



A.F.E.

Faro Abandonment Plan Development Program

Introduction:

As a requirement under the water license, granted by the Yukon Water Board, which formed part of the closing documents between Curragh Resources and the Governments of Canada and the Yukon, Curragh Resources was required to submit an abandonment plan for the tailings and mine site abandonment to the Yukon Water Board by December 31, 1986.

Curragh Resources was unable to meet this deadline and asked the Yukon Water Board, prior to December 31, 1986, to consider an extension of the deadline to September, 1991. The reason for requesting the extension was to allow Curragh Resources to technically and economically evaluate, in particular, the complex problem of long-term abandonment of the tailings.

The technical data existing at the time, which forms the basis of determining the long-term problems, especially the generation of acid caused by the oxidation of sulphide minerals in the tailings, was found by Curragh Resources during 1986 to be deficient. On the advice of a specialist, Dr. A.M. Robertson of Steffen Robertson Kirsten (B.C.) Ltd., Curragh Resources proposed to the Yukon Water Board to conduct a technical investigation over the next four years whereby sufficient data would be gathered to allow a more precise definition of the long-term problem and therefore an acceptable solution. The four year period was predicated on technical, not financial, matters.

Without this proper data and evaluation, it was felt that the Yukon Water Board would demand an abandonment design for the tailings which could be extremely expensive and even beyond the financial capabilities of Curragh Resources; or, and possibly in addition to the foregoing, the Yukon Water Board could demand the establishment of a large and even economically onerous sinking fund to provide monies for abandonment. Curragh Resources wished to avoid both of these possible requirements until a more precise definition of the problem was completed.

In response to the request for a four year extension, the Yukon Water Board has requested that Curragh submit by October 1, 1987, those aspects of the abandonment plan that can be prepared now. Thus, in addition to the tailings abandonment plan, Curragh must provide the following by October 1:

- abandonment plan for the Faro pit and waste dumps including the North Fork Causeway
- interim abandonment plan for the long term stabilization of the Rose Creek Diversion and tailings impoundments.

This AFE covers the development of a long range abandonment plan for the tailings only. In addition this AFE requests 1987 monies

only. AFE's for future years will be generated as required, based on more accurate estimates.

Please refer to "REPORT 60602, Faro Mine Tailings, Tailings Abandonment Plan Development Program" dated January, 1987, by Steffen Robertson and Kristen (B.C.) Ltd. and revisions thereto for detailed information. The "Executive Summary" of this report is attached as Appendix I for reference.

### Problem:

The two primary concerns expressed related to the long term abandonment of the tailings include: (1) the generation of sulphuric acid and solutions containing high metal contents which would be released to water courses and affect the quantity and quality of aquatic wildlife, particularly fish; and (2) the erosion of tailings into water courses.

The range of abandonment options for the tailings pond reflect implementation costs of \$5 to \$70 million. In addition, there is insufficient evidence available to demonstrate that any option will perform satisfactory over the long term. The problem is to develop the lowest cost abandonment plan for the tailings pond that can be demonstrated to the Yukon Water Board to protect long term water quality.

Unless Curragh Resources can either present an acceptable abandonment plan now or outline a program to develop a plan, it faces the possibility of: having its water license cancelled; having the imposition of another onerous abandonment plan; or having a requirement for a multi-million dollar abandonment measures security deposit. All of these possibilities would be extremely detrimental to continued successful operation.

### Solution:

It is proposed to conduct a four year abandonment plan development program which has been developed in consultation with all appropriate regulatory agencies and interested parties that will address all aspects of abandonment. The basis of the plan is Report 60602 by Steffen Robertson and Kirsten (BC) Ltd.

The main elements of the abandonment plan development are: the development and construction of test plots to evaluate six alternative abandonment options for the tailings (See Appendix IV); characteristics of the tailings and subsite soils; the baseline measurements of ground water and surface water; the evaluation of fisheries resources; the computer modelling of tailings behaviour; and the preparation and presentation of the abandonment plan.

It is proposed that during 1987: the test plots be completed and measurements begin; and the measurements of baseline groundwater and surface water begin. During 1988 through 1990 the following will continue: measurements of test plots results; measurements of groundwater and surface water; and measurements of fisheries resource. During 1990 and 1991 computer modelling of the tailings

behaviour and final preparation and presentation of the tailings abandonment will be completed.

