterways traversing the Thorn Scrub. Tree species found in close proximity to the river included Guango, Ackee and Mango. Other noticeable plants found close to the water edge included reeds (Typha domingensis) and water grass (Commelina diffusa)".

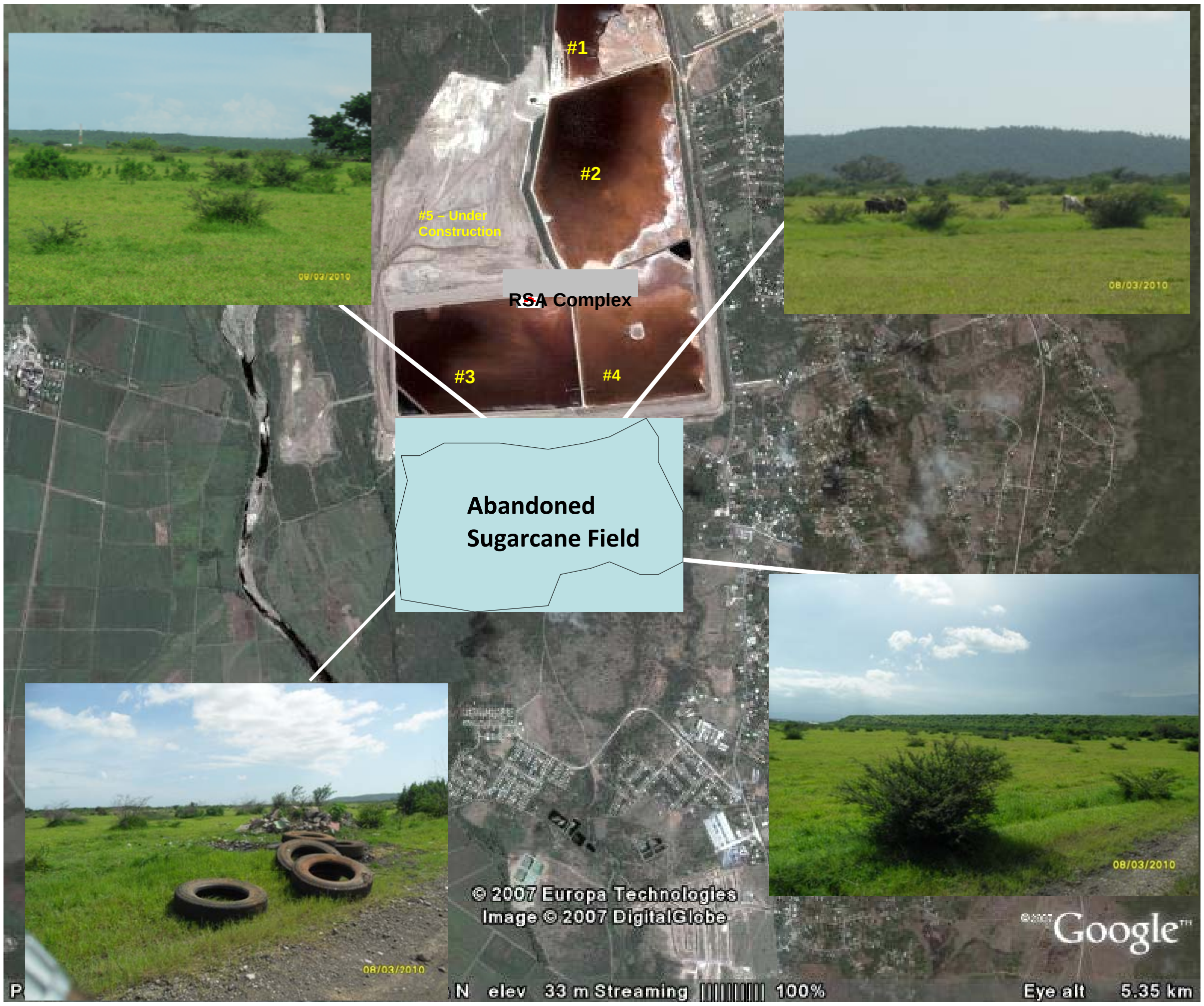

Plate 2: Overview of Sugarcane area field area

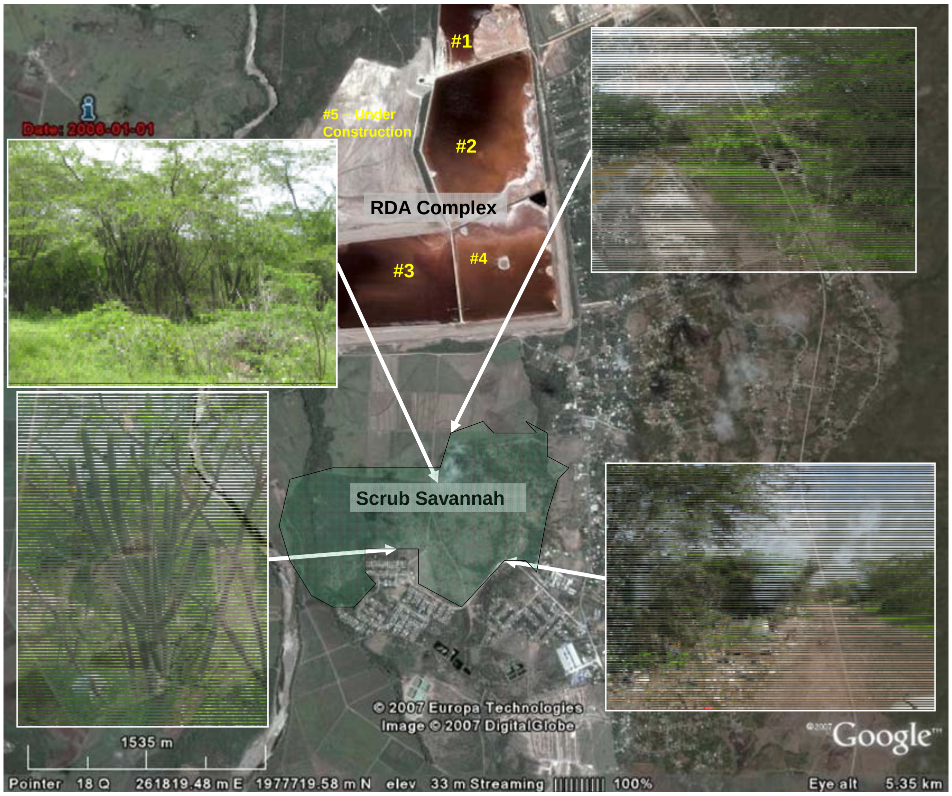

Plate 3: Overview of Scrub Savannah

Table 9: Floral Species observed at the site for ROWS 1 - 5

Family	*Scientific Name*	Common Name	Status
Acanthaceae	*Ruellia tuberosa*		Frequent
Agavaceae	*Agave sp.*		Often
Amaranthaceae	*Amaranthus spinosus*	Wild calaloo	Often
Amaranthaceae	*Achyranthes indica*	Devil's Horsewhip	Often
Amaranthaceae	*Gomphrena decumbens*		Rare
Apocynaceae	*Urechites lutea*	Nightshade	Often
Asclepiadaceae	*Caloptropis procera*	Dumb cotton	Often
Asteraceae	*Bidens pilosa*	Spanish needle	Often
Asteraceae	*Emilia sonchifolia*	Chinese shaving bush	Often
Bignoniaceae	*Crescentia cujete*	Calabash	Often

Family	***Scientific Name***	**Common Name**	**Status**
Bignoniaceae	*Tecoma stans*		Often
Bromeliaceae	*Tillandsia recurvata*	Old Man's Beard	Often
Cactaceae	*Stenocereus hystrix*		Frequent
Commelinaceae	*Commelina diffusa*	Water grass	Frequent
Convolvulaceae	*Ipomea indica*	Morning Glory	Frequent
Cyperaceae	*Cyperus odoratus*		Frequent
Cyperaceae	*Eleocharis sp*		Often
Cyperaceae	*Cladium jamaicense*		Often
Cyperaceae	*Cyperus odoratus*		Often
