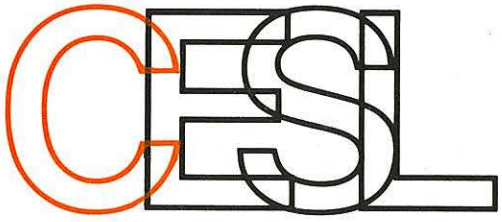
AS-BUILT REPORT
for the
GRUM/VANGORDA
WATER TREATMENT PLANT

Curragh Resources Inc.



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AS-BUILT REPORT
for the
GRUM/VANGORDA
WATER TREATMENT PLANT

Curragh Resources Inc.

Prepared For

CURRAGH RESOURCES INC.
Whitehorse, YT

Prepared By

COMINCO ENGINEERING SERVICES LTD.
Vancouver, BC

Distribution:

Curragh: GB Acott (4)
CESL: TD Lee, WJ Kuit

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Date: 22 November 1991

TDL/mlw

TRANSMITTAL
LETTER

Cominco Engineering Services Ltd.

100 - 1200 West 73rd Ave., Vancouver, B.C., Canada V6P 6G5 / Tel. (604) 264-5500 / Telex 04-55357 / Fax (604) 264-5555

22 November 1991

Mr. G.B. Acott, P.Biol.
Manager, Environmental Affairs
CURRAGH RESOURCES INC.
117 Industrial Road
Whitehorse, Yukon
Y1A 2T8

Dear Mr. Acott:

Re: **AS-BUILT REPORT for the**
GRUM/VANGORDA WATER TREATMENT PLANT

We are pleased to submit four copies of the attached as-built report describing the ARD water treatment facilities which were designed and constructed for Curragh Resources Inc. by Cominco Engineering Services Ltd. (CESL) of Vancouver, B.C. The plant was commissioned in March 1991.

Under separate cover, we are forwarding two full-size rolled sets of mylar drawings, as identified behind Tab 5. We understand that one set will be provided by Curragh to the Water Board. In addition, also under separate cover, we are forwarding one complete, unpunched, unbound copy of this report which Curragh may use to make additional copies.

The report provides an operating overview of each process step from the intake well at Little Creek Pond to the discharge of clear, treated water from the effluent manhole near the Water Treatment Plant. This is followed by a brief technical description of each part of the physical installation. The text is supplemented by the inclusion of nine colour photographs and fifteen photo-reduced as-built construction drawings.

Please do not hesitate to contact us if you desire additional information.

Yours truly,

T.D. Lee, P.Eng.
Chief Projects Engineer

TDL/mlw

Enclosures (4)

Acott.Nov.22

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1. INTRODUCTION

1.1 General

Curragh Resources Inc. operates a large open pit zinc-lead mine near Faro in the Yukon Territory. As part of its on-going operations, Curragh is developing two new open pit orebodies on the Vangorda plateau, about 13 kilometres southeast of the original Faro mine. In general terms, the Company plans to operate the Vangorda mine in the early 1990's while developing the larger Grum pit, which is expected to sustain the operations at Faro until early in the 21st century.

The development of the Grum and Vangorda pits necessitates the creation of waste dumps to store the sulphitic waste rock, the phyllitic waste rock, and the overburden (till). Curragh plans to deposit the sulphitic waste rock in discrete cells to ensure that the consequent acid rock drainages can be captured, combined with pumped drainage waters from the two pits, and treated prior to discharge to the environment.

This report addresses the collection and treatment of these acid rock drainage waters.

1.2 Purpose of Report

It is the purpose of this report to provide a technical description of the as-built "Grum/Vangorda Water Treatment Plant", from the intake well at Little Creek Pond to the discharge point from the sludge pond, as required by the conditions of Curragh's water licence. It is not intended to duplicate the full depth of detail which is included in the Operating Manual and other technical documents which have been provided to Curragh by CESL.

The report includes a description of each process step to provide an operating overview of the facility. This is followed by a brief description of the physical installation to provide an appreciation for the nature of the facility. A number of key drawings and photographs have been included in the report to provide visual documentation of the plant and facilities.

1.3 Project Overview

The "Grum/Vangorda Water Treatment Plant" includes four separate project components which receive and manage the acid rock drainages from the Vangorda pit; pump it to the Water Treatment Plant; treat these drainages with two reagents; and clarify the

drainages prior to discharge to the environment. Provision has been made for receipt and treatment of drainage waters from the Grum pit at a future date.

1.3.1 Project History

CESL submitted a proposal for a feasibility study for the Grum/Vangorda Water Treatment Project on March 7, 1989, in response to Curragh's request five days earlier. The proposal was accepted by Curragh on March 27, 1989. The Feasibility Study was issued on May 16, 1989; it was based on a Curragh-specified flow rate of 3,000 USGPM, half from each of the Grum and Vangorda pits, and included a 90-foot clarifier in the scope of the project. This study was superseded by the Control Estimate on July 7, 1989: it was based on a flow rate of 2,000 USGPM, and introduced other cost-reduction measures. This portion of the project attained Mechanical Completion under budget and ahead of schedule, on June 22, 1990.

On May 25, 1990, Curragh requested that CESL provide EPCM (Engineering, Procurement and Construction Management) services to expedite completion of the Vangorda pipeline, and associated facilities. A number of alternative collection, storage and pumping scenarios were evaluated over the next two months, culminating in a clear decision on August 7, 1990, to proceed with the system described in this report. This portion of the project attained substantial completion on November 7, 1990. The completed facilities lay dormant over winter.

Commissioning and startup commenced on March 4, 1991, and the facilities were formally accepted by Curragh from CESL on March 27, 1991.

1.3.2 Project Description (Summary)

As noted above, there are four separate components to this project:

- Little Creek Pond is located adjacent to the Vangorda pit. It collects the pumped drainages from the pit, and the gravity drainages from the Vangorda Waste dump.

- The Vangorda Pipeline is a 10-inch/12-inch pipeline, 2.3 kilometres long, which delivers the acid rock drainages from Little Creek Pond to the Water Treatment Plant.

- The Water Treatment Plant is a simple, automated, single-pass lime treatment facility followed by flocculant addition.

- The Sludge Clarification/Storage Pond settles and stores the metal-bearing solids, and discharges the clean waters to a natural drainage system which flows into Vangorda Creek, then Pelly River, then the Yukon River, and ultimately through Alaska into the Bering Sea.

1.4 Description of Responsibilities

1.4.1 Process Criteria

It was not possible to accurately predict the flow rates and water quality prior to development of the two pits. In the absence of extensive hard data, Curragh resolved that the Water Treatment Plant should be sized at 2,000 USGPM, with 900 USGPM from the Vangorda pit and 1,100 USGPM from the Grum pit. The water drainage quality was specified for project purposes as "identical to the Faro pit drainage."

1.4.2 Engineering and Procurement

Engineering and Project Management Services for the Vangorda pumphouse and pipeline and for the Water Treatment Plant were provided by CESL's Vancouver offices. Procurement services for most of the equipment and materials were provided by CESL as Agent for Curragh.

Engineering services for the Little Creek Dam were provided directly to Curragh by Steffen Robertson & Kirsten (B.C.) Inc., of Vancouver, B.C.; SRK has since provided Curragh with an "As-Built Construction Report for Little Creek Dam" which summarized the engineering and construction activities related to this dam. (SRK Report 160636/1)

1.4.3 Construction

CESL provided Construction Management Services, engaging a number of sub-contractors to execute the work. The contract packages and general descriptions are listed below:

- Contract #P66.2.79-01 "BUILDING FOUNDATIONS"
  Contractor: Remote Mine Development Limited; Whitehorse
  Scope of Services: Installed concrete foundations for the Water Treatment Plant building, and inside equipment.

- Contract #P66.2.79-02 "BUILDING"
  Contractor: Permasteel Construction Ltd.; Edmonton, AB
  Scope of Services: Supplied and erected the Water Treatment Plant building.

- Contract #P66.2.79-03 "SLUDGE POND"
  Contractor: Remote Mine Development Limited; Whitehorse
  Scope of Services: Constructed the Sludge Pond, including the related piping and the discharge manhole.

- Contract #P66.2.79-04 "MECHANICAL/ELECTRICAL"
  Contractor: Miron Construction Services Ltd.; Esterhazy, SK
  Scope of Services: Installed all of the mechanical and electrical items in the Water Treatment Plant, except the tanks (supplied and erected by G.L.M. Tanks & Equipment Ltd.), and the Lime System (see Contract #P66.2.79-06).

- Contract #P66.2.79-05 "LIME SYSTEM FOUNDATIONS"
  Contractor: Remote Mine Development Limited; Whitehorse
  Scope of Services: Installed the concrete lime bin foundations and the associated retaining wall.

- Contract #P66.2.79-06 "LIME SYSTEM"
  Contractor: Stanco Projects Ltd.; Vancouver, BC
  Scope of Services: Supply and install the lime hopper, lime storage bin, and slaking system.

- Contract #P66.3.79-02 "VANGORDA PIPELINE"
  Contractor: Pelly Construction Ltd.; Whitehorse, YT
  Sub-Contractors: Kathy's Construction Ltd.; Whitehorse
  Remote Mine Development Limited; Whitehorse, YT (Pumphouse)

Scope of Services: Pelly's forces constructed the Little Creek Dam (See SRK Report #160636/1); Kathy's forces installed the Vangorda Pipeline; RMDL installed the Vangorda Pumphouse

1.4.4 Technical Services

Two Whitehorse organizations provided on-going technical support during the construction process. EBA Engineering Consultants Ltd. provided geotechnical services for the entire project, from pre-design testing programs to construction soil-testing programs. Lamerton Associates provided surveying services for the project.

Although not directly involved in the portions of the project described in this report, Steffen Robertson and Kirsten (B.C.) Inc. of Vancouver, BC, was indirectly associated with CESL during the planning and construction phases of the project, due to related, concurrent contracts with Curragh Resources Inc.

2. SCOPE DESCRIPTION

2.1 Little Creek Pond

2.1.1 **Process Description** (Little Creek Pond)

The role of Little Creek Pond is simple but vital: it receives all of the pumped drainages from Vangorda pit (rainwater, run-off and seepages) and receives the gravity drainages from the Vangorda waste dump. The purpose of the pond is to "manage" the inflows by averaging the quantity and quality of these inflows prior to delivering the water to the Water Treatment Plant for treatment and discharge to the environment.

The effective live storage capacity of Little Creek Pond is 100,000 m^3; this capacity was determined by Steffen Robertson and Kirsten (B.C.) Inc. (SRK) as the appropriate volume to manage the governing conditions of snowmelt and rainfall which will accumulate during a plant shutdown period from November to March. The normal operating band has a volume of about 25,000 m^3 over a two-metre elevation differential.

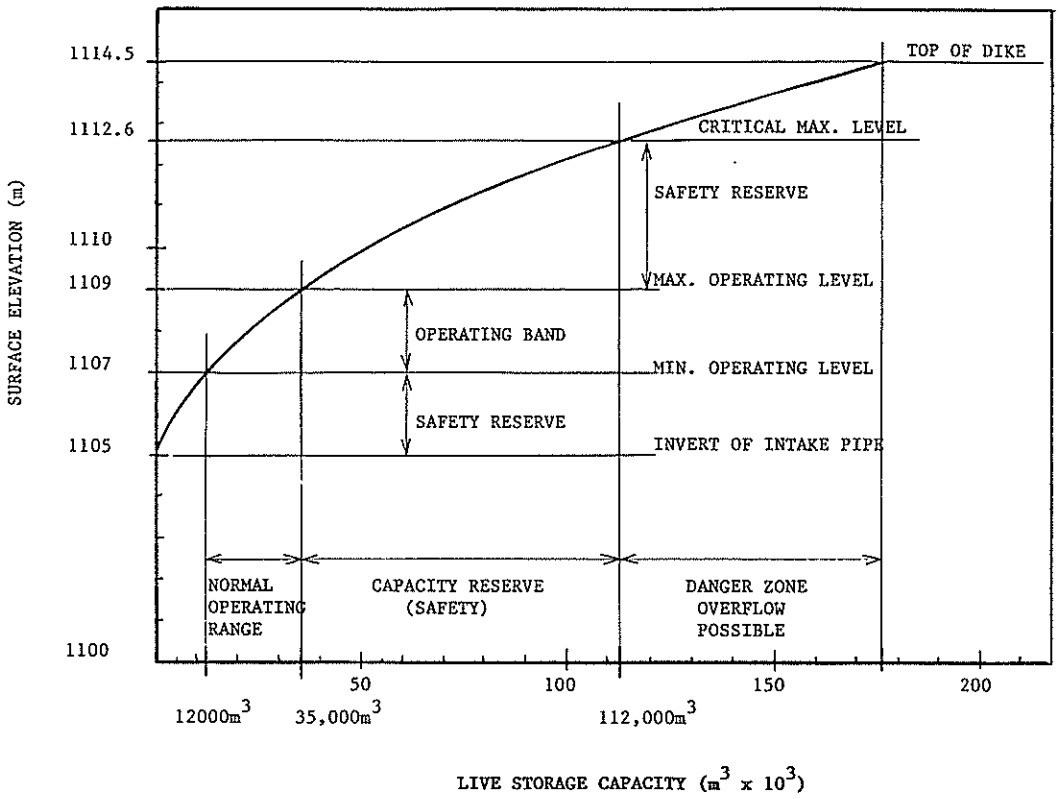
The design normal maximum operating level of the pond is 1109 metres, which ensures that sufficient pond capacity is kept as a safety reserve for periods of excessively high inflows, and/or possible periods of pump failure.

The design normal minimum operating level for the pond is 1107 metres. During normal pond operation, the pond level is designed to remain above this elevation, to ensure that there is sufficient live volume left in the pond for mixing and settling of inflow waters and for protection of the system intake pipe, which has an invert elevation of 1104.55 metres.

During winter, a layer of ice will form over the pond, and was designed to have a thickness up to 2 metres. The water level was designed to be maintained high enough to prevent ice damage to the dewatering system intake pipe. The minimum operating level in winter was designed to be adjusted to ensure a clearance for water flow between the ice and the intake pipe at all times by maintaining the pond elevation above 1108 metres in winter months.

The presence of an ice layer reduces the pond's live storage capacity. When the spring freshet arrives, the total pond capacity may not be available to handle the

influx of extra water until all of the ice is melted. For this reason, special attention should be paid to planning the level management for the winter-to-spring transition period. The relationships between pond elevation and storage volumes are displayed graphically in the Storage Capacity Curve below (after SRK):



While the Vangorda pit is in operation, the inflows to the pond are likely to be difficult to predict, and there may be a degree of difficulty in the management of the pond level. It is expected that these flows will be easier to predict and to manage after the Vangorda pit has been mined out.

2.1.2 **Description of Facilities** (Little Creek Pond)

The design and construction of the Little Creek Dam are described in detail in SRK's Report #160636/1, "Vangorda Plateau Development -- As-Built Construction Report for Little Creek Dam". SRK designed the dam, and was responsible for all technical issues related to construction of the structure. EBA was responsible for soil testing, under SRK's direction. CESL was responsible for administration of the construction program. The dam was constructed by Pelly Construction Ltd. of Whitehorse.

The earth-fill dam was constructed from glacial till obtained from the stripping program associated with development of the nearby Vangorda pit. The dam crest length is about 307 metres long; the maximum height above original ground is about 14 metres; the maximum depth of the cutoff trench below original ground was about 6 metres. The upstream surface is sloped at 2.5:1; the downstream face is slightly steeper at 2:1. The nominal elevation of the top of the dam is 1114.5 metres.

2.2 Vangorda Pumphouse

2.2.1 **Process Description** (Vangorda Pumphouse)

The role of the Vangorda Pumphouse is to draw water from Little Creek Pond, and pump it into the Vangorda Pipeline for delivery to the Water Treatment Plant.

The maintenance of the flow out of Little Creek Pond is crucial to both pond level management and the operating efficiency of the Water Treatment Plant. Due to seasonal changes in precipitation and ground water flows, the pumping rates were designed to be varied in line with a pumping strategy to be developed by Curragh, to account for periods of low and high pond inflows.

Apart for the exceptional pond depths that will be experienced each spring, the pond level was designed to be "managed" to provide a relatively continuous flow to the Water Treatment Plant, and to maintain the pond within the recommended normal operating band of 1107 to 1109 metres.

2.2.2 **Description of Facilities** (Vangorda Pumphouse)

The Vangorda Pumphouse is a small (6m x 4m x 3m high) painted galvanized steel-clad wood frame building sitting on top of the Little Creek Dam. The floor of the building is a thickened concrete slab encircling the top of a 2.4 m diameter wet well.

The wet well is a section of heavy, corrugated, galvanized steel culvert, on end. It is 2.4 m in diameter, and approximately 12 metres high. The bottom of the wet well is supported on a concrete foundation which was cast on undisturbed gravel upstream from the cutoff trench under the core of the dam. The bottom of this wet well is lower than the bottom of the dam.

The bottom of the wet well is connected to Little Creek Pond by a 400 mm diameter HDPE (High Density Polyethylene) line which emerges from the upstream side of the dam at an invert elevation of 1104.55 m. This intake is located in a special channel in the bottom of the pond to provide an additional degree of protection from ice, and to enhance the settlement of solids ahead of the intake. The intake line enters the wet well at an elevation of 1103.98 m, leaving an additional settling depth of about 1.5 m above the well bottom which is at an elevation of 1102.5 m.

There is a fabricated steel platform spanning the top of the wet well; it is supported by the concrete foundation for the pumphouse. The steel platform serves as a pump base and supports three Peerless vertical turbine pumps which are suspended to the bottom of the wet well. One pump is a 14-stage unit with a 125 HP motor; it is rated at 500 USGPM at 700-foot head. The other two pumps are 21-stage units with 50 HP motors; they are rated at 220 USGPM at 700-foot head.

The pumps discharge into a common header connected to the Vangorda Pipeline, which delivers the Vangorda drainages into the Water Treatment Plant more than two kilometres away. The three pumps can be operated individually or in combination to produce flow rates from about 200 USGPM to about 900 USGPM, as shown in the following table:

Pumps Running	#1 only	#2 only	#1 & #2	#3 only	#1 & #3	#1,#2,&#3
Rated Capacity (USgpm)	220	220	440	500	720	940
Pond Volume Discharged (m^3):						
* in 24 hours	1200	1200	2400	2700	3900	5100
* in 48 hours	2400	2400	4800	5400	7800	10200
* in 72 hours	3600	3600	7200	8200	11800	15400
* in 120 hours	6000	6000	12000	13600	19600	25600

Electric power is delivered to the pumphouse by an overhead branch feeder from the Vangorda power line, which is fed from the Grum substation. The pumps are manually started in the pumphouse. A level indicator/recorder provides an indication of the level of the water in the wet well and the pond at all times; this same instrument has a low-level connection to automatically shut down the

pumps if the water level drops below 1107 m, the bottom of the normal operating band.

2.3 Vangorda Pipeline

2.3.1 **Process Description** (Vangorda Pipeline)

The purpose of the Vangorda Pipeline is to accept drainage water from the three deep well pumps in the Vangorda Pumphouse, and deliver it into the primary reactor in the Water Treatment Plant.

2.3.2 **Description of Facilities** (Vangorda Pipeline)

The Vangorda Pipeline is a nominal 10-inch HDPE (High Density Polyethylene) buried pipeline, 2311 metres in length, which rises about 202 metres from the Vangorda Pumphouse to discharge into the primary reactor. Part of the pipeline is nominal 12-inch HDPE. The entire length is continuously sloped to allow the line to drain by gravity, back into the wet well of the Vangorda Pumphouse.

The pipe was purchased by Curragh, and installed through CESL and Pelly Construction Ltd. by Kathy's Construction Ltd. of Whitehorse, YT.

The pipe was supplied in 20-metre lengths and was butt-fused in the field before being placed in a prepared trench. Butt-fused flanges were installed at strategic locations in the area of the Vangorda Creek haul road crossing to allow modifications to be made in future, if necessary.

The required pipe wall thickness was least near the Water Treatment Plant and stepped up progressively as the pressure increased, going downhill toward the pumphouse. About half way down the pipeline, the pipe size was increased from nominal 10-inch to nominal 12-inch diameter to allow the inside diameter of the pipe to remain relatively constant throughout its length, as the wall thickness increased. The following table describes the length of each pipe configuration, using the standard HDPE nomenclature which indicates the ratio of nominal pipe diameter to wall thickness:

2.4 Water Treatment Plant

2.4.1 **Process Description** (Water Treatment Plant)

The primary process objective of the Water Treatment Plant is to treat mine and waste dump drainages to neutralize the acidity and precipitate (remove) soluble metals so the sludge pond effluent meets the following quality requirements as dictated by Water Use Licence #1N89-002:

Zinc (Zn)	maximum 0.50 mg/l
Copper (Cu)	maximum 0.20 mg/l
Lead (Pb)	maximum 0.20 mg/l
Total Suspended Solids (TSS)	maximum 15.0 mg/l
pH	minimum 6.5

The process is straight forward and simple, and most of it is housed in the Water Treatment Plant building. Two chemical reagents are utilized, slaked lime and a prepared flocculant solution.