It may be possible to obtain some government assistance in the form of monies and/or work during the program. This will be pursued to the fullest extent; however, it is not precisely known at this time what type of assistance is available. Any government assistance, however, will require that all data become "public domain".

#### Benefits:

The primary benefits of the proposed tailings abandonment plan development are as follows:

1. Development of the lowest cost abandonment plan that meets the Yukon Water Board's requirement;
2. Avoid the imposition of an immediate (up to) \$70 million abandonment obligation by the Yukon Water Board including an immediate substantial increase in water license security;
3. Curragh will be seen to be addressing this environmental issue in a positive and logical manner and possibly gain positive cooperation from the Yukon Water Board and other governmental regulatory agencies;
4. This approach has the greatest chance of success with respect to universal acceptance of the plan.

#### Effects of Nonexecution:

The effects of not implementing this development plan are:

1. None of the benefits will likely be realized;
2. Possible cancellation of Curragh Resources' water use license which would close the mine;
3. Imposition of an excessively high cost abandonment plan on Curragh Resources by the Yukon Water Board that could be outside Curragh's financial capabilities;
4. Requirement of Curragh Resources to post a (\$10-50 million?) security bond;
5. Curragh will save the costs outlined herein.

#### Cost:

The estimated external costs for this four year program is as follows:

1987	\$292,000
1988	133,000
1989	56,000
1990	121,000

1991 90,000  
 TOTAL \$ 692,000

The detailed breakdown of the above costs are attached as APPENDIX III. For 1987, as per Appendix II, the cost include monies for the test plots and instruments, subsoil and tailings characterization, onsite labs modification and outside labs assistance. These costs identify only costs incurred outside Curragh's existing workforce, offices, etc; costs of any work done by on-site personnel are not included here.

Cash (Expenditure) Flow (\$'000's)

1987								1988				1989	1990	1991	Total	
J	J	A	S	O	N	D	Total	Q 1	Q 2	Q 3	Q 4	Total				
82	30	174	7	0	0	0	292	0	60	43	30	133	56	121	90	692

Financial assistance is being sought from all possible sources (ie, federal and Yukon governments, universities, research institutions). It is probable that various organizations will eventually provide assistance. However, at this point the level of assistance is unknown other than that it will most likely only be available for work carried out during 1988-91.

Thus, approval is being sought for \$292,000 for 1987. One hundred thousand is available in the 1987 budget for this project (reference 6553-340).

**APPENDIX I**

**REPORT 60602**

**FARO MINE TAILINGS  
TAILINGS ABANDONMENT  
PLAN DEVELOPMENT PROGRAM**

**Prepared for:**

**CURRAGH RESOURCES  
117 Industrial Road  
Whitehorse, Yukon**

**Prepared by:**

**STEFFEN ROBERTSON & KIRSTEN (B.C.) INC.  
801 - 1030 West Georgia Street  
Vancouver, B.C. V6E 2Y3**

**January 1987**

## **EXECUTIVE SUMMARY**

This report describes a program of field testing, investigation and design for the development of an Abandonment Plan for the mill tailings at Faro mine, Yukon, which is owned and operated by Curragh Resources.

It is the objective of Curragh Resources to prepare an abandonment plan which satisfies the following objectives:

- It provides adequate protection to the environment, in particular the water quality in Rose Creek, in both the short and long term.
- Maintenance in the long term is reduced to the minimum realistically achievable with available technology and financial resources reasonably available.

The technology for the control and abatement of acid drainage is undergoing rapid development as a result of research and development in both Canada and internationally. Substantial developments are anticipated prior to implementation of abandonment measures at Faro. This Abandonment Plan Program was designed to achieve Curragh's objectives based on current technology, while maintaining flexibility for as long as possible to permit incorporation of new beneficial technology.

Primary concerns, in the development of the Abandonment Plan, are:

- (i) control of acid generation and seepage, and its impact on Rose Creek, and
- (ii) stabilization of the tailings impoundment against the long term erosion forces, particularly by Rose Creek

Considerable uncertainty exists as to the effectiveness of some of the potential acid generation control measures. These uncertainties have been reviewed and discussed in a report by Steffen, Robertson and Kirsten, 1986, who recommended that a program of large scale field testing be undertaken at Faro. The objective of this field program was to determine the effectiveness of alternative cover types in controlling acid generation in the climatic and site specific conditions at Faro.