Euphorbiaceae	*Euphorbia hirta*		Often
Euphorbiaceae	*Jatropha gossypiifolia*	Belly-ache-bush	Frequent
Fabaceae	*Acacia tortuosa*	Wild Poponox	Dominant
Fabaceae	*Acacia farnesiana*		Frequent
Fabaceae	*Mimosa pudica*	Shame weed	Frequent
Fabaceae	*Leucaena leucocephala*	Lead tree	Dominant
Fabaceae	*Haematoxylum campechianum*	Logwood	Frequent
Fabaceae	*Samanea saman*	Guango	Frequent
Fabaceae	*Brya ebenus**	West Indian ebony	Frequent
Fabaceae	*Piscidia piscipula*	Dogwood	Rare
Fabaceae	*Macroptilium lathyroides*		Often
Lamiaceae	*Hyptis pectinata*		Often
Malvaceae	*Sida acuta*	Broomweed	Frequent
Malvaceae	*Urena lobata*		Rare

Family	*Scientific Name*	Common Name	Status
Malvaceae	*Abutilon sp.*	Chinese lantern	Rare
Nyctaginaceae	*Pisonia aculeata*	Cockspur	Often
Plumbaginaceae	*Plumbago scandens*		Often
Poaceae	*Andropogon pertusus*		Often
Poaceae	*Chloris barbata*		Often
Poaceae	*Panicum maximum*	Guinea grass	Frequent
Polygonaceae	*Antigonon leptopus*		Often
Sterculiaceae	*Guazuma ulmifolia*	Bastard cedar	Rare
Verbenaceae	*Stachytarpheta jamaicensis*	Vervine	Often

*Endemic

6.4. Fauna

6.4.1. Baseline Conditions

"A description of fauna species likely to inhabit the site was assessed as part of the EIA for DRSA5. An extract of the findings is provided below. It must be noted that fauna species likely to inhabit the area proposed for ROWS 1-5 would be limited given the current agricultural use of the site.