Calcined lime is fed on demand from the lime storage bin into an automated package slaking system which prepares and stores a slaked lime slurry. This lime slurry is continuously pumped through a recirculation loop in the plant.

Similarly, powdered flocculant is fed into an automated flocculated preparation system which prepares and stores a flocculant solution.

The mine drainage waters are pumped directly into the first agitated process vessel, the primary reactor. Lime slurry is added automatically, controlled by pH measurement probes, to raise the pH to about 9.5. After a brief mixing period, the process water flows by gravity into the agitator-equipped secondary reactor where the primary process reaction occurs.

The reacted process water flows by gravity into a small flocculant mix tank, where the prepared flocculant solution is gently agitated into the water. This serves to agglomerate or flocculate the solids into larger particles which rapidly settle out of the treated water. These larger particles are "flocs" and form the sludge from the overall treatment process.

The process water stream flows by gravity from the flocculant mix tank, through a short length of buried HDPE (High Density Polyethylene) pipeline, into the sludge clarification/storage pond.

2.4.2 **Description of Facilities** (Water Treatment Plant)

The process facilities are primarily housed in the Water Treatment Plant building, a steel framed package building, 11 m x 10.6 m x 10 m high, with painted galvanized steel cladding. This building is located about one kilometre east of the Grum pit limits, at a top-of-slab elevation of 1306.7 m.

The building is heated by indirect-fired propane unit heaters, controlled by thermostats. The propane is supplied from a propane storage tank located near the east wall of the treatment plant.

Electrical power is fed to the Water Treatment Plant by an overhead 4160 V feeder from the Grum Substation. It is stepped down by a 225 kVA 4160 V / 600 V platform-mounted transformer prior to being fed into the MCC (Motor Control Centre) in the Plant.

A small air compressor (13 m^3/minute @ 620 kPa) provides service air to the lime silo baghouse and the lime slurry addition control valve.

Fresh water is provided by a low-capacity pitless-type deep well pump which is located 154 metres down a 215 metres deep well which was drilled adjacent to the plant, 2 metres south of the south wall. This fresh water is used on a regular basis for flocculant preparation and lime slaking; it is available as necessary for the emergency shower and eye-wash station.

The lime receiving, storage and preparation system is a package unit, supplied and largely installed by Stanco Projects Ltd. A steel receiving bin, located below the lip of a truck ramp, receives calcined lime in 20-ton container batches and transfers it pneumatically to the adjacent lime storage silo. The lime silo has nominal dimensions of 12 feet diameter by 40 feet eave height, and holds approximately 40 tonnes of pulverized quick lime. The bin bottom has a 4-foot diameter bin activator. The slaker is an automated unit which is located in the

circular enclosure formed by the first two ring sections at the bottom of the lime bin. The slaker discharges into a mild steel lime slurry storage tank, which has a capacity of 1300 U.S. gallons (4.9 m^3). Two 2" x 2" x 10" lime slurry circulation pumps, one operating and one installed spare, deliver the lime slurry to the primary reactor vessel.

The flocculant preparation system is an automated package dry polymer preparation unit provided by Allied Colloids (Canada) Ltd., the initial supplier of the dry polymers which are being used in this plant. The package includes a hopper to receive the dry flocculant; a tank, complete with a mixer, to hold the prepared solution; metering pumps to deliver the flocculant to the process; and a standard automatic control package.

The process stream consists of three agitated carbon steel tanks set at different elevations in the plant; they are connected by launders so the drainage waters flow by gravity from the primary reactor to the secondary reactor to the flocculant mix tank to the sludge clarification/storage pond.

The Primary Reactor is the highest of the three tanks. It has a volume of 38 m^3 (5 minutes retention time at 2000 USGPM). and has a 10 HP agitator. It discharges through a full-pipe launder into the Secondary Reactor, which has a volume of 114 m^3 (15 minutes retention) and is equipped with a 25 HP agitator. It discharges into the Flocculant Mix Tank, which has a volume of 7.6 m^3 (one minute retention) and is equipped with a 1.5 HP agitator.

The Flocculant Mix Tank discharges into the short underground pipeline (315 mm ϕ x 78 m long) which delivers the treated drainage waters to the sludge clarification/storage pond. The pipeline is protected from freezing by a 2.4 m wide Styrofoam cover layer, up to 100 mm thick, along the full length of the pipeline.

2.5 Sludge Clarification/Storage Pond

2.5.1 **Process Description** (Sludge Pond)

The Sludge Pond receives treated drainage water by buried pipeline from the Flocculant Mix Tank, the last of the three process vessels in the Water Treatment Plant.

The treated water flows into a feed distribution header at the west end of the sludge pond, nearest the Water Treatment Plant. The flocculated solids containing the precipitated metal hydroxides are trapped on the sand filter which forms the bottom of the pond, while the clarified water passes through this filter and into a piping system which delivers the treated water into the discharge manhole.

The discharge manhole has an adjustable-height weir which controls the level in the pond, and the rate of discharge of clear, treated water to the environment.

The discharge line from the manhole is a short length of buried pipeline which discharges into a natural drainage channel leading to Vangorda Creek, about 1.5 kilometres south east of the Water Treatment Plant.

2.5.2 **Description of Facilities** (Sludge Pond)

A nominal 12-inch underground HDPE (High Density Polyethylene) pipeline from the Flocculant Mix Tank, delivers the treated water into a same-size distribution header lying across the west end of the sludge pond. The distribution header is 60 metres in length, and has about 1600-25mm holes in four rows along its length to distribute the inflow evenly at a submerged elevation of 1299.5 metres, about three metres below the normal operating surface of the sludge pond.

The Sludge Pond is 130 m x 85 m, measured at the inside top of the embankments. The inside side slopes are 2.5:1 and the pond is about 8 metres deep, on average. The pond is set into gentle sidehill undulation in the existing glacial till, with one side dyke consequently higher than the other. After

clarified drainages about 75 m to discharge in a rock-lined basin which drains in a natural watercourse to Vangorda Creek.

3. MATERIALS TESTING RESULTS

It was noted that EBA Engineering Consultants Ltd. of Whitehorse provided geotechnical support during the engineering and construction phases of the project.

Two of EBA's reports are enclosed on following pages; they relate specifically to the construction of the Sludge Pond:

3.1 Permeability Test Results

This report, dated 1990-07-11, summarizes the results of laboratory and field testing completed to determine the "as-built" permeability of the bottom of the sludge pond.

3.2 Materials Testing Results

This report, dated 1990-07-10, documents the results of compaction and concrete testing conducted during the construction of the water treatment plant and sludge pond.

EBA Engineering Consultants Ltd.

Civil, Geotechnical and Materials Engineers

1990-07-11

Cominco Engineering Services Ltd.
100-1200 West 73rd Avenue
Vancouver, B.C.
V6P 6G5

EBA File No: 0201-10341

ATTENTION: Mr. T.D. Lee, P. Eng.

Dear Sir:

Subject: Permeability Test Results - Sludge Pond Construction
Water Treatment Plant
Grum/Vangorda Development
Curragh Mine, Faro, Yukon

As requested, this letter summarizes the results of laboratory and field testing completed to determine the "as built" permeability of the bottom of the sludge pond for the Grum/Vangorda Water Treatment Plant in Faro, Yukon.

On 1990-06-04, two falling head permeability tests were performed. Test No. 1 was conducted along the south edge of the pond bottom in an area comprised of fill while Test No. 2 was conducted along the north side of the pond bottom in an area comprised of minimally disturbed native soils. Based on a six hour falling head permeability test, the permeability in the fill area was measured at 5.6×10^{-8} m/s and the minimally disturbed and recompacted cut area along the north side of the pond yielded a permeability of 3.1×10^{-6} m/s.

Two additional tests were performed in an eight hour period on 1990-06-08, in the centre of the scarified and recompacted pond base, with results ranging from 3.8×10^{-7} m/s to 5.6×10^{-8} m/s. A sample was collected in order to determine grain size distribution characteristics of the material utilized for sludge pond construction (test results enclosed) and to perform an additional constant head permeability test. The laboratory permeability was 3.2×10^{-8} m/s, re-confirming the permeability determined during the geotechnical investigation phase of this project. The laboratory test was completed at 97% of Standard Proctor maximum dry density, the minimum density measured during on site compaction testing.

It is hoped that this satisfies your present requirements. However, if additional information is required, please contact this office at your convenience.

Yours truly,

EBA Engineering Consultants Ltd.

M.C. Plaunt, C.E.T.
Engineering Technologist

J.R. Trimble, P. Eng.
Project Director
Office Manager

MCP/JRT/amp

EBA Engineering Consultants Ltd.

PARTICLE - SIZE ANALYSIS OF SOILS

Project: Water Treatment Plant - Sludge Pond
Curragh Mine, Faro, YT

Project Number: 0201-10314

Date Tested: 1990-06-13

Borehole Number:

Depth: Sample from centre of pond base

Soil Description: SILT(ML) - sandy, gravelly, some clay

Cu:

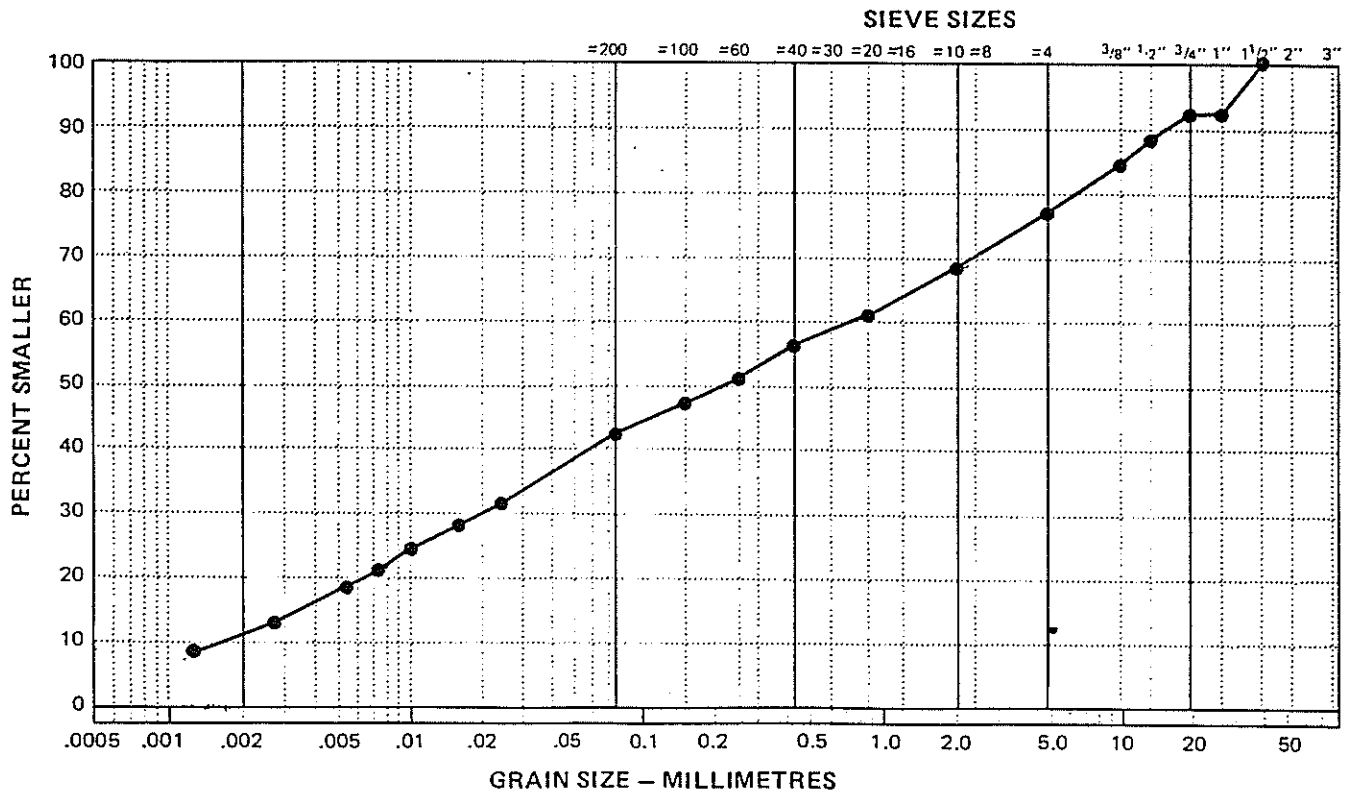
Cc:

Natural Moisture Content: %

Remarks:

SIEVE	PERCENTAGE PASSING
3"	
1 1/2"	100
1"	93
3/4"	93
1/2"	88
3/8"	84
No. 4	77
No. 10	69
No. 20	61
No. 40	56
No. 60	51
No. 100	47
No. 200	42

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering Consultants Ltd.

Civil, Geotechnical and Materials Engineers

1990-07-10

Cominco Engineering Services Ltd.
100-1200 West 73rd Avenue
Vancouver, B.C.
V6P 6G5

EBA File No: 0201-10341

ATTENTION: Mr. T.D. Lee, P. Eng.

Dear Sir:

Subject: Materials Testing Results - Grum/Vangorda Development
Curragh Mine Site
Faro, Yukon

Enclosed herein are the formal results of compaction and concrete testing conducted during the construction of the water treatment plant and sludge pond. The 76 compaction tests and 3 concrete tests were performed from 1990-05-18 to 1990-06-14. The number of site visits and testing frequency was dictated by Mr. Jack Meisl of C.E.S.L.

A brief summary of the test results is as follows:

1) Concrete Testing -

The average 28 day strength of the concrete placed on the lime silo pads and sludge pond manhole walls was 30.5 MPa (25 MPa was specified)

2) Sludge Pond Berm and Bottom Construction-

A total of 65 compaction tests were taken during the construction of the sludge pond berms and bottom. An average of 98.9% of Standard Proctor Maximum Dry Density was realized. This is believed to be representative due to the low number (3) of failed tests.

3) Lime Silo Ramp and Bin Wall Backfill -

A total of 11 compaction tests were taken during the ramp construction. An average of 96.4% of Standard Proctor Maximum Dry Density was realized. However, 4 of the 11 density tests were below 95%.

We hope this satisfies your present requirements. If we can provide additional information please do not hesitate to call.

Yours truly,

EBA Engineering Consultants Ltd.

M.C. Plaunt, C.E.T.
Engineering Technologist

J.R. Trimble, P. Eng.
Project Director
Office Manager

MCP/JRT/amp

EBA Engineering Consultants Ltd.

eba

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Grum/Vangorda Development
Water Treatment Plant
Faro, Yukon
Client: Cominco Eng. Serv. Ltd.

ATTN: Mr. J. Miesl

Test Apparatus: NUCLEAR Mach. No.: 5242
Soil Description: GRAVEL AND SAND(GP/GM)- some silt, trace of clay
Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2190 kg/m3
Optimum M.C.: 7.8%
Date Tested: 1990-05-18 By: MCP

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m³	% Compaction
1/250 mm	Bin ramp-east end	-5.0 m	7.0	2102	96.0
2/250 mm	Bin ramp-west end	-5.0 m	5.7	2172	99.2
3/250 mm	Bin ramp-centre-3.0 m north of bin walls	-4.5 m	6.9	2160	98.6

Remarks:

Reviewed By: M. Mamet

cc

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Grum/Vangorda Development Water Treatment Plant Faro, Yukon
Client: Cominco Eng. Serv. Ltd.
ATTN: Mr. J. Miesl

Test Apparatus: NUCLEAR Mach. No.: 5242
Soil Description: GRAVEL AND SAND(GP/GM)- some silt, trace of clay
Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2050 kg/m3
Optimum M.C.: 10.5%
Date Tested: 1990-05-23 By: MCP

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m3	% Compaction
4/300 mm	25 m east of NW corner on top	-1.5 m	9.2	2091	102.0
	of berm				
5/300 mm	Centre of north berm on top	-1.5 m	12.4	1920	94.0
6/300 mm	NE corner of sludge pond	-2.5 m	8.3	2035	99.3
7/300 mm	West end berm north side	-6.0 m	14.0	2026	98.9
	inside face				
8/300 mm	West end berm north side	-6.0 m	10.5	2076	101.3
	outside face				
9/300 mm	SE corner of sludge pond	-8.0 m	10.7	1990	97.1
	centreline of berm				

Remarks:

Reviewed By:

cc

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Grum/Vangorda Development
Water Treatment Plant
Faro, Yukon
Client: Cominco Eng. Serv. Ltd.

ATTN: Mr. J. Miesl

Test Apparatus: NUCLEAR Mach. No.: 5242
Soil Description: GRAVEL AND SAND(GP/GM)- some silt, trace of clay
Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2050 kg/m3
Optimum M.C.: 10.5%
Date Tested: 1990-05-24 By: MCP

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
10/300 mm	SW corner of sludge pond centre of berm	-8.5 m	10.6	1873	91.4
11/300 mm	Retest of #10	-8.5 m	11.8	1983	96.7
12/300 mm	30 m east of SW corner centre of berm	-7.0 m	11.4	1991	97.1
13/300 mm	Toe of berm on inside of pond at SE corner of pond bottom	-0.5 m	12.5	2007	97.9
14/300 mm	Toe of berm on pond bottom at centre of south side	-0.5 m	10.1	2059	100.5
15/300 mm	West berm at 4915N & 13270E	-8.0 m	13.2	2003	97.7
16/300 mm	Pond bottom at 4920N & 13275R	-3.0 m	13.6	1981	96.7

Remarks: TEST #10 taken on 1990-05-23

Reviewed By: M. Plant

cc

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Water Treatment Plant
Grum Vangorda Mine Site
Faro, Yukon
Client: C.E.S.L.
ATTN: Mr. Jack Meisl,

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: SAND AND SILT(TILL)(SM) -some gravel, occasional cobbles and boulders
Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2050 kg/m3
Optimum M.C.: 10.5%
Date Tested: 1990-05-31 MCP By: ____

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
17/300 mm	13325 E and 4915 N on top of North Berm	-0.6 m	10.0	2082	101.6
18/300 mm	13390 E and 4955 N at NE corner	-0.6 m	12.5	2023	98.7
19/300 mm	13380 E and 4915 N on East Berm	-3.8 m	8.9	2147	101.3
20/300 mm	13350 E and 4875 N on South Berm	-6.0 m	8.4	2162	102.0
21/300 mm	13310 E and 4880 N on South Berm	-3.0 m	8.9	2151	101.5
22/300 mm	13250 E and 4900 N at S W corner	-1.0 m	7.9	2166	102.2

Remarks: TEST # 17, 18 SAND AND SILT(TILL)(SM) -some gravel, occasional cobbles and boulders Max. dry den. 2050 kg/m^3 @ 10.5%. TEST # 19, 20, 21, 22 SAND AND SILT(TILL)(SM) -some gravel, occasional cobbles and boulders Max. dry den. 2120 kg/m^3 @ 9.8%.

Reviewed By: J. Richard Trimble P.Eng.

cc ____

EBA Engineering Consultants Ltd.

eba

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Water Treatment Plant
Grum/Vangorda Mine Site
Faro, Yukon
Client: C.E.S.L.
ATTN: Mr. Jack Meisl

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: SAND AND GRAVEL(SM/SP)
-some silt
Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2190 kg/m^3
Optimum M.C.: 7.5%
Date Tested: 1990-05-31 By: MCP

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
23/300 mm	Intake line to MH in sludge	Grade	10.8	1994	91.5
	pond at 13360 E and 4900 N				
24/300 mm	Intake line to MH in sludge	Grade	11.8	1980	90.4
	pond at 13370 E and 4890 N				
25/250 mm	13260 E and 4960 N on top of	-0.6 m	5.7	2156	98.4
	west berm				
26/250 mm	13300 E and 4975 N on top of	-0.3 m	7.6	2102	96.0
	north berm				
27/250 mm	N.W. corner on top of berm	-0.2 m	8.2	2103	96.0
28/250 mm	13260 E and 4960 N on top of	Grade	6.7	2114	96.5
	west berm				

Remarks: TEST # 23, 24 SAND AND SILT TILL MIXED WITH BEDROCK Max. dry den. 2190 kg/m^3 @ 7.8%. TEST # 25, 26, 27, 28 SAND AND GRAVEL(SM/SP) -some silt Max. dry den. 2190 kg/m^3 @ 7.5%. TESTS 26, 27, 28 taken on 1990-06-01.