The vegetation types identified in the study area have the potential to support a number of bird species, providing habitats particularly for columbids, and passerines. The vegetation types have also been known to support a large number of migrant warblers in the winter season.

Generally, bird counts conducted over the study period did not confirm a large number of bird species and only one migrant was identified in the total of fifteen (15) species identified.

Insects were fairly well represented, with butterflies and bees being the most obvious of the group. Lepidoptera (butterflies etc.) were represented with at least 5 different species noted. More importantly is the ecological functions of these insects where they act as pollinators. Other insect's species included ants, beetles, stinkbugs, wasps and honeybees.

Reptiles and amphibians were not noted during surveys however literature reviews indicated the likely occurrence of certain species in the study area".

7. POTENTIAL IMPACTS AND MITIGATION

A description of the environmental resources of the area and the potential environmental impacts that may result from construction and operation of the ROWS 1-5 is provided from information gathered for the Environmental Impact Assessment (EIA) of RSA5 and from groundwater monitoring during the recent ground investigations and post-fieldworks. The information below has been extracted from various sections of the Environmental Impact Assessment for which was prepared for the Construction of the New Residue Storage Area (RSA5) by Jamalco, October 2005 and supplemented with information known about the conditions of the area proposed for construction of the ROWS 1-5. Where sections of text have been extracted directly from the EIA, these are shown in quotes and indented.

7.1. Potential Impacts [Physical & Biological]

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
Aesthetics/Visual							
Construction	Humans, Flora & Fauna	Negative	**Item A1** – The clearance and removal of any vegetation will result in a visually negative impact and loss of natural resources. All activities on the site will be carefully examined to ensure as little impact on the surrounding communities as possible	Proper upkeep and maintenance of the site will be done. Landscaping and building orientation will be utilized where necessary to enhance the visual aesthetics of the areas.	Short Term	Minor Negative	Moderate
Surface Water Hydrology and Groundwater							
Operation	Humans, Flora and Fauna	Negative	**Item WQ1** – The potential impacts to surface water quality will be negligible, as the operation of ROWS 1-5 will not contribute to the constituents of surface water runoff, except in the unlikely case of an overflow.	The Storm Lakes will be designed to ensure adequate containment of large flood events. In addition, contingencies will be in place to eliminate the potential for overflow to ground surface. Surface water drainage and management in areas outside of the storm lakes will be controlled by the relocated/repositioned drainage features	Long - term	Major Negative	Low
Operation	Humans, Flora and Fauna	Negative	**Item WQ2** - Although unlikely, a potential impact on the associated groundwater in the area is possible if a design flaw or liner failure results in a breach of the geo-membrane or clay seal and the release of contaminated storm water into the subsurface soils.	The effectiveness of the design of the compacted clay liner with HDPE geo-membrane liner, together with the quantities of water extracted from the proposed Storm Lakes, are integral as mitigation measures to possible system failure in the operational phase of the project. Maintaining the freeboard capacity in the Storm Lakes is necessary as excessive influent can lead to overflow. Monitoring the volumetric capacity of the Storm Lakes and appropriate management of levels through pumping will mitigate the potential for overflow.	Long - term	Major Negative	Low
Air Quality							
Pre-construction and construction	Humans, Flora and Fauna	Negative	**Item AQ1** – The possibility exists for fugitive dust formation during the clearing of the project site. Heavy vehicular traffic during site clearance and construction activities may also contribute to the emission of fugitive dust	Jamalco has a lot of experience, equipment and staff to provide ongoing wetting of the project area as necessary to limit dust formation and dispersion. A monitoring plan will be submitted to NEPA prior to commencement of construction that will include dust as a parameter to be monitored.	Short Term	Minor Negative	Medium
			Item AQ2 – Gaseous emissions from heavy equipment.	While gaseous emissions from heavy equipment may not be significant in light of the plant operations within the vicinity, heavy equipment will be maintained in proper working condition to produce minimal emissions.	Short Term	Minor Negative	Low

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
Operation	Humans, Flora and Fauna	Negative	**Item AQ3** – Potential for fugitive dust generation from the storm pond	The operation of the ROWS pond is unlikely to generate any significant level of dust. However, Jamalco is prepared to apply effective strategies such as hydro seeding of the embankment if the operation of the pond becomes a dust nuisance.	Long Term	Minor Negative	Low
Noise & Vibration							
Construction	Humans and Fauna	Negative	**Item N1** – Construction activities such as earthworks and movement of heavy vehicles to and from the site have the potential to generate noise.	Noise levels from heavy vehicles and equipment will be minimised by regular maintenance of equipment, installation of mufflers and regular monitoring. Noise levels will also be monitored at the property line on a regular basis and compared with measured baseline conditions. Monitoring results will be analysed to determine compliance with the following proposed standard. In the event of non-compliance, corrective action will be taken, such as removal of the equipment from the fleet	Short Term	Minor Negative	Medium
Wildlife & Vegetation Resources							
Pre-Construction and Construction	Flora	Negative	**Item WVR1** –Construction activities will require removal of the existing sugar cane plantation. Some removal of native vegetation may be required in the south-eastern corner of the site; however this is still to be confirmed. Operation of the ROWS pond will result in permanent loss of sugar cane farming land in this area. No other impacts on flora are likely during operation.	Mitigation for this type of impact can be realised in the replanting of vegetation on the sides of the embankments. Since the lands were under agricultural production, it is not anticipated that any endemics, protected or rare flora will be impacted. Construction activities include primarily excavation and earth movement. This should not result in any additional impacts to flora other than realised in the pre-construction phase. No negative impact on flora is anticipated during this phase. A positive impact will be realised with the vegetation of the lake embankments.	Long Term	Negative	High
Pre-Construction, Construction & Operation	Fauna	Negative	**Item WVR2 –** Any faunal species located in the area proposed for the storm lakes will be impacted during this phase of the project. The clearing of land will remove nesting and breeding areas if they exist. This is a direct, irreversible impact. Construction of ROWS 1-5 will involve removal of the existing sugar cane plantation. As the sugar cane plantation is unlikely to support faunal species, the potential impact on fauna is minimal. Operation of the ROWS pond will have minimal impact on fauna species.	The faunal specie identified in that area will most likely be very mobile, should not be rare and capable of resettling in the adjacent areas with limited difficulty. Operation of the ROWS pond will have minimal impact on fauna species.	Long Term	Minor Negative	Low
Land Use							

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
Construction and Operation		Negative	**Item LU1** – The land is currently used for sugar cane cultivation and as such, a change in land use will result from construction and operation of the ROWS pond. Approval for change of use from agricultural to industrial has been sought from the Rural Physical Planning Unit.	The trade-off for the benefits of implementing ROWS pond is positive. The bauxite sector plays a significant role in Jamaica's economy, and to ensure continued and efficient operation of the plant, it is required that proper storage facilities for residue disposal are put in place.	Long term	Minor Negative	High

8. ENVIRONMENTAL MONITORING AND MANAGEMENT

An independent Environmental, Health and Safety (EHS) Consultant will be engaged to periodically monitor the overall EHS performance of construction activities. This will include monitoring of environmental impacts and recommendation/implementation of appropriate management measures. The EHS Consultant will prepare monthly status reports which can be provided to NEPA upon request.

In addition, the project will be completed in accordance with all local legal and regulatory requirements, Jamalco policies and procedures, and Alcoa Engineering Standard 33.051 – Contractor and Contracted Services EHS Process.

9. RISK ASSESSMENT

9.1. Emergency Response Plan

Jamalco maintains an Emergency Response Plan for the Clarendon Alumina Refinery and Residue Storage Area. The Plan covers a number of situations including spills, leakages, dike and pipeline failures and releases due to catastrophic events. Given that Jamalco has identified the risks associated with shortages of storm water storage capacity and the on-coming hurricane season, the Emergency Response Plan will be further developed to include procedures for managing such an incident.

The following text has been extracted from pertinent sections of Jamalco's Emergency Response Plan.

1. The emergency response procedures included in the following sections are designed as guidelines to follow when a spill, fire, explosion, of other catastrophic event causes a release of oil or other hazardous material to the environment. The procedures presented in this document are intended for use by Jamalco personnel responding to emergency situations at the refinery (including the Residue Disposal Areas). In general, the following types of emergency scenarios are covered by the plan:
    - Storage unit leaks and/or rupture,
    - Dike failures,
    - Leaks/spills during loading/unloading operations,
    - Pipeline failures,
    - Releases due to catastrophic events (e.g., fires, explosion, earthquakes, floods, and hurricanes).
2. The emergency response procedures are intended to be the primary document that provides the procedures to be followed during a spill event.