Reviewed By: ____ P.Eng.

cc ____

EBA Engineering Consultants Ltd.

eba

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Water Treatment Plant
Grum/Vangorda Mine Site

Client: C.E.S.L.
ATTN: Mr. Jack Meisl,

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: SAND AND SILT(TILL)(SM)-some gravel
Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2120 kg/m3
Optimum M.C.: 9.8%
Date Tested: 1990-06-01 By: MCP

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
29/300 mm	13270 E and 4940 N along face of west berm - 3 m above pond bottom	GR	8.2	2139	100.9
30/300 mm	13270 E and 4915 N along face of south berm - 3 m above pond bottom	GR	9.1	2103	99.2
31/300 mm	13330 E and 4895 N along face of south berm - 3 m above pond bottom	GR	8.1	2112	99.6
32/300 mm	13330 E and 4880 N along face of south berm - 5 m above pond bottom	GR	7.3	2203	103.9
33/300 mm	13285 E and 4895 N along face of south berm-5 m above pond bottom	GR	9.0	2148	101.3
34/300 mm	top of berm and SW corner at 13245 E and 4890N	-0.5 m	9.4	2112	99.6

Remarks: ____

Reviewed By: J. Michael Mackle P.Eng.

cc ____

EBA Engineering Consultants Ltd.

eba

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Water Treatment Plant
Grum/Vangorda Mine Site
Client: C.E.S.L.
ATTN: Mr. Jack Meisl,

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: SAND AND SILT(TILL)(SM)
Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2120 kg/m3
Optimum M.C.: 9.8%
Date Tested: 1990-06-04 By: MCP

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
35/300 mm	Pond bottom 13280 E and 4920 N	GR	8.3	2144	101.1
36/300 mm	Pond bottom 13285 E and 4950 N	GR	7.5	2117	99.9
37/300 mm	Pond bottom 13308 E and 4945 N	GR	8.3	2080	98.1
38/300 mm	Pond bottom 13305 E and 4920 N	GR	6.0	2213	101.1
39/300 mm	Pond bottom 13325 E and 4915 N	GR	7.4	2171	99.1
40/300 mm	Pond bottom 13330 E and 4940 N	GR	7.2	2148	101.3

Remarks: TEST # 35, 36, 37 - SAND AND SILT(TILL)(SM) -some gravel to gravelly, occasional cobbles and boulders Max. dry den. 2120 kg/m^3 @ 9.8%.
TEST # 38 AND 39 - SAND AND SILT(SM) -some gravel, trace to some bedrock fragments Max. dry den. 2190 kg/m^3 @ 7.5 %.

Reviewed By: _____ P.Eng.

cc ____

The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance of material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Water Treatment Plant
Grum/Vangorda Mine Site

Client: C.E.S.L.

ATTN: Mr. Jack Meisl

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: SAND AND SILT(TILL)(SM)
-some gravel to gravelly

Temperature Air: ____ ° C Soil: ____ ° C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2120 kg/m3
Optimum M.C.: 9.8%
Date Tested: 1990-06-04 By: MCP

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
41/300 mm	Pond bottom 13315 E and 4930 N	Grade	7.4	2118	99.9
42/300 mm	South berm 13380 E and 4870 N	-7.0 m	8.7	2191	100.0
43/300 mm	South berm 13350 E and 4875 N	-5.5 m	6.0	2256	103.0
44/300 mm	South berm 13300 E and 4885 N	-2.5 m	7.9	2175	99.3
45/300 mm	South berm 13275 E and 4890 N	Grade	7.4	2045	96.5
46/300 mm	South berm 13250 E and 4890 N	Grade	7.3	2105	96.1

Remarks: TEST # 42, 43, 44, 46 - SAND AND SILT(TILL)(SM) - some gravel, bedrock fragments throughout Max. dry den. 2190 kg/m^3 @ 7.5%.

Reviewed By: _____ P.Eng.

cc ____

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Sludge Settling Pond
Water Treatment Plant
Grum/Vangorda Mine Site
Client: C.E.S.L.
ATTN: Mr. Jack Meisl

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: SAND AND SILT(TILL)
gravelly, some cobbles and boulders
Temperature Air: + 10 °C Soil: _____ °C
Specified Compaction: 95%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: _____
Maximum Dry Density: 2190
Optimum M.C.: 7.8
Date Tested: 1990-06-07 By: JRT

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m³	% Compaction
47/250 mm	Top of W. berm centre	grade	3.1	2198	100.0
48/250 mm	Top of W. berm S W corner	+ 0.1 m	4.8	2234	100.0
49/300 mm	Pond base, S W corner	grade	4.6	2140	97.7
50/300 mm	Pond base centre	grade	5.5	2163	98.8
51/250 mm	Pond base N E corner	grade	6.7	2237	100.0
52/300 mm	Pond base S E corner	grade	7.1	2125	97.0

Remarks: _____

Reviewed By: J. Richard Marble P.Eng.

cc _____

EBA Engineering Consultants Ltd.

eba

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Sludge Settling Pond
Water Treatment Plant
Grum/Vangorda Mine Site
Client: C.E.S.L.
ATTN: Mr. Jack Meisl

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: GRAVEL AND SAND (GP/GM)
- some silt, trace of clay
Temperature Air: + 10 °C Soil: _____ °C
Specified Compaction: 98%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: _____
Maximum Dry Density: 2190 kg/m3
Optimum M.C.: 7.8
Date Tested: 1990-06-14 By: BCF

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m³	% Compaction
53/300 mm	N 4870 and E 13360	Grade	5.7	2191	100.1
54/300 mm	N 4880 and E 13360	- 3.0 m	7.3	2172	99.2
55/300 mm	N 4890 and E 13350	- 6.0 m	7.7	2071	100.9
56/300 mm	N 4870 and E 13350	Grade	4.7	2209	100.9
57/300 mm	Right hand side 2 m from Bin end	+ 8.0 m	3.7	2147	98.0
	Bin Ramp				
58/300 mm	Left hand side 2.5 m from Bin end	+ 8.0 m	8.3	2196	100.3

Remarks: TEST #55 SAND (SP) - silty, some gravel Max. dry den. 2050 kg/m³ @ 10.5%. Bin Ramp

Reviewed By: Richard Hinkle P.Eng.

cc _____

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Sludge Settling Pond
Water Treatment Plant
Grum/Vangorda Mine Site
Client: C.E.S.L.
ATTN: Mr. Jack Meisl

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: GRAVEL AND SAND (GP/GM)
- some silt, trace of clay
Temperature Air: + 10 ° C Soil: ____ ° C
Specified Compaction: 98%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2190 kg/m3
Optimum M.C.: 7.8
Date Tested: 1990-06-14 By: BCF

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
59/300 mm	10 m from Bin Right hand side	+ 8.0 m	4.1	2123	96.9
60/300 mm	10 m from Bin Left hand side	+ 8.0 m	4.4	2102	96.0
61/300 mm	20 m from Bin Right hand side	+ 6.0 m	4.7	2024	92.4
62/300 mm	20 m from Bin Left hand side	+ 6.0 m	5.2	2075	94.7
63/300 mm	30 m from Bin Right hand side	+ 4.0 m	4.0	2055	93.8
64/300 mm	30 m from Bin	+ 4.0 m	4.2	2076	94.8

Remarks: BIN RAMP

Reviewed By: Rhodes Dimble P.Eng.

cc ____

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Sludge Settling Pond
Water Treatment Plant
Grum/Vangorda Mine Site
Client: C.E.S.L.

ATTN: Mr. Jack Meisl

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: GRAVEL AND SAND (GP/GM) - some silt, trace of clay
Temperature Air: + 10 ° C Soil: ° C
Specified Compaction: 98%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density:
Maximum Dry Density: 2120 kg/m3
Optimum M.C.: 9.8
Date Tested: 1990-06-14 By: BCF

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
65/300 mm	East side North end inside of berm	- 4.0 m	7.5	2026	95.6
66/300 mm	East side inside center of berm	- 4.0 m	7.6	2132	100.6
67/200 mm	East side South end inside berm	- 4.0 m	7.0	2088	98.5
68/300 mm	3 m East of manhole	- 3.5 m	4.2	2219	101.3
69/300 mm	2 m West of manhole	- 4.0 m	6.6	2062	97.3
70/300 mm	East side outside center of berm	- 4.0 m	7.1	2109	99.5

Remarks: TEST # 65, 66 - some gravel, boulders. TEST # 68 - SAND AND GRAVEL (SM/SP) Max. dry den. 2190 kg/m^3 @ 7.5%.

Reviewed By: _____ P.Eng.

cc

EBA Engineering Consultants Ltd.

DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 0201-10341
Project: Sludge Settling Pond
Water Treatment Plant
Grum/Vangorda Mine Site
Client: C.E.S.L.
ATTN: Mr. Jack Meisl

Test Apparatus: NUCLEAR Mach. No.: 7866
Soil Description: GRAVEL AND SAND (GP/GM) - some silt, trace of clay
Temperature Air: + 10 °C Soil: ____ °C
Specified Compaction: 98%
Compaction Standard: STANDARD PROCTOR
Minimum Dry Density: ____
Maximum Dry Density: 2190 kg/m3
Optimum M.C.: 7.5%
Date Tested: 1990-06-14 By: BCF

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m^3	% Compaction
71/300 mm	East side - North outside corner	- 5.0 m	6.6	2150	98.2
72/300 mm	4 m North of manhole	- 2.5 m	6.0	2131	97.3
73/300 mm	East side - North end	- 4.0 m	5.9	2253	100.1
74/300 mm	East side - centre	- 3.0 m	6.0	2112	96.4
75/300 mm	East side - South end	- 2.0 m	7.0	1969	96.1
76/300 mm	East side - South end	Grade	5.8	2189	100.0

Remarks: TEST #73 - GRAVEL AND SAND - trace of silt Max. dry den. 2250 kg/m^3 @ 5.5%. TEST #75 SAND AND SILT(TILL)(SM) - some gravel Max. dry den. 2050 kg/m^3 @ 10.5%.

Reviewed By: J. Richard Nimble P.Eng.

cc

EBA Engineering Consultants Ltd.

Standard A 283 Concrete Testing Laboratory Category II Certification

CONCRETE STRENGTH TEST RESULTS

CSA Specification CAN3 - A23.2

Project No.: 0201-10341

Project: Water Treatment Plant
Grum/Vangorda Mine Site
Faro. Yukon

Client: Cominco Engineering Serv. Ltd.

ATTN: Mr. Jack Meisl

Test Location: Bottom lime silo pad

Placing Method: Chute

Test No.: T- 1

INFORMATION FROM DELIVERY SLIP

Supplier: Remote Mine Development

Truck No.: _____ Plant Dep.: _____

Ticket No.: _____ Mix No.: _____

Load Amount: _____ m^3

Admixture: Air ___ $CaCl_2$ ___ Other _____

Specified Strength: 25 MPa

Cement Type: Normal

Max. Aggregate Size: 20 mm

Test Time: _____

Temperature: Air: _____ °C Concrete: _____ °C

Concrete Setting Temp.: Min.: _____ °C Max.: _____ °C

Slump: _____ mm Air Content: _____ %

Unit Weight: _____ kg/m^3

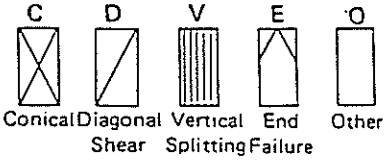
Date Cast: 1990-05-10 By: BCF

Date Received: 1990-05-18 By: BCF

Cylinder Number	Age Days	Test Date	Test By	Comp. Strength MPa	Type of Failure	Comments
10341-001	12	90-05-22	BCF	25.05	C	
10341-002	28	90-06-07	BCF	26.75	D	

Remarks: Cast by Contractor and Field cured until 1990-05-22.

Type of Failure



Reviewed By: Richard Nimble P.Eng.

cc _____

EBA Engineering Consultants Ltd.

eba

Standard A 283
Concrete Testing
Laboratory Category II
Certification

CONCRETE STRENGTH TEST RESULTS

CSA Specification CAN3 - A23.2

Project No.: 0201-10341
Project: Water Treatment Plant
Grum/Vangorda Mine Site
Faro, Yukon
Client: C.E.S.L.
ATTN: Mr. J. Meisl

Test Location: Top Lime Silo Pad

Placing Method: Chute
Test No.: T - 2

INFORMATION FROM DELIVERY SLIP

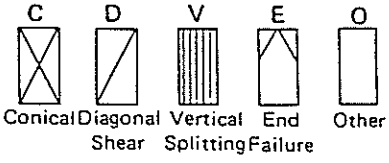
Supplier: Remote Mine Development
Truck No.: _____ Plant Dep.: _____
Ticket No.: _____ Mix No.: _____
Load Amount: _____ m^3
Admixture: Air ___ $CaCl_2$ ___ Other _____
Specified Strength: 25 MPa
Cement Type: Normal
Max. Aggregate Size: 20 mm

Test Time: _____
Temperature: Air: _____ °C Concrete: _____ °C
Concrete Setting Temp.: Min.: _____ °C Max.: _____ °C
Slump: _____ mm Air Content: _____ %
Unit Weight: _____ kg/m^3
Date Cast: 1990-05-12 By: Contractor
Date Received: 1990-05-10 By: MCP

Cylinder Number	Age Days	Test Date	Test By	Comp. Strength MPa	Type of Failure	Comments
10341-003	10	90-05-22	BF	21.95	C	
10341-004	28	90-06-09	BF	30.25	C & D	

Remarks: Cast by Contractor & Field cured until 1990-05-22

Type of Failure



Reviewed By: Richard Nimble P.Eng.

cc _____

EBA Engineering Consultants Ltd.

Standard A 283 Concrete Testing Laboratory Category II Certification

CONCRETE STRENGTH TEST RESULTS

CSA Specification CAN3 - A23.2

Project No.: 0201-10341

Project: Water Treatment Plant
Sludge-pond Manhole

Client: C.E.S.L.

ATTN: Mr. Jack Meisl

Test Location: Sludge pond manhole
first lift above base

Placing Method: chute & wheelbarrow

Test No.: T-3

INFORMATION FROM DELIVERY SLIP

Supplier: Remote Mine Development

Truck No.: _____ Plant Dep.: _____

Ticket No.: _____ Mix No.: _____

Load Amount: _____ m^3

Admixture: Air X $CaCl_2$ ___ Other _____

Specified Strength: 250 MPa

Cement Type: Normal

Max. Aggregate Size: 20 mm

Test Time: 13:00

Temperature: Air: + 5 °C Concrete: _____ °C

Concrete Setting Temp.: Min.: _____ °C Max.: _____ °C

Slump: _____ mm Air Content: _____ %

Unit Weight: _____ kg/m^3

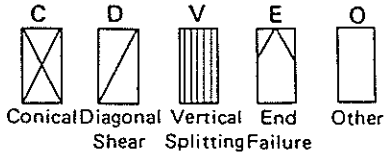
Date Cast: 1990-06-01 By: MCP

Date Received: 1990-06-04 By: MCP

Cylinder Number	Age Days	Test Date	Test By	Comp. Strength MPa	Type of Failure	Comments
10341-005	7	1990-06-08	JSB	31.80	D	
10341-006	28	1990-06-29	JSB	34.40	C	

Remarks: _____

Type of Failure



Reviewed By: _____

cc _____

The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance of material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

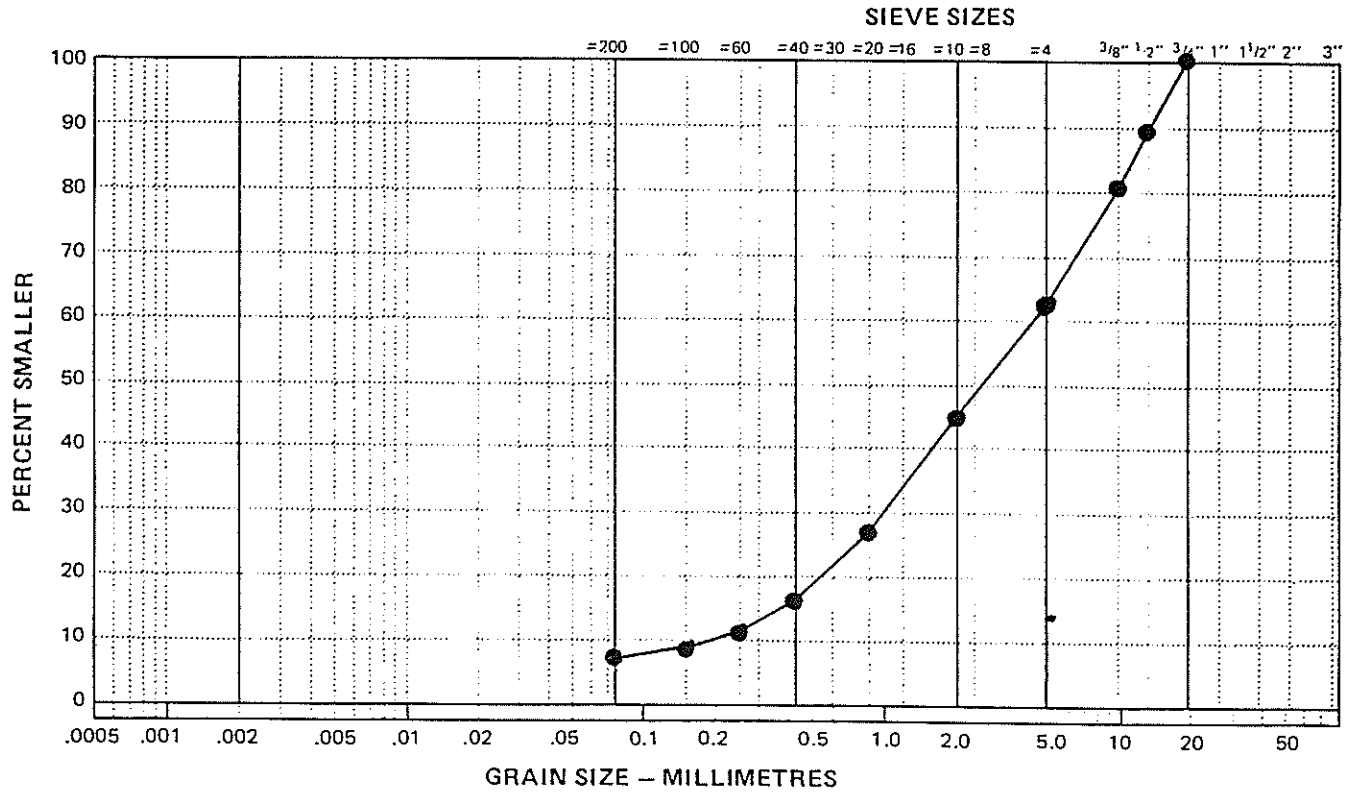
EBA Engineering Consultants Ltd.

PARTICLE - SIZE ANALYSIS OF SOILS

Project: Sludge Pond
Vangorda Mine Site
Project Number: 0201-10314
Date Tested: 1990-06-06
Borehole Number:
Depth:
Soil Description: SAND AND GRAVEL (SW/SM) - trace of silt
Cu: 21
Cc: 1.2
Natural Moisture Content: 5.1 %
Remarks:

SIEVE	PERCENTAGE PASSING
3"	
1 1/2"	
1"	
3/4"	100
1/2"	90
3/8"	81
No. 4	64
No. 10	44
No. 20	28
No. 40	16
No. 60	11
No. 100	9
No. 200	8

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



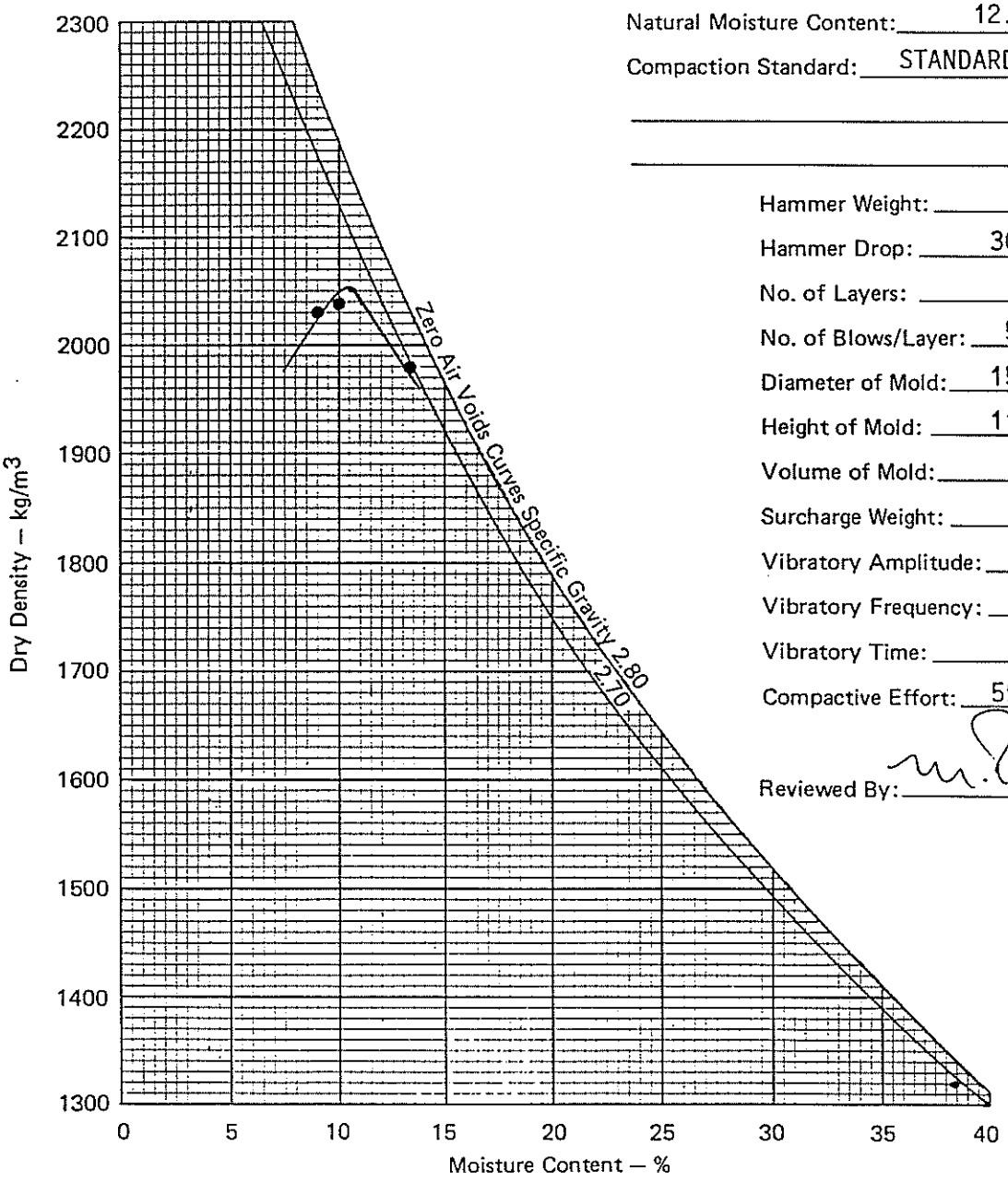
Tested in accordance with ASTM D422 unless otherwise noted.