3. These procedures will be reviewed annually and amended as needed to address changes or additions to facilities, processes, operations, hazardous substances, and personnel which would adversely impact their effectiveness.
4. Following the occurrence of a spill, release, fire, or explosion that requires implementation of this plan, the Primary Emergency Coordinator should immediately notify the proper regulatory agencies and follow-up with a written Spill Report which will be submitted within the time frame requirements of the applicable regulations.

9.2. Alert Procedures

If a minor leak, spill, release, or fire occurs, the individual discovering the incident should attempt to locate and eliminate the source. If possible, he/she should try to stop or at least contain the release. This can involve closing valves, turning drums upright, activating emergency pumps, using absorbent materials, or extinguishing the fire. These measures should only be undertaken if they can be accomplished without any risk to the individual. If the source is not immediately obvious or if these measures are not effective and the situation is beyond his/her control, then the discoverer should initiate the following emergency procedures using the telephone and radio listing included in this Plan.

9.2.1. First Plant Contact Responsibilities

1 Contact the shift supervisor with responsibility over the affected department or area, who has been designated as the First Plant Contact.

2 Pass along the following information:

a. Exact location of the emergency event;
b. Type and description of the emergency;
c. Estimate of the amount of material released, or the size of the fire;
d. Extent of injury or property damage incurred;
e. Extent of the actual and potential environmental damage; and
f. Remedial action taken, if any.

If significant spill conditions exist to the extent that assistance from outside the department is needed, the First Plant Contact should immediately contact the following individuals and communicate the information listed above.

- Security
- Area Superintendent
- Department Manager

It will be Security's responsibility to then contact one of the Emergency Response Coordinators.

9.3. Emergency Notification Procedures

The Emergency Response Coordinators will provide on-site coordination of safety, emergency response, and remedial measures taken. Responsibilities will also include initial and follow-up notification of spill conditions to government authorities, if required. This information could include the following:

- Time of the spill;
- Identity of material spilled
- Approximate quantity spilled;
- Location and source of spill;
- Cause and circumstances of spill;
- Potential hazards (e.g., fire, explosion, etc.)
- Personal injuries or casualties, if any;
- Corrective action being taken and an appropriate timetable to control, contain, and clean up spill;
- Name(s) and telephone number(s) of individual(s) who discovered and/or reported the spill; and
- Other unique or unusual circumstances.

9.4. Required ALCOA Notifications

The Environmental Affairs Department in the Pittsburgh Office must be notified after every release or emergency response event that requires notification of local government agencies. An Environmental Event/Procedure Report should be completed and mailed to Ms. I. J. Soukup in the Pittsburgh Office.

9.4.1. Emergency Response Procedures

Based on information obtained from the First Plant Contact, department personnel, and emergency response guidance materials, the Emergency Response Coordinator will develop an initial response plan. At a minimum, the response plan should accomplish the following:

Determine the classification of the material (e.g., flammable, poison, corrosive or otherwise);

Determine the level of protection required (e.g., type, level and availability of breathing and skin protection);

Discuss the hazards (e.g., specific to the material and danger from terrain, ruptures, leaks, falling objects, etc.);

Direct the staging of response equipment;

Determine if assistance from agencies outside the facility are needed; and

Initiate the immediate steps necessary to contain or divert releases away from surface water bodies and other sensitive receptors.

The Emergency Response Coordinator will direct response personnel to obtain the necessary absorbents, barrier materials, or pipe plugging devices that are required to contain the spill and prevent it from reaching surface water bodies or drains that cannot accept the material.

The following information provides general response guidance for spills in specific areas.

1. Spills in Dike Areas

Absorbent material or booms will be placed to contain the spill within the dike area, it possible. If the spilled material is pumpable, portable pumps and/or the suction truck from the Clarification Department will be used to remove as much of the spilled material as possible. The material will be transported to an appropriate disposal site or placed in proper containers for later shipment. All attempts will be made to prevent the released material from entering surface water systems or associated storm drains. Acidic materials may be neutralised with material from the limestone storage pile.

2. Spills in Un-diked Areas

Every attempt will be made to contain the spill as rapidly as possible to prevent runoff from reaching surface water bodies or a storm drain system. If necessary, earthen materials will be used to construct temporary dikes or berms around the spilled material for placement in proper containers. Construction equipment may be used to build diversionary structures to divert or block releases from contaminating soils and/or surface waters. Acidic materials may be neutralised with material from the limestone storage pile.

3. Spills to On-Site Lakes/Lagoons

Every attempt will be made to limit the amount of spilled materials that could enter lakes/lagoons at Jamalco. In the event that a large spill enters these areas, floating booms will be used to restrict the release to a limited area, if possible. Absorbent material and/or skimming equipment may be used to remove floating materials (e.g. oils and other petroleum products). If the spilled material is one that will mix with water, attempts will be made to isolate the lake/lagoon to keep contaminated material from entering other containment systems. If the released material is compatible with materials already present in lakes/lagoons at the site, those systems may be used for spill containment at the discretion of the Emergency Response Coordinator.

4. Spills on Soil

An attempt will be made to minimise the surficial area of the spill. Earthen dikes or berms will be used to provide containment for the spill. If possible or as practicable, absorbent materials will be placed on the spill area in an attempt to absorb freestanding material from the soil surface. Contaminated soil will be excavated and disposed or containerised for later disposal. Acidic materials may be neutralised in place with limestone.

5. Spills to Receiving Streams

An attempt will be made to contain spilled material at the source of the release, if possible. If the spilled material is moving across land, diversionary dikes, ditches, or berms will be placed using construction equipment to contain or divert the material prior to its reaching surface water bodies or other sensitive receptors.

If the spilled material reaches surface water, absorbent materials or booms will be used to control the material on the water (e.g., petroleum products). If the released material can be controlled, an attempt will be made to remove the material using portable pumps, skimmers, or the suction truck from the Clarification Department. If the spilled material cannot be controlled, other response measures may be taken at the direction of the Emergency response Coordinator including in situ treatment (e.g., neutralisation of acidic materials) and diversion to less sensitive containment areas.

9.5. Preventative Measures Loading/Unloading Operations

The following information provides a description of the spill preventative measures employed at loading/unloading operations.

9.5.1. Red Mud Lake System

The Red Mud Lake System incorporates:

- Plant runoff from ROWS 1-5 to RSA 2
- Caustic/Mud from the plant to RSA 1, RSA 3, RSA 4 and RSA 5
- Cooling water from the Clear lake to the process

To facilitate sound management and operational integrity,

i. Pumping operations are conducted by trained personnel
ii. Liquid levels in the receiving impoundments are monitored
iii. Equipment inspections are performed including pre-pump checks to ensure proper operation, moisture levels in pumps, pump packings, weekly pressure checks and motor control center cleanings

9.5.2. Air Emissions

The potential sources that would be the likeliest contributors to air emissions are:

- Excavation and stockpiling of soil material during pre-construction and construction activities
- Excavation and stockpiling of sand for use during the construction phase of the project
- Haul road traffic
- Engine emissions from heavy equipment

Practical measures will be utilised during periods of excavation and earth movement to reduce the levels of air emission. Equipment emissions will be controlled through comprehensive maintenance and overhaul programs to ensure that equipment is in sound operational condition.

Dust control on haul roads will be accomplished through applications of calcium chloride to the road surface. Maintenance applications will be made as necessary to maintain the integrity of the roadway. Calcium chloride attracts moisture from the air and binds with the limestone chips used to construct the roads effectively forming a low grade pavement.

9.6. Contingency Plan

9.6.1. Preparedness and Prevention

The following information describes the actions and equipment that are available and maintained for immediate use in the event of an emergency release situation.

9.6.1.1. Plant Communication Systems

An extensive communications network is maintained at Jamalco for accessing necessary emergency personnel during an emergency situation. Relevant components of the overall communication system are briefly described below.

a. Telephone system - an external telephone system connects each operation of Jamalco including the refinery, Williamsfield Land Office, Mount Oliphant Mines and Rocky Point Port. An internal system extends throughout the refinery and is connected to the Williamsfield Land Office and Mount Oliphant mines.

b. Radio System - a radio communication system is in place and is an effective method for communicating emergency messages throughout the refinery/chemical plant and especially areas out of reach of the telephone system. Radio communication equipment includes hand-held units and mobile radio units installed in facility vehicles. During emergencies, limited communications can be maintained on F-1 frequency.

c. HAM radio system - A HAM radio system is in place to provide long-range communication support in the event normal communication systems are inoperable due to an extreme emergency (e.g. hurricane, earthquake, etc.). The HAM radio system is maintained at the Powerhouse Control Room, Building 110.

d. Alarm system - A plant emergency siren is maintained for immediate warning to facility personnel in the event of an emergency. In an emergency situation, security personnel will sound the siren with 2 blasts of 10 seconds each.

9.6.1.2. Outside Agency Support

a. May Pen Fire Brigade: The plant Fire Brigade Leader will notify the May Pen Fire Brigade in the event of an emergency and will provide an estimate of additional services needed.

b. May Pen Hospital/Lionel Town Hospital/University of the West Indies Hospital: Jamalco maintains its own medical staff (doctors and nurses) as well as ambulances located at the refinery, Mt Oliphant Mines, and Rocky Point Port.

c. The facility will normally transport its own injured personnel to the hospital. However, if conditions warrant, medical staff/security will notify the appropriate hospital in the event of an emergency and will provide an estimate of additional services needed.

9.7. Evacuation Plan

If it has been determined by an Emergency Response Coordinator that an emergency evacuation is required, employees will be notified via the facility communication system (e.g., emergency siren, telephone system, radio system or directly).