MOISTURE - DENSITY RELATIONSHIP

ASTM Designation D698, D1557, or D2049

Project No.: 0201-10341
Project: Water Treatment Plant
Address: Grum/Vangorda Mine Site
Faro, Yukon
Date Tested: 1990-05-22 By: JSB
Client: Cominco Eng. Serv. Ltd.
Attention: Mr. J. Meisl

Sample No.: 1978
Sample Location: Pond Area
Sample Description: SAND AND SILT(TILL)(SM)-some gravel
Minimum Dry Density: _____ kg/m3
Maximum Dry Density: 2050 kg/m3
Optimum Moisture Content: 10.5 %
Natural Moisture Content: 12.0 %
Compaction Standard: STANDARD PROCTOR



Hammer Weight: 2.494 kg
Hammer Drop: 304.8 mm
No. of Layers: 3
No. of Blows/Layer: 56
Diameter of Mold: 152.3 mm
Height of Mold: 116.5 mm
Volume of Mold: 0.00212 m3
Surcharge Weight: _____ kg
Vibratory Amplitude: _____ mm
Vibratory Frequency: _____ vib./min.
Vibratory Time: _____ min.
Compactive Effort: 590.3 kJ/m3

Reviewed By: M. Mount

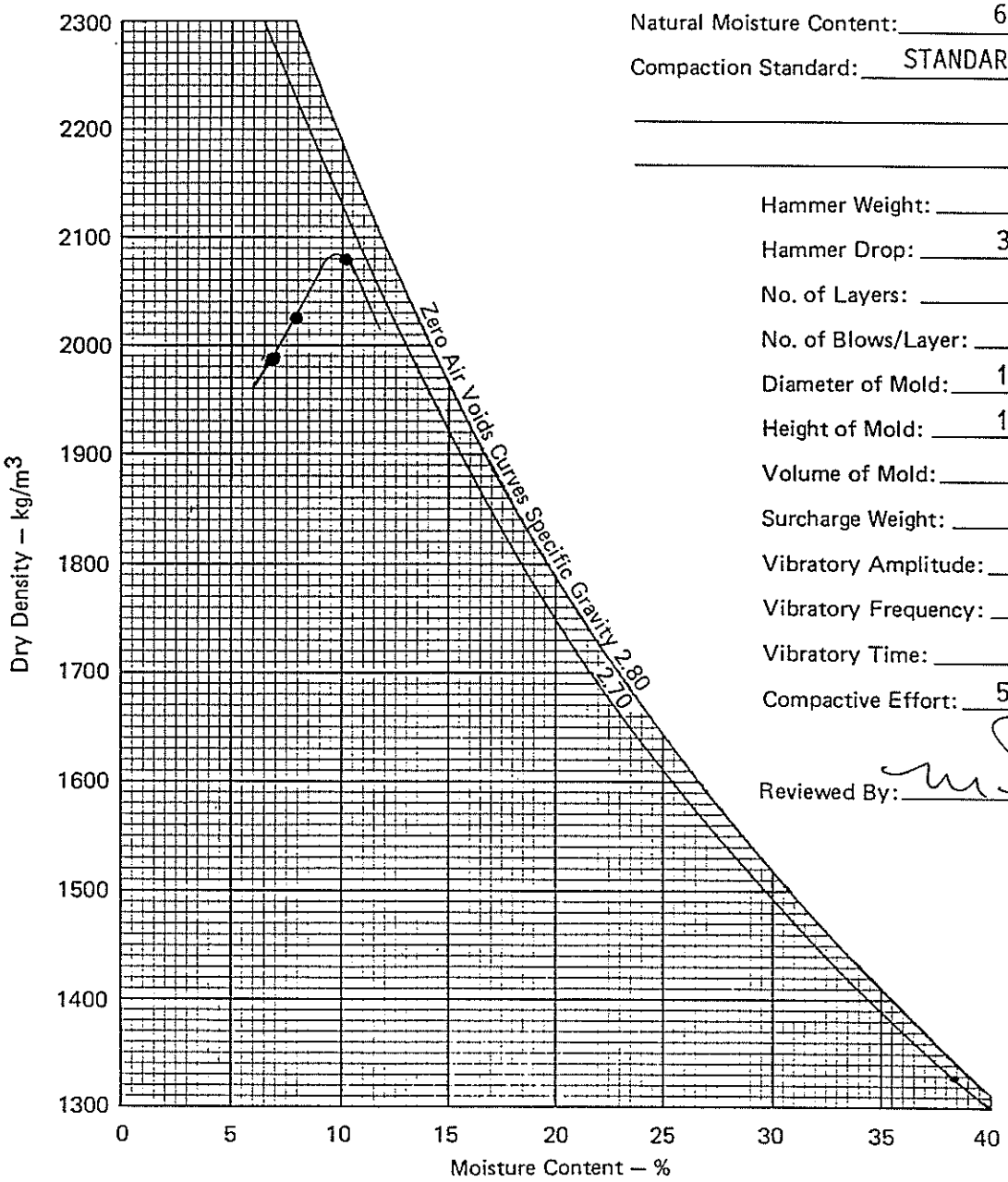
EBA Engineering Consultants Ltd.

MOISTURE - DENSITY RELATIONSHIP

ASTM Designation D698, D1557, or D2049

Project No.: 0201-10341
Project: Water Treatment Plant
Address: Grum/Vangorda Mine Site
Faro, Yukon
Date Tested: 1990-05-22 By: JSB
Client: Cominco Eng. Serv. Ltd.
Attention: Mr. J. Meisl

Sample No.: 1979
Sample Location: Lime Silo Ramp
Sample Description: SAND AND GRAVEL (SP)
trace to some silt
Minimum Dry Density: _____ kg/m^3
Maximum Dry Density: 2082 kg/m^3
Optimum Moisture Content: 9.7 %
Natural Moisture Content: 6.9 %
Compaction Standard: STANDARD PROCTOR



Hammer Weight: 2.494 kg
Hammer Drop: 304.8 mm
No. of Layers: 3
No. of Blows/Layer: 56
Diameter of Mold: 152.3 mm
Height of Mold: 116.5 mm
Volume of Mold: 0.00212 m^3
Surcharge Weight: _____ kg
Vibratory Amplitude: _____ mm
Vibratory Frequency: _____ vib./min.
Vibratory Time: _____ min.
Compactive Effort: 590.3 kJ/m^3

Reviewed By: M. Plant

4. PHOTOGRAPHS

The photographs on the following pages have been selected from CESL's construction photos on the basis of their technical content and their ability to supplement the description of facilities provided in text and by drawings in other sections of this report.

4.1 Little Creek Pond: Under Construction

The dam was constructed during September and October 1990. This photo was taken at mid-October with the dam about 75 percent complete. The wet well can be seen at the centre of the photograph, near the packer. The Vangorda waste dump is in the background.

4.2 Little Creek Pond: In Operation

This photo shows the completed dam, with the stored water at the "normal" operating level. The Vangorda Pumphouse is just off the right side of the picture. The ditch at the centre of the photo receives drainages from the waste dumps, at the extreme left, and leads them into Little Creek Pond.

(September, 1991)

4.3 Vangorda Pumphouse: Location

The Vangorda Pumphouse is located on an extension of the upstream face of the Little Creek Dam, over the wet well.

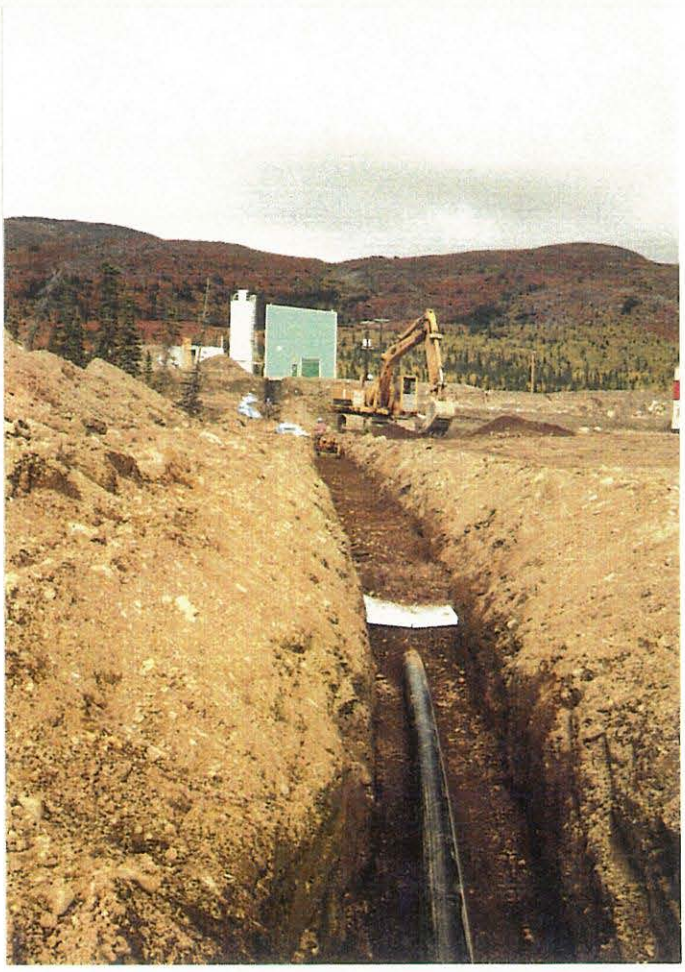
4.4 Vangorda Pumphouse: Appearance

The Vangorda Pumphouse is 4 m x 6 m x 3.5 m high, with a sloped roof. It is of wood frame construction and is clad with pre-painted galvanized steel siding. It houses 3 pumps.

(September, 1991)

4.5 Vangorda Pipeline

The pipeline is nominal 10 inch/12 inch HDPE (High Density Polyethylene) bedded into a prepared trench. The pipe is protected from freezing by a continuous layer of Styrafoam, 100 mm thick by 2400 mm wide. The pipeline is 2311 m long, and the location is conspicuously flagged by marker posts.



(September 1990)

4.6 Water Treatment Plant

The process tanks were installed, then the building was erected around them (September, 1989).

4.7 Water Treatment Plant

The truck ramp on the left allows lime to be dumped into the low white hopper, prior to being blown into the lime storage silo. The Plant is a steel frame structure, heated by propane from the two tanks on the right.

(September, 1991)

4.8 Sludge Pond

The Sludge Pond is located near the Water Treatment Plant. It is a rectangular pond, 130 m x 85 m at the top of the embankment, and about 8 m deep. The inside side slopes are 2.5:1.

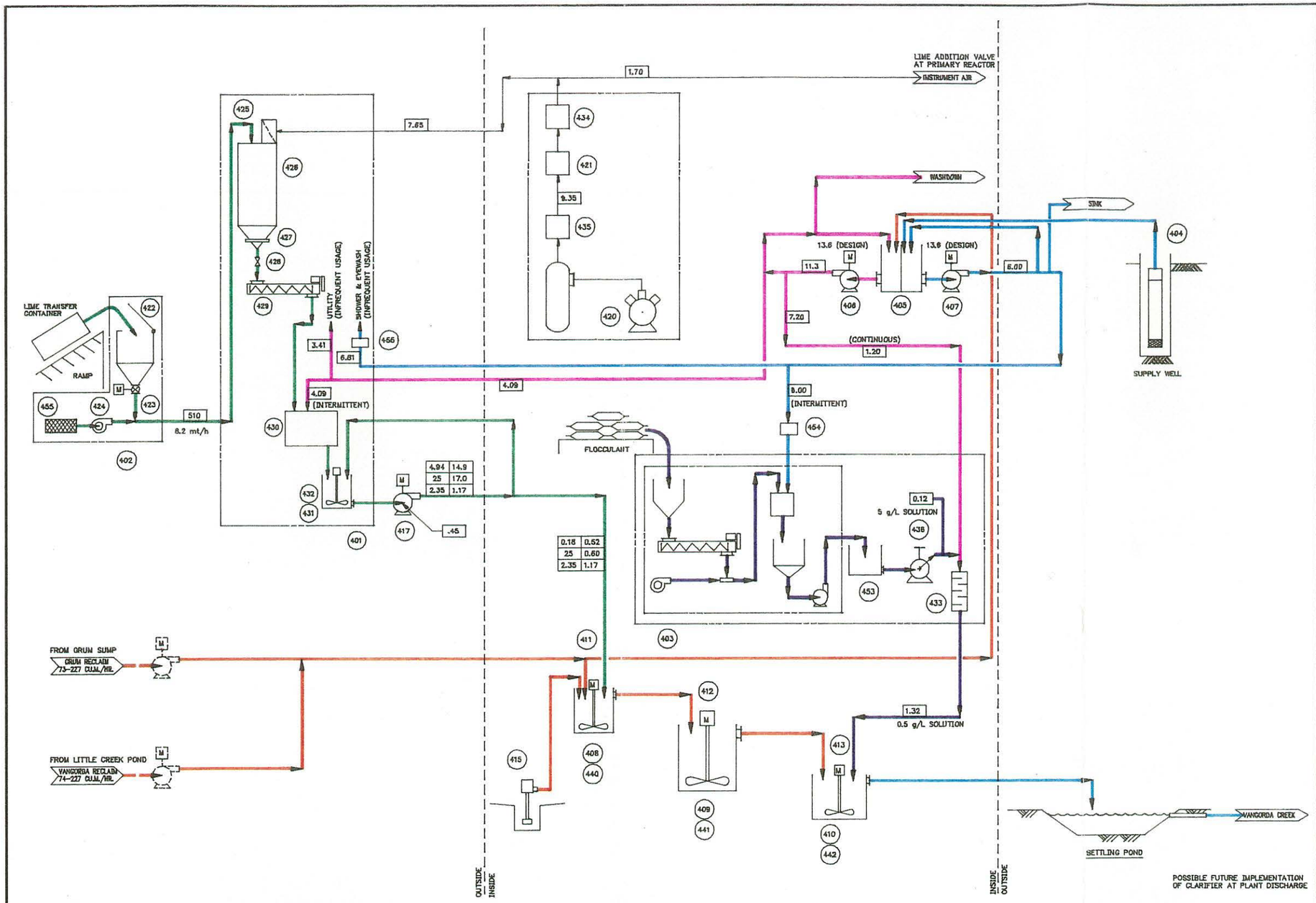
(September, 1991)

5.0 DRAWINGS

The as-built revisions of fifteen drawings are included in this report to provide explicit description of the Grum/Vangorda Water Treatment Plant; each drawing has been photographically reduced for ease of presentation and handling.

These drawings are enclosed:

Drawing Number	Revision	Description
P662-A-001	4	Process Flowsheet
P662-A-006	3	P&ID's: Line Feed & Air
P662-A-007	3	P&ID's: Reactor Water Supply & Flocculant Feed
P662-A-015	4	Treatment Plant Mechanical G.A. Plan
P662-A-016	4	Treatment Plant Sections
P662-B-060	3	Sludge Settling Pond
P662-B-061	1	Sludge Pond Manhole
P662-B-063	2	Effluent Piping Plan & Profile
P662-B-102	5	Water Treatment Building
P662-B-130	3	Vangorda Pipeline, Plan & Profile
P662-B-136	2	Vangorda Pumphouse Building Details
P662-B-139	1	Vangorda Pipeline
P662-E-001	2	Single Line Diagram
P662-E-002	3	MCC Block Diagram (WT Plant)
P662-E-031	1	MCC Block Diagram (Vangorda Pumphouse)



ITEM NO.	NO. REQ'D	EQUIPMENT NO.	DESCRIPTION	MOTOR HP/UNIT
400				
401	1	P662-401	LIME STORAGE AND PREPARATION SYSTEM (3.65M#x12.2M)	
402	1	P662-402	LIME SILO FILL SYSTEM	
403	1	P662-403	FLOCCULANT PREP. UNIT (ALLIED COLLOIDS)	.2,.37,2.1
404	1	P662-404	PLANT WATER SUPPLY PUMP	
405	1	P662-405	PLANT WATER STORAGE TANK (2M#x1.5M 4.4 CU.M.)	——
406	1	P662-406	MINE WATER CIRCULATION PUMP H/G ANSI AA-6	5
407	1	P662-407	FRESH WATER CIRCULATION PUMP H/G ANSI AA-6	5
408	1	P662-408	PRIMARY REACTOR (3.6M#x4.3M 37.9CU.M.)	——
409	1	P662-409	SECONDARY REACTOR (5M#x6.4M 114CU.M.)	——
410	1	P662-410	FLOCCULANT MIX TANK (2.2M#x2.6M 7.57CU.M.)	——
411	1	P662-411	PRIMARY REACTOR AGITATOR	10
412	1	P662-412	SECONDARY REACTOR AGITATOR	25
413	1	P662-413	FLOCCULANT MIX TANK AGITATOR	1.5
VOID				

ITEM NO.	NO. REQ'D	EQUIPMENT NO.	DESCRIPTION	MOTOR HP/UNIT
415	1	P662-415	PLANT SUMP PUMP (1 1/2" GALIGHER)	3
VOID				
417	2	P662-417-1,2	LIME SLURRY CIRCULATION PUMP A-C 2x2 SLF	5
VOID				
VOID				
420	1	P662-420	PLANT AIR COMPRESSOR (13.0 CUM/HRx620kPa)	3
421	1	——	AIR DRYER	——
422	1	——	LIME UNLOADING BIN(25t CAP)	——
423	1	——	ROTARY AIR LOCK FEEDER	.33
424	1	——	BLOWER	20
425	1	——	BIN VENT FILTER (23.2 SQ.M FLEX-KLEAN)	——
426	1	——	LIME SILO 40t CAPACITY (PEABODY TECTANK)	——
427	1	——	BIN ACTIVATOR 1.21M# (METALFAB)	1.5
428	1	——	SILO DISCHARGE VALVE (203mm#)	——
429	1	——	VOLUMETRIC SCREW FEEDER (51mm# METALFAB)	.75

ITEM NO.	NO. REQ'D	EQUIPMENT NO.	DESCRIPTION	MOTOR HP/UNIT
430	1	——	LIME SLAKER (WALLACE & TIERNAN 454 kg/HR CAPACITY)	.25,.50
431	1	——	LIME SLURRY STORAGE TANK(4.92 CU M CAP)	——
432	1	——	LIME SLURRY STORAGE TANK AGITATOR (PROCHEM)	3
433	1	——	STATIC MIXER (KOCH TYPE MXLB)	——
434	1	——	AFTER FILTER	——
435	1	——	PREFILTER	——
436	1	——	DOSING PUMP (BORNEMANN EH 236-2)	1 DC
VOID				
VOID				
VOID				
440	1	P662-440	PRIMARY AGITATOR BRIDGE	——
441	1	P662-441	SECONDARY AGITATOR BRIDGE	——
VOID				
VOID				

ITEM NO.	NO. REQ'D	EQUIPMENT NO.	DESCRIPTION	MOTOR HP/UNIT
VOID				——
VOID				
VOID				
VOID				
VOID				
VOID				
VOID				
453	1	——	HOLDING TANK 1.1 CU.M.	——
454	1	P662-454	WATER FILTER	——
455	1	P662-455	WATER FILTER	——
456	1	——	FILTER/SILENCER	
457				
458				
459				

REVISIONS

NO.	DATE	APP'D	DESCRIPTION
A	89/04/26		PRELIMINARY
P1	89/05/22		PRELIMINARY (SCOPE CHANGES)
P2	89/06/15		FOR APPROVAL
0	89/06/26		FOR QUOTATION
1	89/07/28		FOR TENDER
2	89/09/15		FOR CONSTRUCTION
3	94/09/17		FRESH WATER PUMP ADDED
4	94/09/11		ADDED BAFFLE PLATE TO 405

REFERENCE

ISSUE

LEGEND

cu m/hr	cu m/hr norm. / cu m/hr max.	mt/h solids / % solids / S.G. solids	cu m/h solution / cu m/h slurry / S.G. slurry

Cominco Engineering Services Ltd.