Evacuation from facilities operated by Jamalco, including the refinery, Williamsfield Land Office, Mount Oliphant Mines and Rocky Point Port will be conducted according to the following procedure:

a. At the sound of the evacuation announcement, work will be stopped in an orderly manner and preparations made to evacuate the area immediately.

b. Upon receiving notification of an impending evacuation, each department supervisor will report to their respective department/area and direct their employees to the nearest sate exit route (if this is feasible). After observing that all employees have evacuated the area, the supervisor will exit the area in question. All facility personnel will relocate to the company parking lot. Upon arrival at the parking lot, the emergency coordinator of his designee (e.g. each department supervisor) will take roll call.

c. If it is necessary to relocate at a greater distance from the facility, the decision for the required relocation will be made by the emergency coordinator or his designee.

d. Plant Security and Fire Brigade personnel, when designated by the emergency coordinator to be traffic controllers, will position themselves in proper areas to direct traffic exiting the facility. Traffic controllers may also have the responsibility of escorting emergency vehicles to the incident location.

e. Personnel designated by the emergency coordinator, as necessary, will be expected to search and assure that the area is clear of employees and that all equipment is turned off that is not absolutely necessary.

f. Maintenance personnel will see that utilities are turned off and/or controlled to minimise the potential for secondary fires, explosions, electrical shocks, etc.

Once the evacuation is complete, it will be at the discretion of the emergency coordinator as to whether additional tasks are considered safe and/or necessary. Additional tasks could include minor fire fighting assistance, removal or materials or equipment to safe locations, and proper operation/shutdown of plant processes.

9.8. Emergency Response Participation in the Community

If called upon, Jamalco will donate and use whatever communications and emergency response equipment it has at its disposal to assist during a community wide emergency.

9.8.1. Effects of External Factors on Emergency Response Procedures

Certain catastrophic events (e.g., hurricanes, earthquakes, power failures, fires, flood, worker strikes, etc.,) could occur that would limit the ability of Jamalco to implement the emergency response procedures contained in this plan. In this event, Jamalco's Emergency Response Coordinators will quickly assess the situation and make the modifications necessary to ensure the success of response efforts.

The following information is provided to identify the adverse effects associated with catastrophic events that have the potential for occurring at Jamalco:

- Disruption of telephone communication;
- Loss of lighting;
- Loss of computer support affecting process equipment and information services;
- Immediate shutdown of spill control sumps, process equipment, and air control devices;
- Disruption of evacuation procedures;
- Limitations on emergency response and/or vehicle access
- Loss of electrical power
- Loss and/or contamination of water supply (both potable and for fire response)
- Complications resulting from dike failure
- Releases resulting from dike failures

9.9. Landslide Risk Assessment

While no detailed assessment of the landslide risk has been carried out in southern Clarendon to date, the landslide inventory map of Jamaica shows no record of landslide events for the southern Rio Minho flood plain. The landslide hazard zonation map of Jamaica shows this area to be at low risk of landslides (Area No. 1 on the map). The low landslide risk can be attributed to the flat lying nature of the topography, the presence of fairly easily drained alluvial soils, and the relative dry climate.

9.9.1. Local and Regional Tectonic Activity

An investigation of the historical records of seismic activity in this area has shown that the adverse effects of earthquakes have been experienced. The well-documented 1692 Port Royal earthquake had disastrous effects in the Lower Vere Plains, with modified Mercalli intensities of MM(X) being experienced in Alley and Salt River, both of which lie at about a 10 km radius from the study area.

The following quote from a newspaper clipping written by the local Rector illustrates: “all brick and stone building were thrown down and water spewed out of the chasms opened in the ground by the earthquake so that even dry gullies ran water”. The St. Peters Anglican Church in Alley built in 1671 was destroyed beyond repair. However, the HaIse Hall Great House, where alluvial thicknesses are comparatively low, survived the 1692 earthquake, as well as subsequent ones. The Great House is situated approximately about 6 km to the north of the JAMALCO alumina plant.

Subsequent damaging earthquakes are, most notably, those of 1907 and 1957. The 1907 earthquake appears to have caused some damage in the Vere Plains. Intensities of MM (Vll) were reported in Alley with incidence of damage to chimneys and buildings (Tomblin & Robson, 1977). The 1957 earthquake had intensities of MM (IV) to MM (V) in the Lower Vere Plains (Robinson et al., 1962).

In each 50-year period, starting with 1991 and counting backward for four 50-year cycles, at least one damaging earthquake, i.e. MM (VI) of higher, has occurred in the area. Shepherd (1971) reported that Lower Vere had a frequency of 5-9 damaging earthquakes per century on average.