VANCOUVER-TRAIL-CALGARY-SASKATOON

DRAWN BY	SES	89/04/26
CHECKED BY		
DESIGNED BY		

SCALE N.T.S.

TITLE
PROCESS FLOWSHEET
CURRAGH RESOURCES INC.
GRUM/VANGORDA
WATER TREATMENT PLANT

DRAWING NO. P662-A-001

REV. 4

FIRE ALARM XS 105 — XA 105

MCC

POWER FAILURE XS 106 — XA 106

BUILDING TEMP. TSL 107 — TAL 107

AIR INTAKE

PREFILTER

CONTRACT | VENDOR

MOISTURE TRAP

AFTER FILTER

PLANT AIR COMPRESSOR PACKAGE
EQ.NO. P662-420

LIME ADDITION VALVE

PI 103

AUXILLARY OUTLET

15 A 978-002

25 A 978-001

158I-1

BI-1

TO SHOWER & EYE WASH

OUTSIDE | INSIDE BUILDING

SET @ 350 kPa

PSL 104

PAL 104

LIME SILO

WATER FILTER
EQ.NO. P662-455

40 W 009-038

FRESH WATER

40 W 009-027

ET

P662-A-007
MINE WATER

INSIDE SILO SKIRT | OUTSIDE

NONE

25 W 009-033

CONTRACT | VENDOR

LIME SILO FILL SYSTEM
EQ.NO. P662-402

LIME TRANSFER CONTAINER

FEEDER

XS 131 — XA 131

SLAKER

50 R 230-014

50 R 216-014

P662-A-007
LIME SLURRY RETURN

DI-1

PAL 118

PSL 119
SET @ 70 kPa

FILTER/SILENCER

BLOWER

OUTSIDE | INSIDE FILL SYSTEM SKIRT

INSIDE FILL SYSTEM SKIRT | OUTSIDE

LSL 133

LIME STORAGE AND PREPARATION SYSTEM
EQ.NO. P662-401

HS 4171

80 R PVC-010

50 R 216-012

25DI-1

50DI-1 (DRAIN)

80x50 RED

LIME SLURRY CIRCULATION PUMP
EQ.NO. P662-417-1

P662-A-007
LIME SLURRY TO PROM. REACTOR

HS 4172

80 R PVC-011

50 R 216-013

50DI-1 (DRAIN)

LIME SLURRY CIRCULATION PUMP
EQ.NO. P662-417-2
(STANDBY)

LAL 133

P662/ADM
9/11/25

REVISIONS			
NO.	DATE	APP'D	DESCRIPTION
P2	88/08/08		FOR COMMENTS
0	88/09/20		FOR QUOTATION
1	89/02/28		FOR TENDER
2	89/04/05		FOR CONSTRUCTION
3	89/08/10		FRESH WATER PUMP ADDED

2	P662-A-001	PFD
1	P662-A-007	P&ID

REFERENCE

ISSUE

3 AS-BUILT REPORT

DN	NPS	DN	NPS
15	1/2	150	6
20	3/4	200	8
25	1	250	10
32	1 1/4	300	12
40	1 1/2	350	14
50	2	400	16
65	2 1/2	450	18
80	3	500	20
100	4	600	24
125	5	750	30

Cominco Engineering Services Ltd.

VANCOUVER-TRAIL-CALGARY-SASKATOON

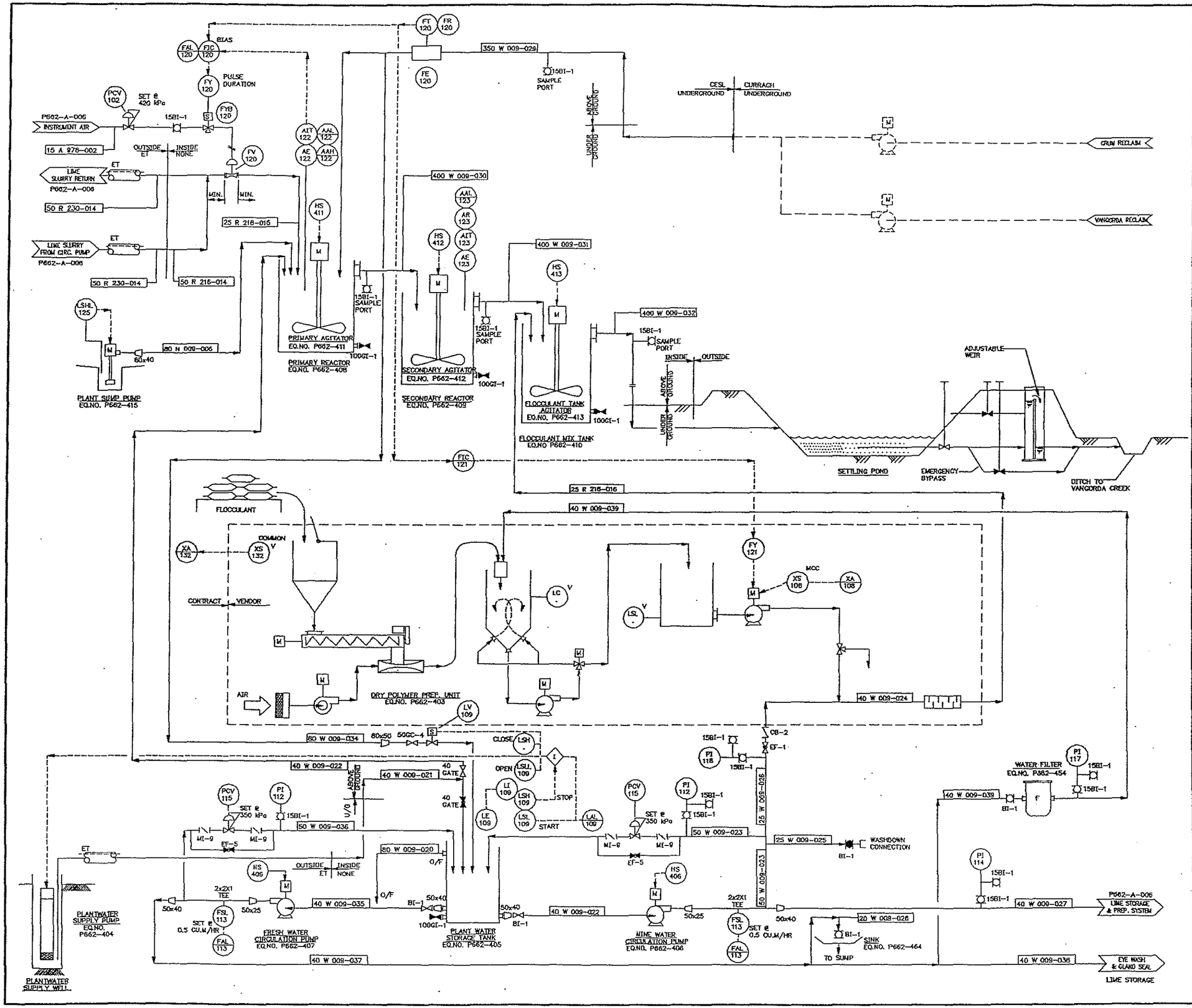
DRAWN BY SES	89/08/08
CHECKED BY	
DESIGNED BY PW	

SCALE N.T.S.

TITLE
CURRAGH RESOURCES INC.
FARO, YUKON GRUM/VANGORDA
WATER TREATMENT PLANT
LIME FEED AND AIR P & ID

DRAWING NO. P662-A-006

REV. 3



REVISIONS			
NO.	DATE	APP'D	DESCRIPTION
P1	89/05/17		FOR COMMENTS
0	89/06/06		FOR QUOTATION
1	90/02/28		FOR TENDER
2	90/04/25		FOR CONSTRUCTION
3	95/09/18		FRESH WATER PUMP ADDED

2	P662-A-001 PFD
1	P662-A-006 P&ID

REFERENCE

ISSUE

3 AS-BUILT REPORT

DN	NPS	DN	NPS
15	1/2	150	6
20	3/4	200	8
25	1	250	10
32	1 1/4	300	12
40	1 1/2	350	14
50	2	400	16
65	2 1/2	450	18
80	3	500	20
100	4	600	24
125	5	750	30

Cominco Engineering Services Ltd.

VANCOUVER—TRAIL—CALGARY—SASKATOON

DRAWN BY SES	89/06/12
CHECKED BY	
DESIGNED BY PW	

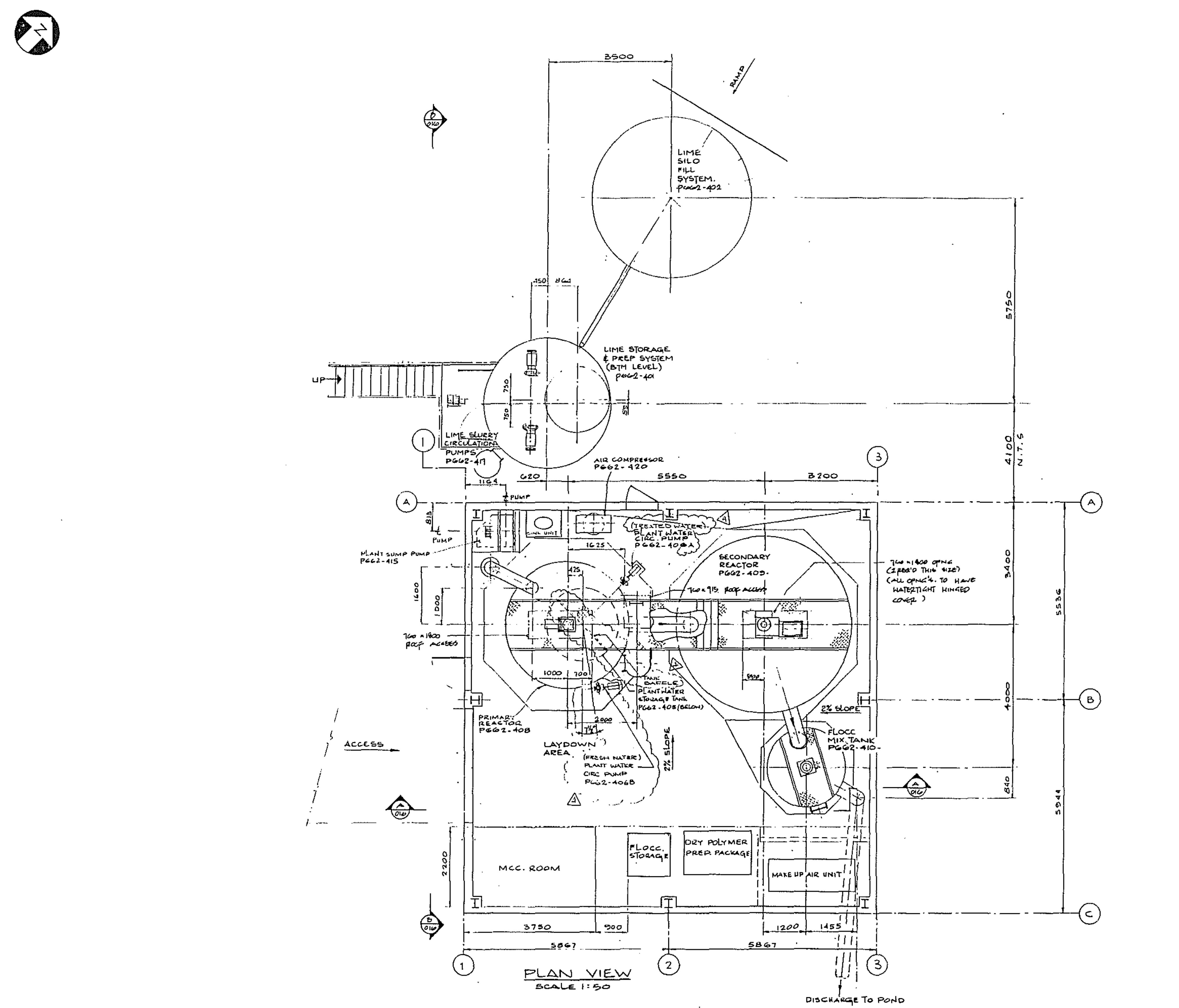
SCALE N.T.S.

TITLE
CURRAGH RESOURCES INC.
FARO, YUKON GRUM/VANGORDA
WATER TREAT. PL. P&ID REACTOR
WATER SUPPLY & FLOCC. FEED

DRAWING NO. P662-A-007

REV. 3

P662A007
97/07/29



REVISIONS

NO	DATE	APP'D	DESCRIPTION
P1	[illegible]		FOR APPROVAL
0	[illegible]		ISSUED FOR CONSTRUCTION
1			GENERAL REVISION
2	[illegible]		FOR TENDER
3	[illegible]		FOR CONSTRUCTION
4	91/10/25		AS BUILT

P662-A-016 - SECT A-A & B-B

REFERENCE

ISSUE

4 AS-BUILT REPORT

NOTES.

CESL
Cominco Engineering Services Ltd.

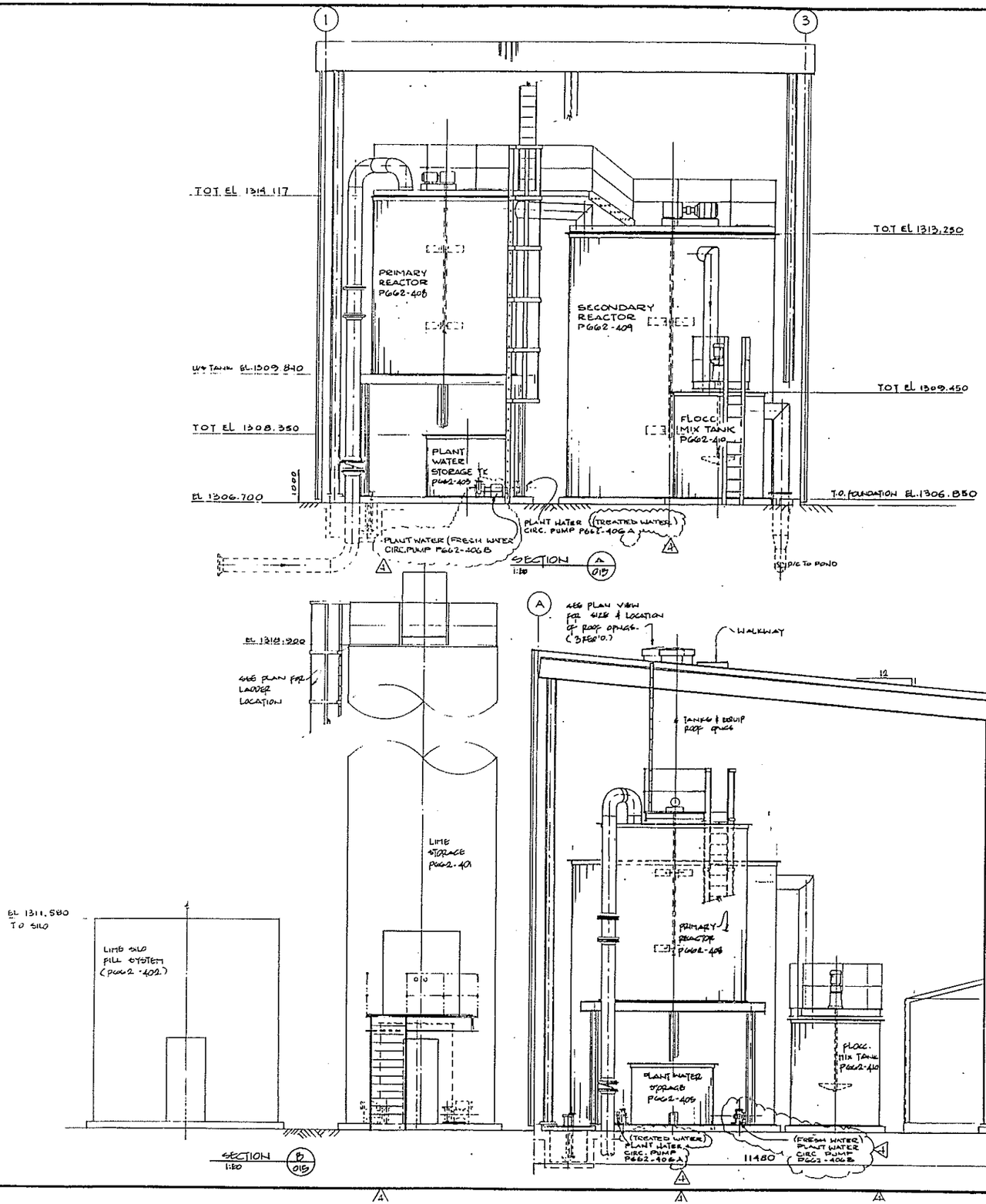
VANCOUVER — TRAIL — CALGARY

DRAWN BY	G FINDLAY	JUNE 89
CHECKED BY		
DESIGNED BY	A. RYLANDSHOLM	JUNE 89

SCALE 1:50

TITLE
CURRAGH RESOURCES INC
GRUM VANGORDA WATER TREATMENT PLANT
MECHANICAL G.A. PLAN

DRAWING NO P662-A-015 REV 4



REVISIONS			
NO	DATE	APP'D	DESCRIPTION
P1	87/04/13		FOR APPROVAL
0	87/06/11		ISSUED FOR CONSTRUCTION
1			GENERAL REVISION
2	90/04/30		FOR TENDER
3	90/05/30		FOR CONSTRUCTION
4	92/09/25		AS-BUILT

PG62-A-017 PLAN VIEW
REFERENCE

ISSUE

4 AS-BUILT REPORT

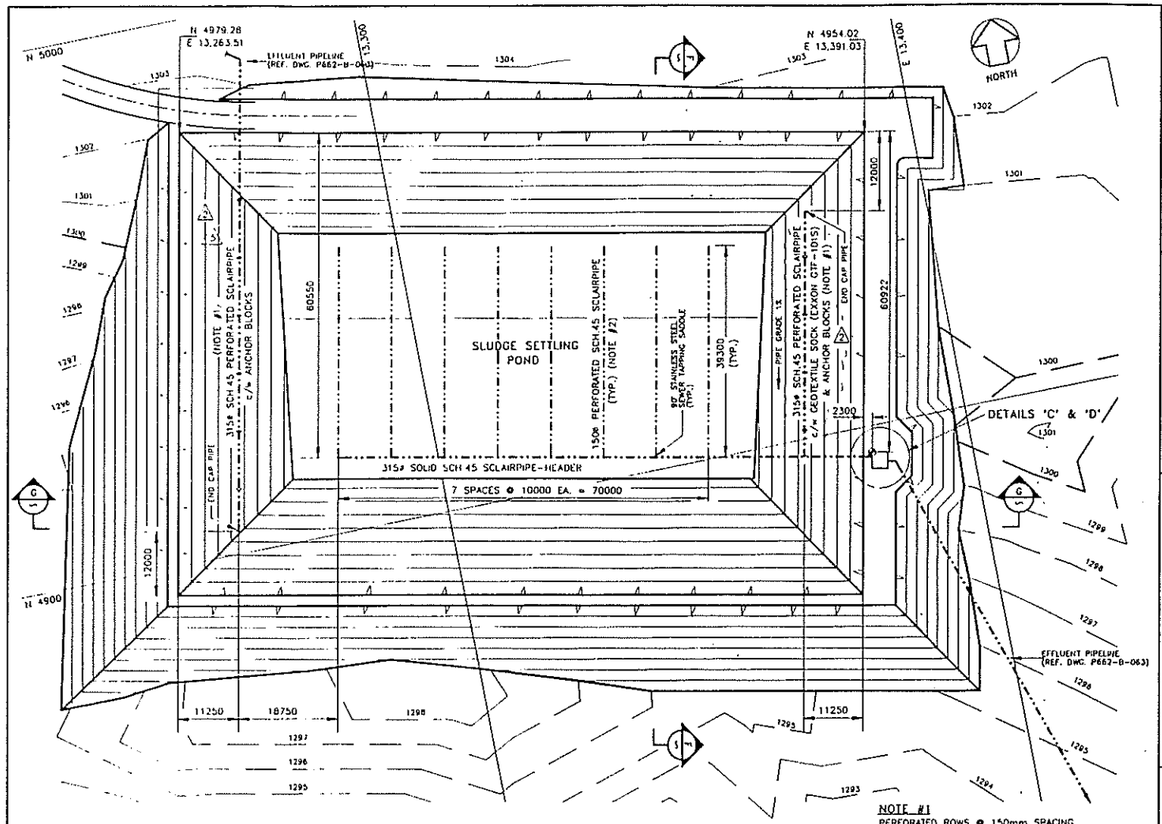
Cominco Engineering Services Ltd.

VANCOUVER — TRAIL — CALGARY

DRAWN BY	G FINDLAY	JUNE 87
CHECKED BY		
DESIGNED BY	A RYLANDSHOLM	JUNE 87
SCALE	1:50	

TITLE
CURRAGH RESOURCES INC
GRUM VANGORDA WATER
TREATMENT PLANT
SECTIONS

DRAWING NO	REV
PG62-A-016	4

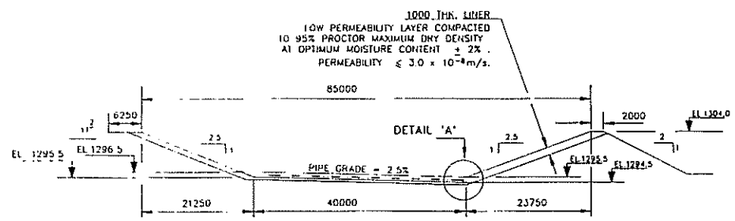


SLUDGE SETTLING POND PLAN

SCALE 1 : 500

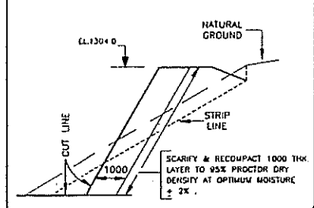
NOTE #1
PERFORATED ROWS @ 150mm SPACING
4 – 25mm HOLES PER ROW .

NOTE #2
PERFORATED ROWS @ 150mm SPACING
4 – 15mm HOLES PER ROW c/w
GEOTEXTILE CLOTH COVER .



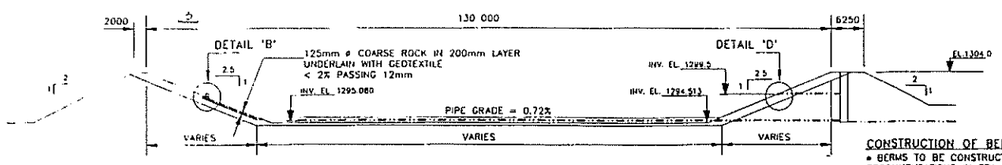
SECTION F–F

SCALE 1 : 500



TYPICAL CUT–FILL SECTION

N.T.S.



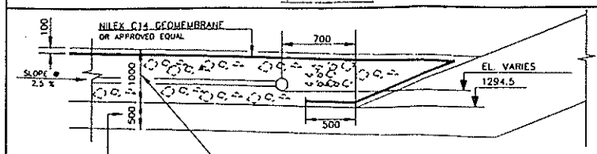
SECTION G–G

SCALE 1 : 500

CONSTRUCTION OF BERMS

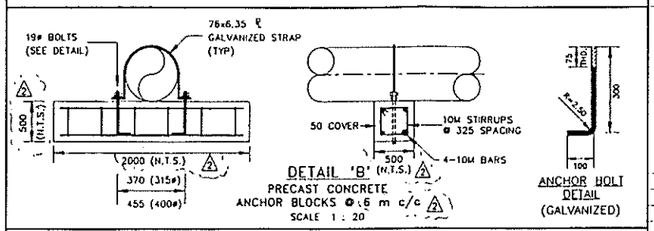
- BERMS TO BE CONSTRUCTED ACCORDING TO RECOMMENDATIONS IN EBA ENGINEERING SOILS REPORT "PROPOSED WATER TREATMENT SETTLING PONDS."
- MAXIMUM LIFT THICKNESSES OF 200mm.
- EACH LIFT COMPACTED TO 95% PROCTOR MAXIMUM DENSITY AT OPTIMUM MOISTURE CONTENT ± 2% .

DETAILS



DETAIL 'A'

SCALE 1 : 50



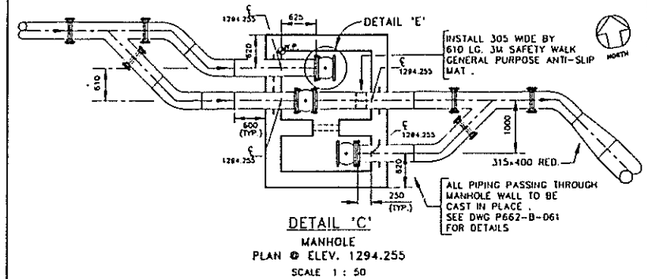
DETAIL 'B'

PRECAST CONCRETE ANCHOR BLOCKS @ 6 m c/c

SCALE 1 : 20

ANCHOR BOLT DETAIL

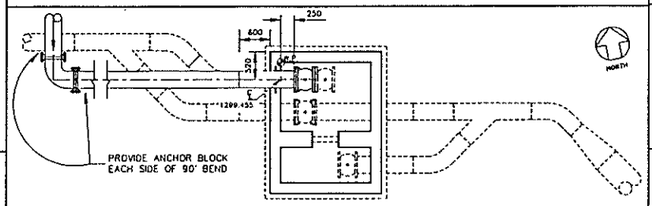
(GALVANIZED)



DETAIL 'C'

MANHOLE
PLAN @ ELEV. 1294.255

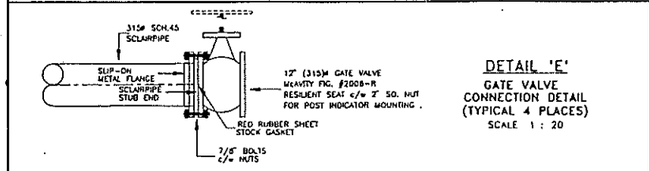
SCALE 1 : 50



DETAIL 'D'

MANHOLE
PLAN @ ELEV. 1299.455

SCALE 1 : 50



DETAIL 'E'

GATE VALVE CONNECTION DETAIL (TYPICAL 4 PLACES)

SCALE 1 : 20

NOTES :

- ALL SCLAIRPIPE TO BE FUSION WELDED EXCEPT WHERE INDICATED OTHERWISE.
- AT COMPLETION OF COMPACTION OF LOW PERMEABILITY LAYER IN BASE AND SIDES OF POND, SURFACE SHALL BE INSPECTED BY GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF ANY FILL OR COVERING MATERIAL.
- INSPECTED LOW PERMEABILITY LAYER SHALL BE PROTECTED FROM TRAVEL BY WHEELED OR TRACKED EQUIPMENT.
- SPREADING OPERATIONS OF GRANULAR FILTER IN BASE OF POND SHALL BE CONDUCTED TO PREVENT DIRECT VEHICULAR TRAFFIC ON LOW PERMEABILITY LINER.

REVISIONS

NO	DATE	APP'D	DESCRIPTION
P	88/07/04	PwC	PRELIMINARY
P1	90/01/25	AJB	FOR APPROVALS
0	90/02/02	PwC	ISSUED FOR CONSTRUCTION
1	90/02/06		REVISED NOTE #1 & #2
2	90/04/03	[illegible]	REVISED AS NOTED
3	92/12/14	[illegible]	AS BUILT

P662-B-063	EFFLUENT PIPING
P662-B-061	SLUDGE POND MANHOLE
P662-B-050	PLOT PLAN

REFERENCE

ISSUE

3 AS-BUILT REPORT

Cominco Engineering Services Ltd.

VANCOUVER – TRAIL – CALGARY
SASKATOON

DRAWN BY	AB
CHECKED BY	PwC
DESIGNED BY	PwC / AJB

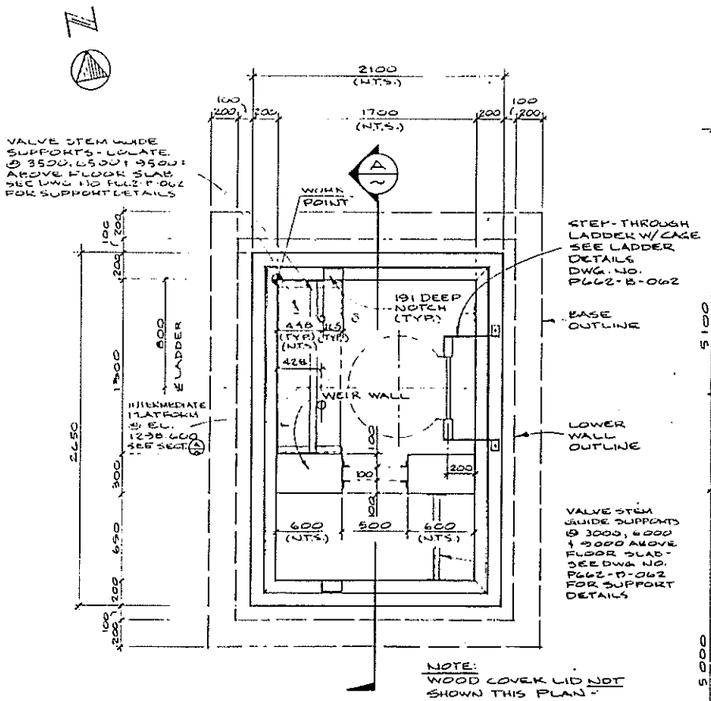
SCALE AS NOTED

TITLE
CURRAGH RESOURCES
GRUM/VANGORDA WATER TREATMENT
SLUDGE SETTLING POND

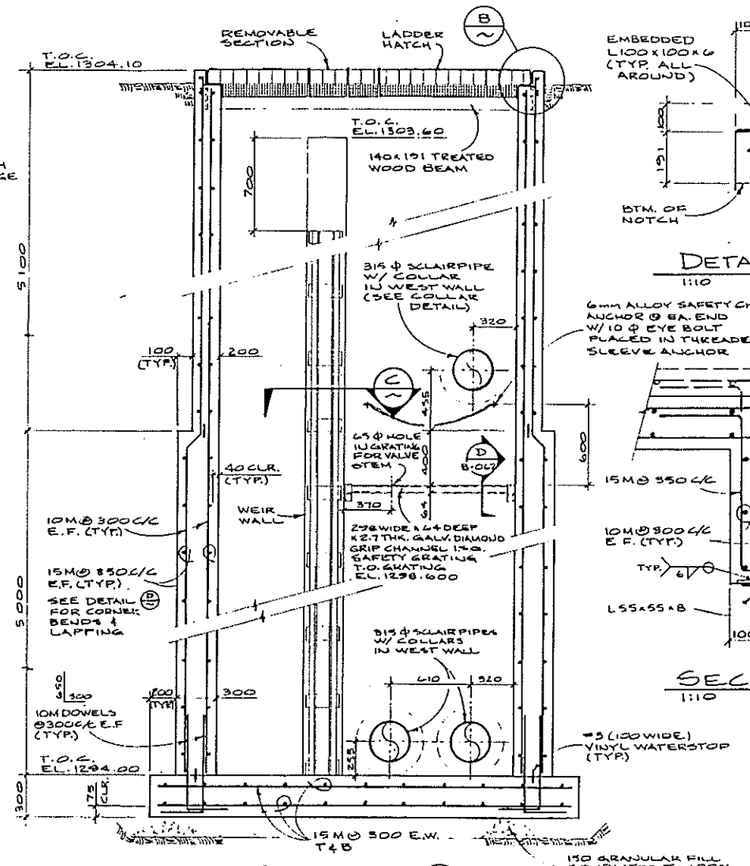
DRAWING NO. P662-B-060

REV. 3

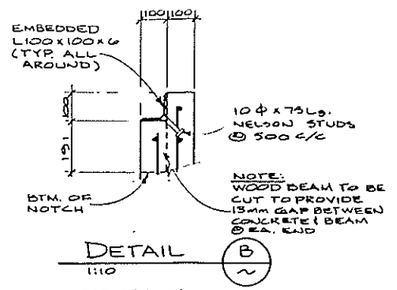
P662B060 - MAR 30, 1990 - 15:16



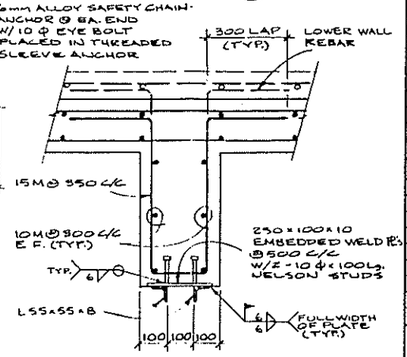
PLAN
1:20



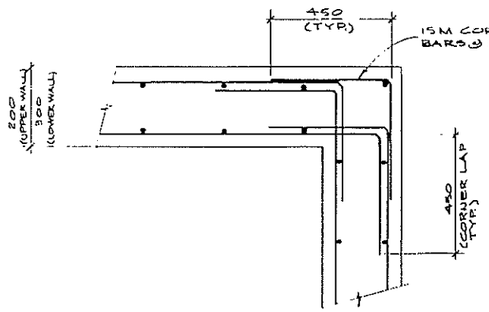
SECTION (A)
1:20



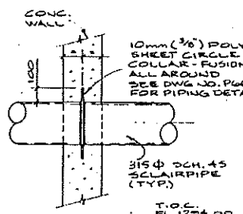
DETAIL (B)
1:10



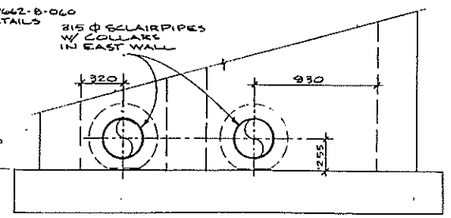
SECTION (C)
1:10



TYP. CORNER DETAIL (D)
1:10



PIPE COLLAR DETAIL



EXTERIOR ELEVATION - BTM. OF EAST WALL
1:20

NOTES:

1. ALL EXPOSED & EMBEDDED STEEL, EXCLUDING REINFORCING STEEL, TO BE HOT DIPPED GALVANIZED IN ACCORDANCE WITH C.S.A. G164 LATEST EDITION. MINIMUM MASS OF ZINC COATING SHALL BE 610g/m² FOR STRUCTURAL SECTIONS. HOT DIPPED GALVANIZED STEEL SHALL COMPLY WITH A123 LATEST REVISIONS & AMENDMENTS RECOMMENDED PRACTICE FOR SAFEGUARDING AGAINST EMBRITTLEMENT OF HOT DIPPED GALVANIZED STRUCTURAL STEELWORK & PROCEDURE FOR DETECTING EMBRITTLEMENT.
2. ALL FIELD WELDS TO BE PAINTED WITH A MINIMUM OF 2 COATS (6 mils) OF CARBOLINE GALVANOX TYPE I, OR APPROVED EQUAL, TO PRESERVE GALVANIZED FINISH OF ALL GALVANIZED STEEL.

REVISIONS

NO.	DATE	APP'D	DESCRIPTION
0	00.01.05	AF	ISSUED FOR CONSTRUCTION
1	02.11.11	TOL	AS BUILT

P662-B-062 SLUDGE POND MANHOLE DETAILS
P662-B-060 SLUDGE SETTLING POND

REFERENCE

ISSUE

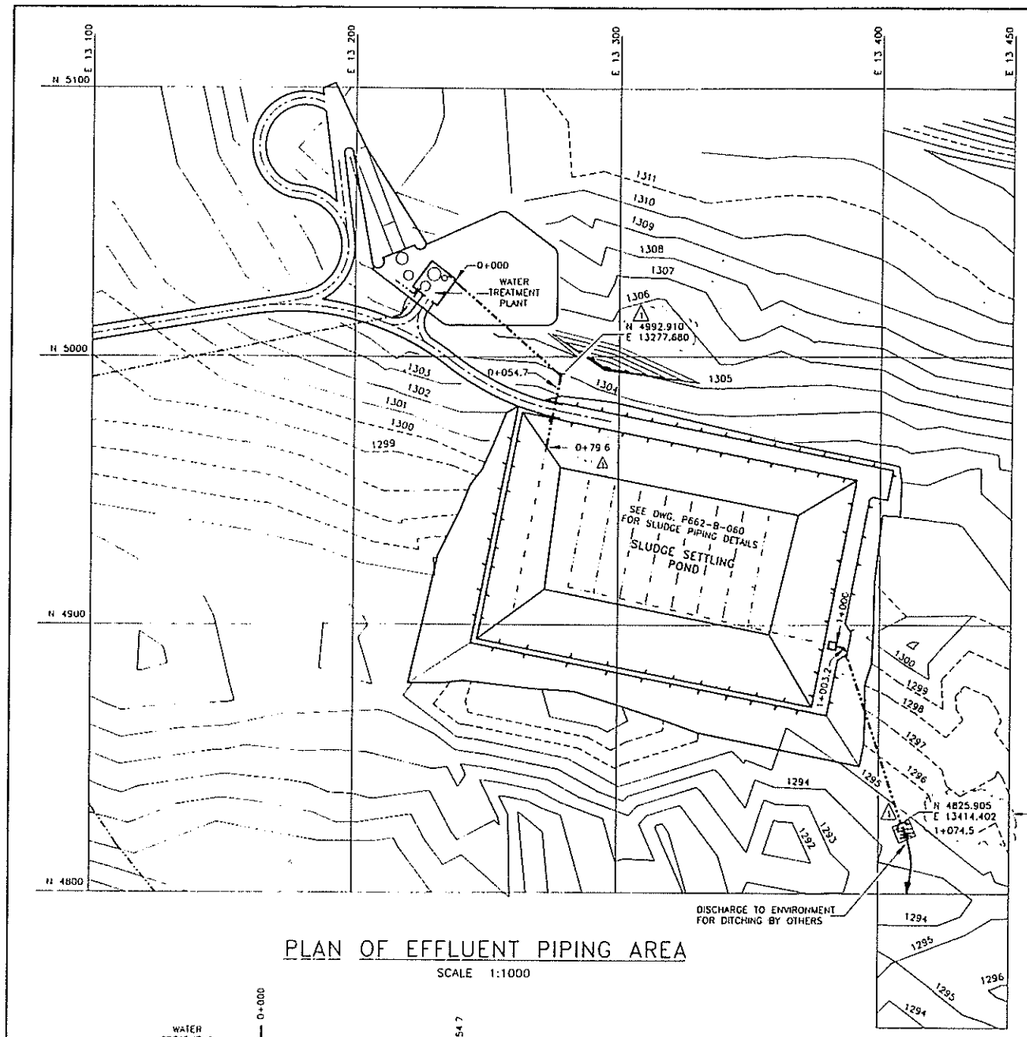
1 AS-BUILT REPORT

Cominco Engineering Services Ltd.
VANCOUVER - TRAIL
CALGARY - SASKATOON

DRAWN BY	AAF	00.01.15
CHECKED BY		
DESIGNED BY	A J BARR	00/02/02
SCALE	AS NOTED	

TITLE
CURRAGH RESOURCES
GRUM/VANGORDA WATER TREATMENT
SLUDGE POND MANHOLE

DRAWING NO.	REV.
P662-B-061	1



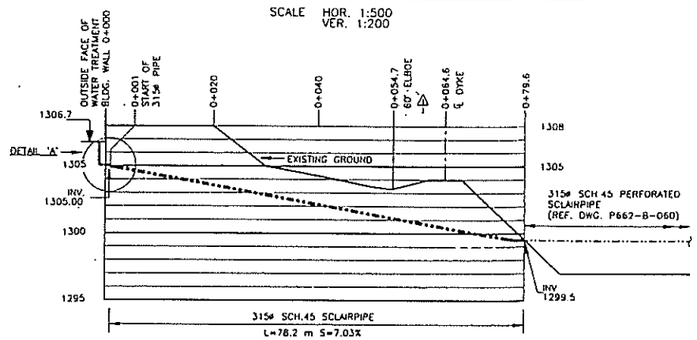
PLAN OF EFFLUENT PIPING AREA

SCALE 1:1000

NORTH

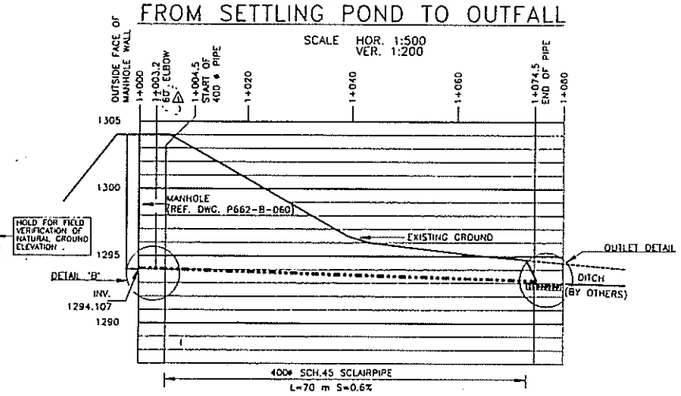
PROFILE ALONG ℄ OF PIPELINE FROM TREATMENT PLANT TO SETTLING POND

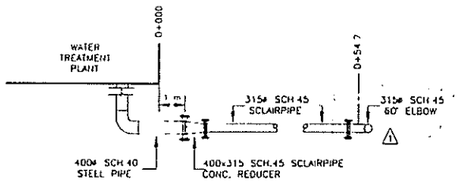
SCALE HOR. 1:500
VER. 1:200



PROFILE ALONG ℄ OF PIPELINE FROM SETTLING POND TO OUTFALL

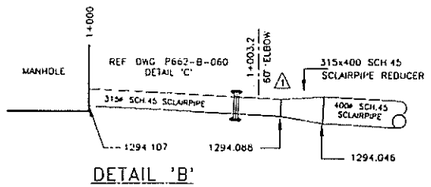
SCALE HOR. 1:500
VER. 1:200





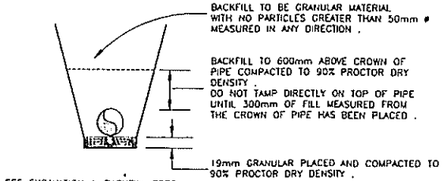
DETAIL 'A' TIE-IN AT TREATMENT PLANT

SCALE 1:50



DETAIL 'B' INVERTS AT MANHOLE

SCALE 1:50



SEE EXCAVATION & BACKFILL SPEC. B-200, PIPE BACKFILL FOR GRADATION REQUIREMENTS.