A map of epicenters in the study area represents data gathered between 1981 and 1995 by the national seismograph network. It shows a scatter of small earthquakes around the site. It must be pointed out here that the error in these locations could be up to +1- 5km. The earthquakes shown have magnitudes of between 1.9 and 3.6.

Halse Hall falls within the area designated ‘PC’ - soils on old alluvium. While there is a high potential for liquefaction along the coastal sections of the Rio Minho alluvial plain, the area inland does not fall into that category. This is due to the fact that the coastal sediments would have a greater percentage of water contained within them, and also the coastal sediments would be more recently deposited and therefore less compacted than those inland.

APPENDIX

Appendix 1: Photo-Inventory

Plates depicting the Scrub Savannah

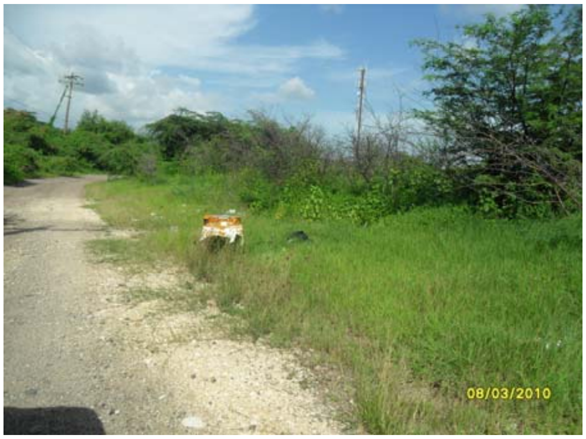

Plate 4: Roadway through Scrub Savannah

Plate 6: A large pile of animal bones found in Scrub Savannah

Plate 5: Typical Acacia Stand

Plate 7: Typical Cacti found in Savannah

Plate 8: A large pile of used metal containers

Plate 10: Acacia stand

Plate 9: Flooded roadway through the Scrub Savannah

Plates depicting the Abandoned Sugarcane lands

Plate 11: South Dyke Wall in distance [Looking north from field]

Plate 12: Sugacane lands (previously abandoned sugarcane field)

Plate 15: Appears to be a decommissioned pipe outlet (N17º 52.630' W77º 15.426')

Plate 13: Roadway through sugarcane lands looking south

Plate 14: Livestock rearing observed

Plate 16: Drain canal south of the RSA complex (N17º 52.669' W77º 14.707')

Plates depicting the Neighbouring Community

Plate 17: Roadway to south of Scrub Savannah - Hayes New Town Phase II

Plate 20: Public Road south of RSAs [To be realigned with construction of Storm Lakes]

Plate 18: Community to the south -east of property obtained by Jamalco

Plate 21: Drainage Canal running north to south of the RSA complex

Plate 19: Dis-used School Building south of RSA complex

Plate 22: Public roadway south of RSA

Plates depicting the Solid Waste Disposal within the Scrub Savannah

Plate 23: Poor disposal of solid waste by residents of neighbouring communities

Plate 24: Illegal Dumping along the entire stretch of roadway from the boundary with the Ratoon Sugarcane Fields to the Hayes New Town Phase II roadway

Plate 25: Used Tyres scattered along roadside through Scrub Savannah

Plate 26: Various discarded material

Plate 27: Ponding in Scrub Savannah

Plate 28: Solid waste at side of road in Scrub Savannah

Appendix 2: Change of Land Use Authorisation

RURAL PHYSICAL PLANNING DIVISION
MINISTRY OF AGRICULTURE AND LANDS
HOPE GARDENS,
KINGSTON 6
JAMAICA

Please Quote
Reference No.

September 18, 2006

Mr. George Morgan
JAMALCO
Clarendon Alumina Works
Halse Hall, Clarendon
P.O. Box 64
May Pen

Dear Sir,

Re: - Change of Land Use from Agricultural to Industrial Usage for Lands located at Folio 956 Volume 1238 and Folio 49 Volume 967.

An inspection of the above mentioned property was carried out on September 12, 2006 by the Rural Physical Planning Division to determine the suitability of the area for agricultural development.

The soil types found in the area are Agualta Loam (#103), Agualta Clay (#104), Halse Hall Clay (#113), Halse Hall, Red Phase (#114) and Rhymesbury Clay (#202). The slope ranges from almost flat to undulating (5-11%).

The area is suitable for cultivation with strong limitations. Poor drainage is the main limiting factor. Based on information obtained on the property and its surroundings, the area can be used for industrial purpose with conditions. It is of paramount interest to protect the environment; hence:

1. A buffer must be maintained with the Rio Minho on the West.
2. The residential and commercial developments to the east should also be protected.

Yours Truly,

Wesley G. Watt
for **Director**
Rural Physical Planning Division

Appendix 3: Engineering Drawings

See Following Sheets