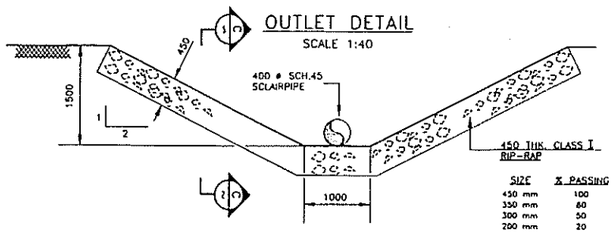
NOTE:
FULL DEPTH OF BACKFILL BELOW ROADWAYS AND SLUDGE POND BERMS TO BE COMPACTED TO 95% PROCTOR DRY DENSITY AT OPTIMUM MOISTURE CONTENT ± 2%.

TYPICAL PIPE EXCAVATION

N.T.S.

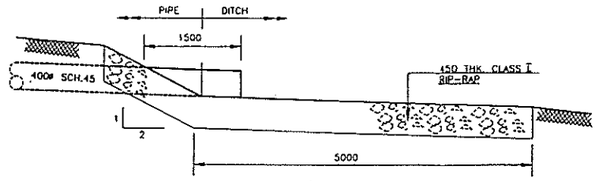
OUTLET DETAIL

SCALE 1:40



SECTION C-C

SCALE 1:40



REVISIONS			
NO.	DATE	APP'D	DESCRIPTION
P	90/01/30	PMC	PRELIMINARY
0	90/02/02	PMC	ISSUED FOR CONSTRUCTION
1	90/03/05		REVISED EFFLUNT DITCH
2	90/04/19	PMC	AS BUILT

P662-B-061	SLUDGE POND MANHOLE
P662-B-060	SLUDGE SETTLING POND
P662-B-050	PLOT PLAN

REFERENCE

ISSUE

⚠ AS-BUILT REPORT

Cominco Engineering Services Ltd.

VANCOUVER – TRAIL
CALGARY – SASKATOON

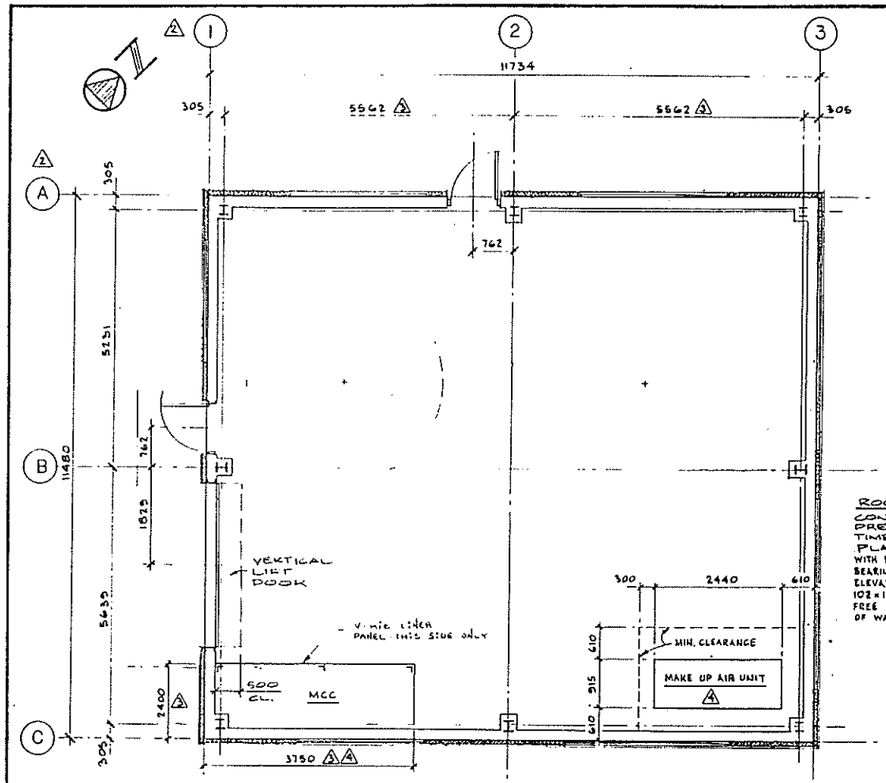
DRAWN BY AB
CHECKED BY PMC
DESIGNED BY AJB

SCALE AS NOTED

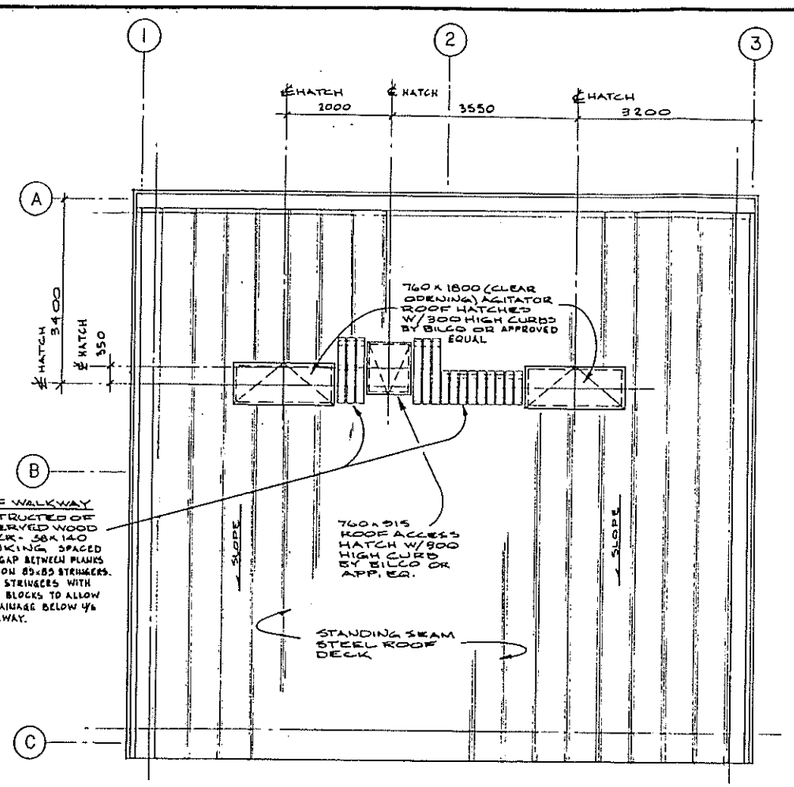
TITLE
CURRAGH RESOURCES
GRUM/VANGORDA WATER TREATMENT
EFFLUENT PIPING PLAN & PROFILE

DRAWING NO. P662-B-063
REV. 2

P662B063 - MAR 07, 1990 - 11:34

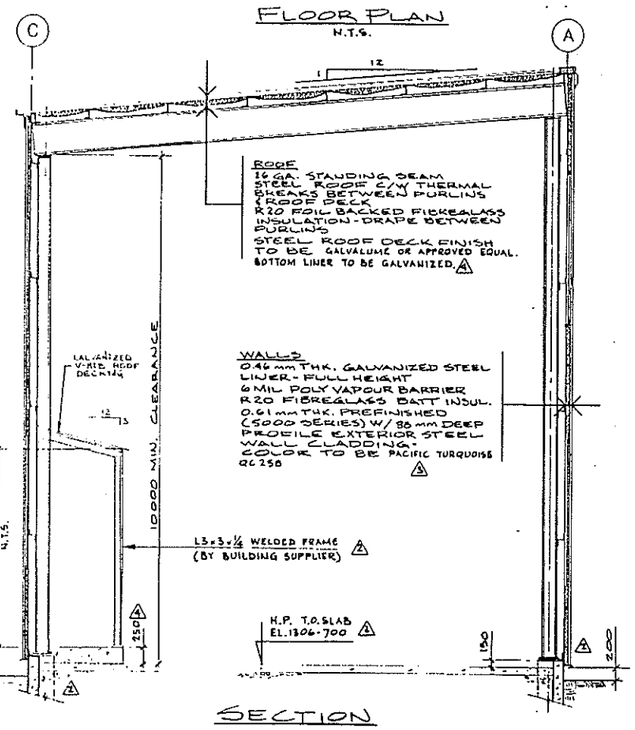


FLOOR PLAN
N.T.S.

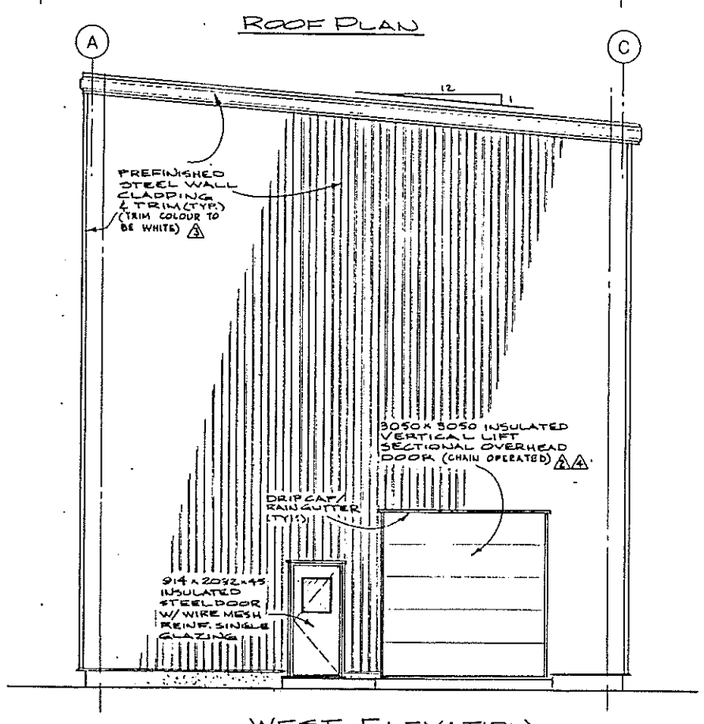


ROOF WALKWAY
CONSTRUCTED OF PRESERVED WOOD TIMBER - 38x140 PLANKING, SPACED WITH 13 GAP BETWEEN PLANKS BEARING ON 89x89 STRINGERS. ELEVATE STRINGERS WITH 102x102 BLOCKS TO ALLOW FREE DRAINAGE BELOW 4/5 OF WALKWAY.

ROOF PLAN



SECTION



WEST ELEVATION

REVISIONS			
NO	DATE	APPD	DESCRIPTION
P	[illegible]	[illegible]	ISSUED FOR TENDER
0	[illegible]	[illegible]	ISSUED FOR CONSTRUCTION
1	99/07/14	EEP	SUPERSEDED
2	99/12/21	EEP	GRADE BEAMS, GRID LINES, & DWG. Nº REV'D.
3	00/04/4	EEP	FLR. PLAN REV'D AS NOTED COLOURS ADDED TO SECT. & ELEV.
4	00/11/20	KAR	MCC DIM REV'D.; MAKE UP AIR UNIT ADDED; GEN. REVS.
5	01/06/01	TJC	AS BUILT

REFERENCE

ISSUE

A AS-BUILT SUPPLY

Cominco Engineering Services Ltd.

VANCOUVER — TRAIL — CALGARY

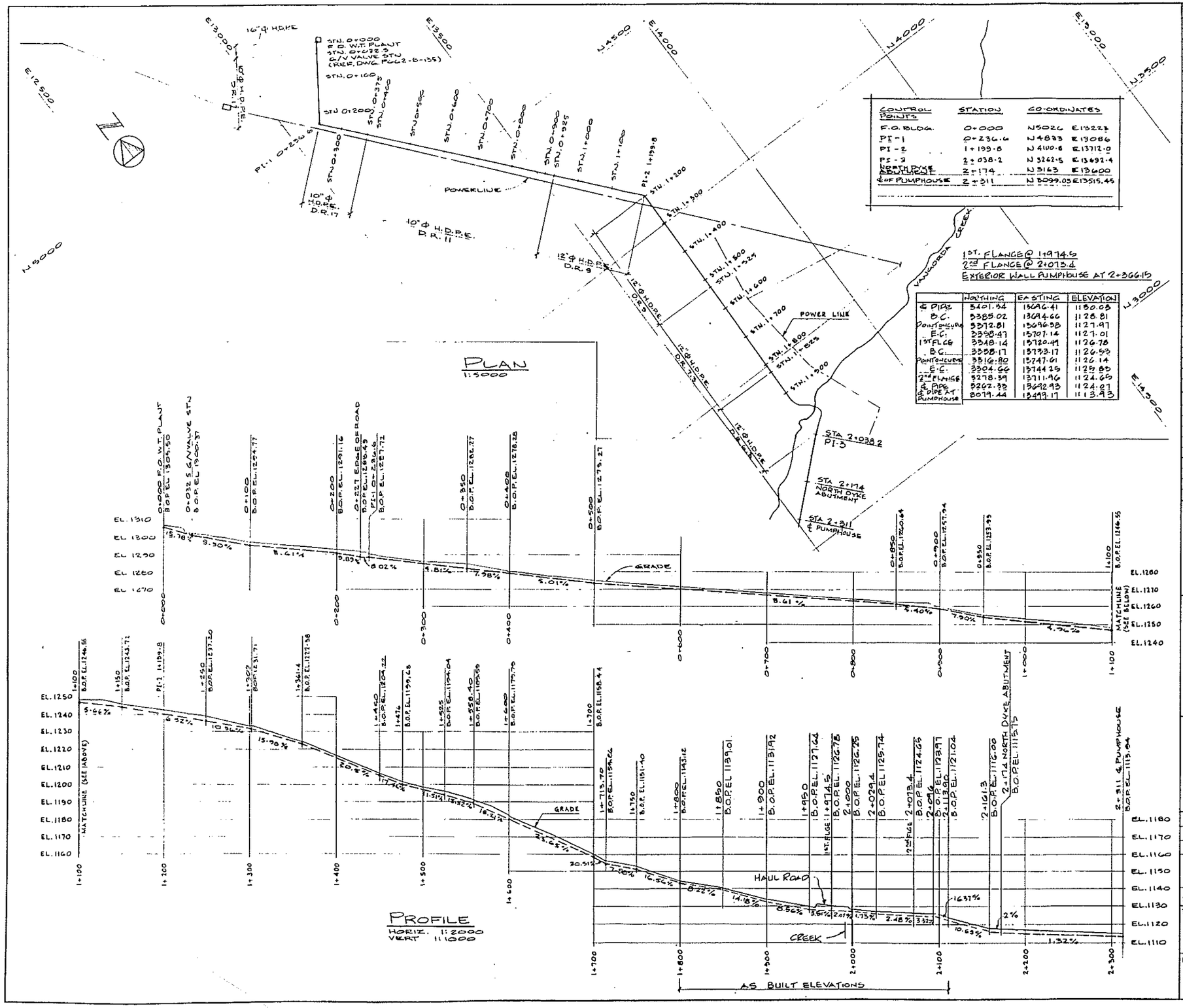
DRAWN BY	MAF	06/89
CHECKED BY		
DESIGNED BY	PMC.	06/01

SCALE 1:50 U.N.O.

TITLE
CURRAGH RESOURCES INC.
GRUM/VANDORA WATER TREATMENT
WATER TREATMENT BUILDING

DRAWING NO. P662-B-102 A

REV. 5



CONTROL POINTS	STATION	CO-ORDINATES	
F.O. BLDG.	0+000	N5026	E13223
PI-1	0+236.6	N4833	E13086
PI-2	1+199.8	N4100.8	E13712.0
PI-3	2+038.2	N3262.5	E13692.4
NORTH DYKE ABUTMENT	2+174	N3163	E13600
Φ OF PUMPHOUSE	2+311	N3099.05	E13515.45

	NORTHING	EASTING	ELEVATION
Φ PIPE	5401.54	13696.41	1150.05
B.C.	5385.02	13694.66	1128.81
POINT OF CURVE	5372.81	13696.58	1127.97
E.C.	5358.47	13707.14	1127.01
1ST FLGE	5348.14	13720.49	1126.78
B.C.	5338.17	13733.17	1126.53
POINT OF CURVE	5316.80	13747.01	1126.14
E.C.	5304.66	13744.25	1129.85
2ND FLANGE	5278.39	13711.96	1124.65
Φ PIPE AT PUMPHOUSE	5262.33	13692.93	1124.07
	5019.44	13499.17	1113.93

REVISIONS			
NO.	DATE	APP'D	DESCRIPTION
0	06/10	KY	ISSUED FOR CONSTRUCTION
1	06/07	JS	ALIGNMENT/PROFILE REVISED
2	08/21	JS	DYKE ADDED
3	OCT 25/11	KY	AS BUILT IN FIELD.

PGL2-B-135 VANGORDA PUMPHOUSE
PGL2-B-134 G/V VALVE STATION

REFERENCE ISSUE
CURRAGH - DKM, JRB'
VANC. - TDL' WWWC' KS', JMC'
CALG. - AJD'
Δ AS-BUILT & PART

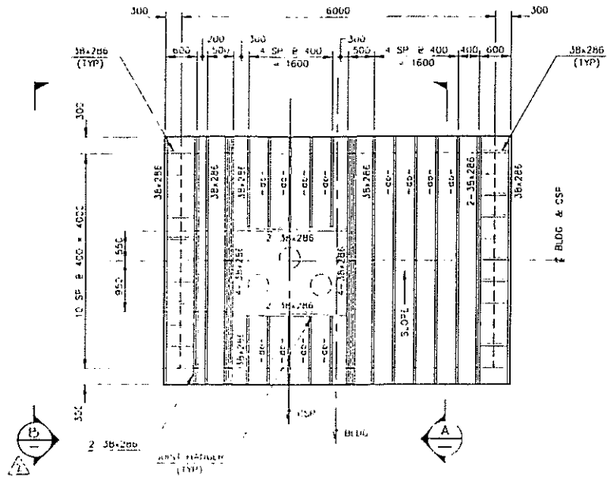
Cornico Engineering Services Ltd.
VANCOUVER - TRAIL
CALGARY - SASKATOON

DRAWN BY	AAF	30.06
CHECKED BY	D VINISH	JUNE 15 '06
DESIGNED BY	A J BARR	JUN/06

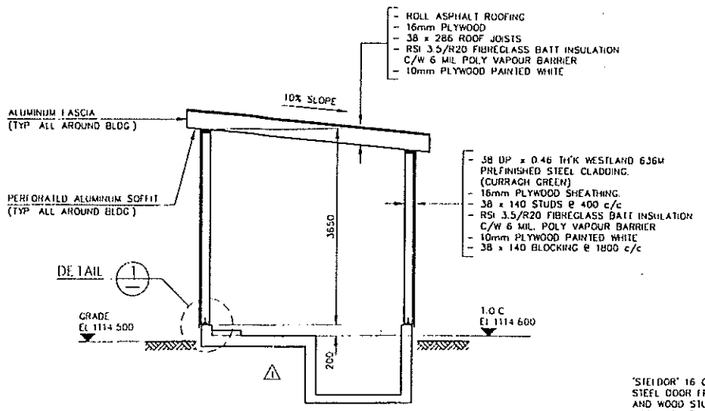
SCALE AS NOTED

TITLE
CURRAGH RESOURCES INC.
VANGORDA DEWATERING PROJECT
W.T. PLANT TO VANGORDA SUMP
PLAN & PROFILE

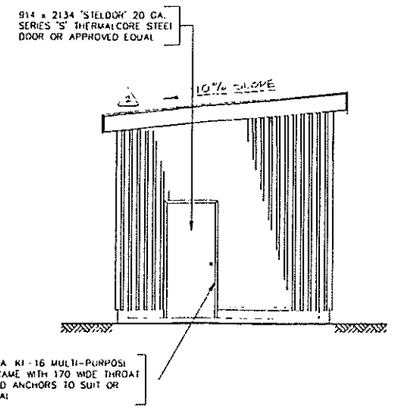
DRAWING NO.	REV.
P662-B-130	3



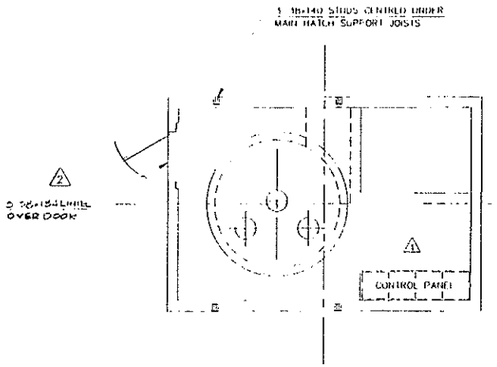
ROOF FRAMING PLAN



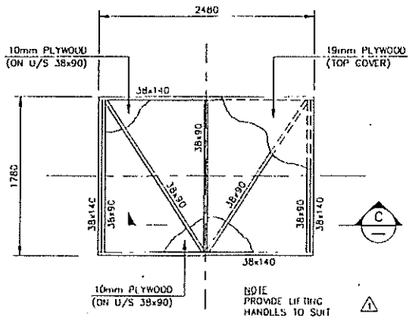
SECTION A



ELEVATION B

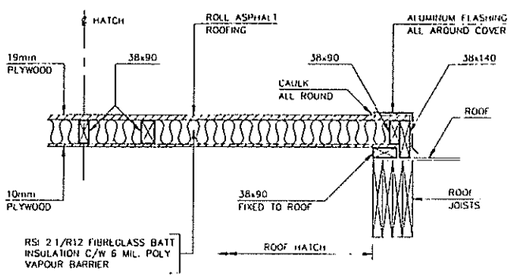


FLOOR PLAN



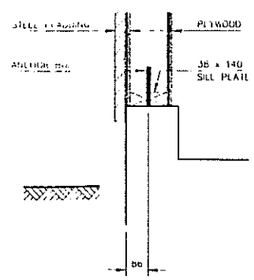
PLAN – HATCH COVER

SCALE = 1:30



SECTION C

SCALE = 1:10



DETAIL 1

SCALE = 1:10

P662B136 - 21 AUGUST 1990 - (1=50)

REVISIONS

NO	DATE	APP'D	DESCRIPTION
P			PRELIMINARY
P1			PRELIMINARY
0	90 8 13	AJB	ISSUED FOR CONSTRUCTION
1	90 8 21	AJB	REVISED AS NOTED
2	90 09	JOL	AS BUILT

REFERENCE

ISSUE

	VANC TDI¹, KS¹, MJL¹, JMC¹
	CALG AJB¹
	FARO DKM¹, JHG¹
2	AS BUILT REPORT

Cominco Engineering Services Ltd

VANCOUVER – TRAIL
CALGARY - SASKATOON

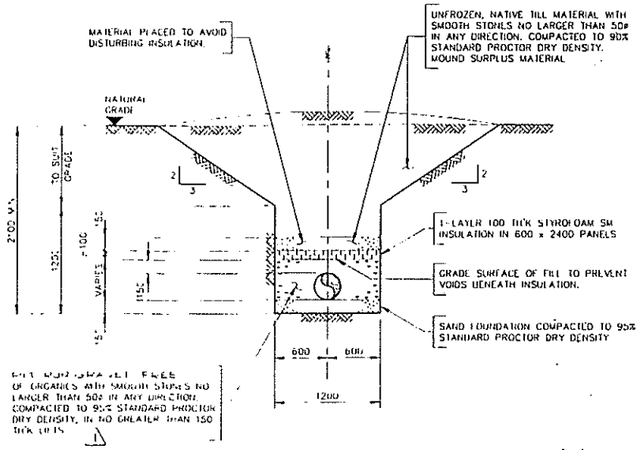
DRAWN BY	BL	90 07 26
CHECKED BY	AJB	90 08 13
DESIGNED BY	AJB	JULY 1990

SCALE 1:50 U.N.O

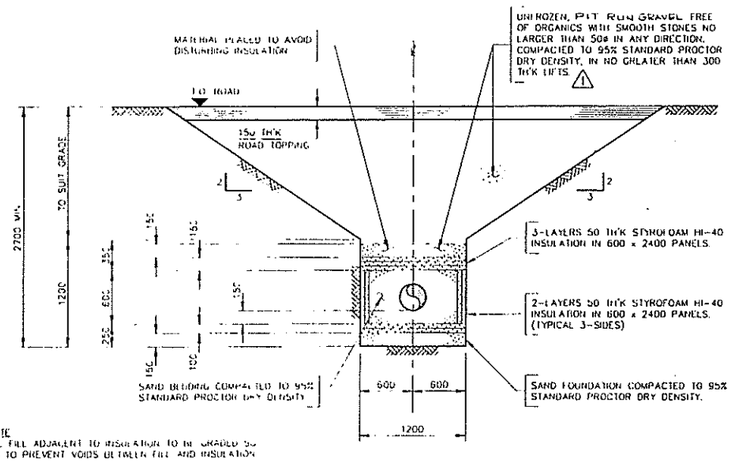
TITLE
CURRAGH RESOURCES INC.
VANGORDA DEWATERING PROJECT
SUMP WELL / PUMPHOUSE
BUILDING DETAILS

DRAWING NO P662-B-136

REV. 2

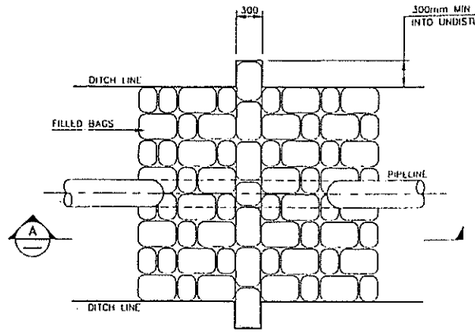


TYPICAL SECTION THROUGH PIPE TRENCH



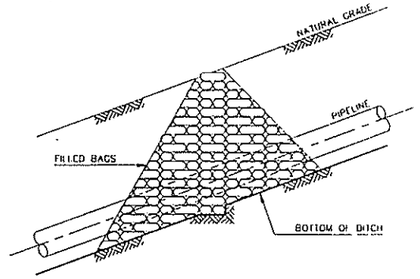
NOTE
ALL FILL ADJACENT TO INSULATION TO BE GRADED SO AS TO PREVENT VOIDS BETWEEN FILL AND INSULATION

TYPICAL SECTION THROUGH ROAD CROSSING



PLAN – TYPICAL DITCH PLUG DETAIL

NTS



SECTION A

NTS

NOTES

1. THE FREQUENCY AND PRECISE LOCATION OF THE PLUGS IS TO BE ESTABLISHED IN THE FIELD BY THE AUTHORIZED PIPELINE INSPECTOR, UNLESS OTHERWISE SPECIFIED ON THE LINE DRAWINGS.
2. PLUGS TO BE INSTALLED IN LOCATIONS WHERE IT IS POSSIBLE THAT THE BACKFILL IN THE PIPELINE DITCH COULD BECOME UNSTABLE
3. BAGS TO BE MADE OF A NON-DEGRADABLE MATERIAL AND FILLED WITH MINERAL SOIL - THEN TIED TOGETHER IN SUCH A WAY AS TO PRODUCE MAXIMUM DITCH BACKFILL STABILITY

* = THAT MATERIAL (CLAY, SAND, SILT, TILL) BELOW THE ORGANIC TOPSOIL

REVISIONS

NO	DATE	APP'D	DESCRIPTION
P			PRELIMINARY
0	90.8.13	AJB	ISSUED FOR CONSTRUCTION
1	2nd [illegible]	TPL	AS BUILT

REFERENCE

ISSUE	
1	AS-BUILT REPORT

Cominco Engineering Services Ltd

VANCOUVER - TRAIL
CALGARY - SASKATOON

DRAWN BY	BL	90.08.3
CHECKED BY	AJB	90.08.13
DESIGNED BY	AJB	AUGUST '90

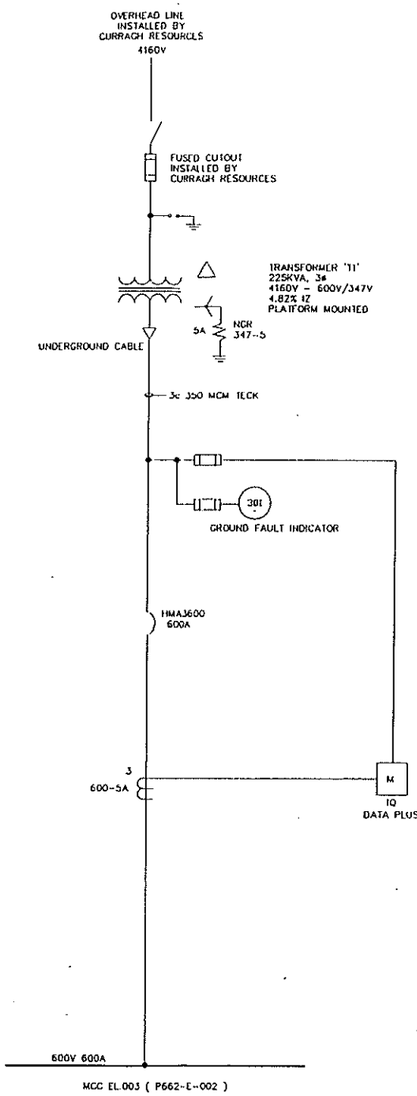
SCALE 1:30 U.N.O.

TITLE
CURRAGH RESOURCES INC.
VANGORDA DEWATERING PROJECT
PIPELINE DETAILS

DRAWING NO. P662-B-139

REV. 1

P662B139 - 13 AUGUST 1990 - (1=1C



LEGEND

IQ DATA PLUS WILL METER THE FOLLOWING FUNCTIONS

- AC VOLTAGE
- AC AMPS
- POWER FACTOR
- KW
- Kvars
- FREQUENCY
- KWH METER
- KW DEMAND

LIGHTNING ARRESTER

FUSE

3
600-5A — CURRENT TRANSFORMER (3)

NGR 347-5 — NEUTRAL GROUND RESISTOR

HMA3600 600A — CIRCUIT BREAKER

CAD FILE NAME: P662E001

LAST UPDATE: 93/08/18

REVISIONS

NO.	DATE	APP'D	DESCRIPTION
P1		SVEC	FOR COMMENTS
0	89/09/18	SVEC	FOR CONSTRUCTION
1	90/02/28	SVEC	MCC INDICATING CIRCUIT ADDED
2	90/08/27	MJL	AS BUILT

P662-E-002 MCC#003 BLOCK DIAGRAM

REFERENCE

ISSUE

P1	IDL, JC, LRDM, MJL [2]
0	IDL, JC, LRDM, MJL [2] WMHC, SVEC, FILE
1	AS ABOVE

Cominco Engineering Services Ltd

VANCOUVER - TRAIL - CALGARY

DRAWN BY FMB			89/06/21
CHECKED BY SVEC			89/09/18
DESIGNED BY JJO			89/06/21
MJL 19/9/89			

SCALE N.T.S.

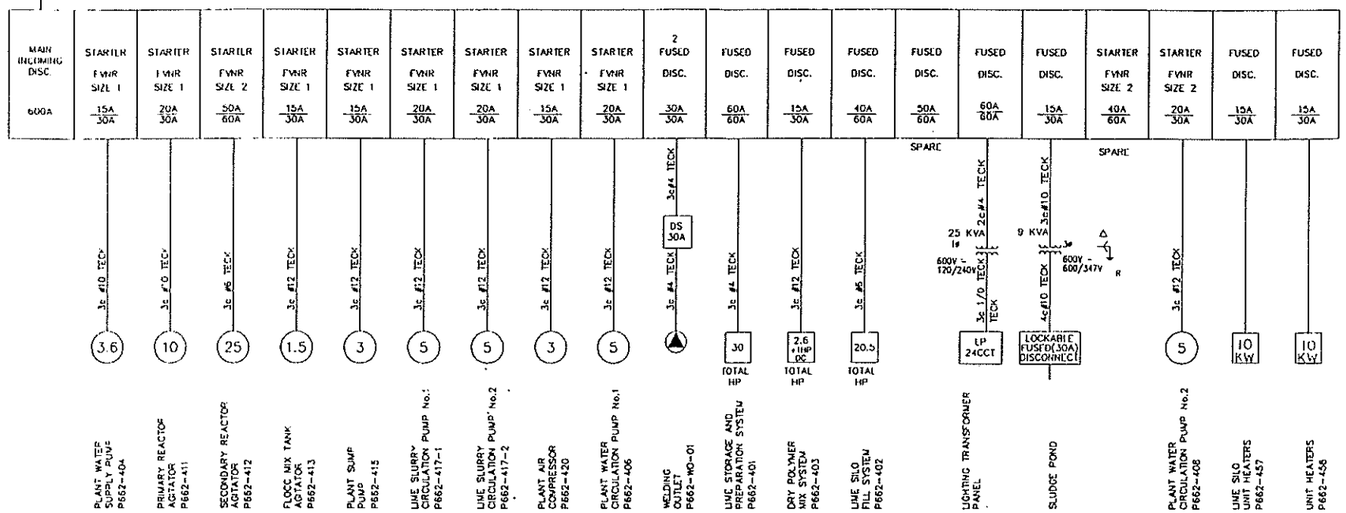
TITLE
CURRAGH RESOURCES INC.
GRUM/VANGORDA
WATER TREATMENT PLANT
SINGLE LINE DIAGRAM

DRAWING NO.	REV.
P662-E-001	2

FROM 4160V – 600V, 225KVA
PLATFORM MOUNTED TRANSFORMER

3c 350 MCM TECK

MCC EL 003, 600V, 3 PHASE, 600A, PRODUCTION AREA



ESTIMATED CONNECTED LOAD
MCC EL 003
HP : 140
KVA(1ø): 25
KVA(3ø): 9
Kw(3ø): X

NOTE: WELDING OUTLETS HAVE NOT BEEN CALCULATED IN THE ABOVE FIGURES.

LEGEND:

FVNR	FULL VOLTAGE NON-REVERSING
RVNR	REDUCE VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
DS	DISCONNECT SWITCH
FDS	FUSED DISCONNECT SWITCH
JB	JUNCTION BOX
80A / 100A	FUSE SIZE (CONTACTORS AND FUSED DISC.–HRC FORM 1J, STARTERS–HRC FORM 11C) / MAXIMUM FUSE CLIP RATING
mmC	DENOTES CONDUIT NOMINAL DIAMETER
(ESI)	ESTIMATE–ON HOLD PENDING EQUIPMENT PURCHASE ORDER

NOTES:

1. • DENOTES TERMINALS ON STARTER/CONTACTOR INTERNALLY WIRED TO MASTER TERMINAL BLOCK SECTION (REFER TO LOOP SHEETS)
2. ALL MOTORS DENOTED IN HORSEPOWER.
3. ALL CABLES SHOWN ARE OF TECK CONSTRUCTION, UNLESS OTHERWISE NOTED.
4. ALL FEEDERS ARE SIZED BASED ON RANDOM FILL EXCEPT 75 HP AND GREATER & THOSE CABLES MARKED 'SPACED' WHICH ARE BASED ON GREATER THAN 100% OF LARGEST CABLE DIAMETER MAINTAINED AIR SPACE.
5. FIELD DEVICES INCLUDE P/B STATIONS, LIMIT SWITCHES, EMERGENCY PULL CORDS, SPEED SWITCHES, LEVEL SWITCHES, ETC.

REVISIONS

NO.	DATE	APP'D	DESCRIPTION
P1			FOR COMMENTS
0	89/08/17	SVEC	FOR CONSTRUCTION
1			ROADWAY TRANSFORMER ADDED
2	89/08/17	MJL	AS BUILT
3	89/09/19	MJL	AS BUILT

P662-E-001 SINGLE LINE DIAGRAM
REFERENCE

ISSUE

P1	TDL, JC, ERBM, MJL[2]
0	TDL, JC, ERBM, MJL[2], WMIC, SVEC, FILE
1	DFAV, MJL[2], JGM, JMC, WJK, JFB[2]
	TDL(STICK FILE), CONTRACTOR[6]
2	VANCOUVER: TDL, KS, MJL
	CALGARY: AJD
	FARO: DKM[3], JRD
3	MJL, TDL, WJK, CLIENT[4]

Cominco Engineering Services Ltd.

VANCOUVER – TRAIL – CALGARY

DRAWN BY	FMB	89/06/14
CHECKED BY	SVEC	17/08/089
DESIGNED BY	JJO	89/06/08
MJL 19/09/89		

SCALE NTS

TITLE
CURRAGH RESOURCES INC.
GRUM/VANGORDA
WATER TREATMENT PLANT
MCC BLOCK DIAGRAM

DRAWING NO. P662-E-002
REV. 3

P662E002 89/08/08

INCOMING CABLING
BY CURRAGH RESOURCES

MCC EL 011, 600V, 3 PHASE, 60Hz

800A, 65000A BUS

MAIN INCOMING CB	STARTER FVNR SIZE 5	STARTER FVNR SIZE 4	STARTER FVNR SIZE 4	STARTER FVNR SIZE 2	STARTER FVNR SIZE 2	FUSED DISC	FUSED DISC.	FUSED DISC.	FUSED DISC.	FUSED DISC.	FUSED DISC.
800A	250A / 400A	100A / 200A	100A / 200A			30A / 30A	15A / 30A	15A / 30A	35A / 60A	60A / 60A	30A / 30A
	3c#2/0 TECK (SPACED)	3c#1 TECK	3c#1 TECK				3c#10 TECK	3c#10 TECK	2c#8 TECK + 8 15 KVA 1Ø 600V - 120/240V 3c#2 TECK		
	(125)	(50)	(50)				10 kW	10 kW	LP 24CCI		
	PUMP #3 ⚠1	PUMP #2	PUMP #1 ⚠1	SPARE	SPARE	SPARE	HEATER & BLOWER	HEATER & BLOWER		SPARE	SPARE

1.) ESTIMATED CONNECTED LOAD MCC EL 011

HP:	225
kVA (1ø):	15
kVA (3ø):	N/A
kW (3ø):	20

2.) LEGEND:

FVNR	FULL VOLTAGE NON-REVERSING
RVNR	REDUCE VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
DS	DISCONNECT SWITCH
FDS	FUSED DISCONNECT SWITCH
JB	JUNCTION BOX
80A	FUSE SIZE (CONTACTORS AND FUSED DISC 1)
100A	STARTERS-HRC FORM IIC) MAXIMUM FUSE CLIP RATING

3.) NOTES

1.) ALL MOTORS DENOTED IN HORSEPOWER

2.) ALL CABLES SHOWN ARE OF TECK CONSTRUCTION, UNLES OTHERWISE NOTED.

3.) ALL FEEDERS ARE SIZED BASED ON RANDOM FILL EXCEPT 75HP AND GREATER & THOSE CABLES MARKED "SPACED" WHICH ARE BASED ON GREATER THAN 100% OF LARGEST CABLE DIAMETER MAINTAINED AIR SPACE.

4.) FIELD DEVICES INCLUDE P/B STATIONS, LEVEL SWITCHES, EMERGENCY PULL STATIONS, E.T.C..

CAD FILE NAME: P662E31 LAST UPDATE: 91/04/17

REVISIONS

NO.	DATE	APP'D	DESCRIPTION
0	90/08/09		ISSUED FOR CONSTRUCTION
1	91/04/17	MJL	AS BUILT

DWG. 060208700 - WESTINGHOUSE
REFERENCE

ISSUE	
0	VANC.: TDL, KS, MJL
	CALG.: AJB
	FARO : DKM*, JRB
1	TDL, MJL, CLIENT *

Cominco Engineering Services Ltd.

VANCOUVER - TRAIL
CALGARY - SASKATOON

DRAWN BY MJL			90/08/09
CHECKED BY .			.
DESIGNED BY JJO			90/08/08
MJL			

SCALE N.T.S.

TITLE

CURRAGH RESOURCES INC.
VANGORDA DEWATERING PROJECT
MCC BLOCK DIAGRAM

DRAWING NO.	REV.
P662-E-031	1