A program consisting of four phases is proposed, as follows:

### **Phase I: Investigation and Basic Design of Abandonment Plan**

This phase will take four years and comprise:

- (i) Field test plot covers investigation program
- (ii) Baseline tailings, foundation soils, groundwater and surface water characterization program
- (iii) Modelling of acid generation and contaminant migration
- (iv) Preparation of basic design and abandonment program

Detailed descriptions of the various test programs are provided in this report. Estimated costs for this phase is \$1,072,000.

### **Phase II: Implementation of Pre-Close-Out Measures and Re-Evaluation of Abandonment Plan**

This phase extends from year five to time of close-out.

### **Phase III: Implementation of Final Abandonment Plan**

This phase follows on mine closure.

### **Phase IV: Monitoring and Maintenance**

After implementation of the final abandonment plan there will be a period of monitoring which will determine the need, if any, for continued maintenance.

The field testing and modelling, which comprises the bulk of Phase I of the Program, is of considerable interest and benefit to other members of the mining industry, as well as government departments responsible for both resource development and environmental protection. This part of the program is expected to add significantly to the understanding of acid generation control.

The cost of the proposed program is large, even if limited to the absolute minimum required to demonstrate the effectiveness of acid generation abatement measures at Faro. Securing co-sponsorship for the program will enable the program to be undertaken at a level which will considerably enhance the value of the research. It is recommended that organization with a vested interest in acid generation control be approached for such co-sponsorship.

APPENDIX II



APPENDIX III

FILE: "MARV/TAILSAB"

CURRAGH RESOURCES  
 Tailings Abandonment Plan Development  
 RE: SRK REPORT 60602  
 REVISED: 25-May-87  
 (\$'000's)

	1987							1988					1989	1990	1991	TOTAL	
	June	July	Aug	Sept	Oct	Nov	Dec	Total	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total	Total	Total		Total
<b>A) Test Plot</b>																	
- Final Design and Set-up	25	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0
- Construction	39.6	16.5	140.8616	0	0	0	0	196.9616	0	0	0	0	0	0	0	0	196.9616
- Site Lab	0	0	10	0	0	0	0	10	0	0	0	0	0	0	0	0	10
- Water Sampling	0	0	0	0	0	0	0	0	0	5	5	0	10	10	10	0	30
- Laboratory Testing	0	0	5	5	0	0	0	10	0	7.5	7.5	0	15	15	15	0	55
- Data Evaluation	0	0	0	0	0	0	0	0	0	0	5	5	10	20	10	0	40
- Vehicle	2	3	3	2	0	0	0	10	0	0	0	0	0	0	0	0	10
<b>B) Surface Water</b>																	
- Sampling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Laboratory Testing	0	0	0	0	0	0	0	0	0	0	2	0	2	2	2	0	6
- Data Evaluation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
<b>C) Groundwater</b>																	
- Wells (2) installation	0	0	0	0	0	0	0	0	0	25	0	0	25	0	0	0	25
- Sampling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Laboratory Testing	0	0	0	0	0	0	0	0	0	0	2	0	2	2	2	0	6
- Data Evaluation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
<b>D) Tailings and Subsoils Characterisation</b>																	
- Wells (3) installation	0	0	0	0	0	0	0	0	0	12	0	0	12	0	0	0	12
- Sampling	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
- Laboratory Testing	12	0	0	0	0	0	0	12	0	0	2	0	2	2	2	0	18
- Data Evaluation	0	0	0	0	0	0	0	0	0	0	5	0	5	5	5	0	15

FILE: "MARV/TAILSAB"

CURRAGH RESOURCES  
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 (\$'000's)

	1987							1988					1989	1990	1991	TOTAL	
	June	July	Aug	Sept	Oct	Nov	Dec	Total	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total	Total	Total		
E) Fisheries - Study	0	0	0	0	0	0	0	0	0	10	15	25	50	0	0	0	50
F) Interim Plan (Temp Closure)	0	10	15	0	0	0	0	25	0	0	0	0	0	0	0	0	25
G) Computer Modelling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	40	80
H) Final Abandonment Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	50	75
<b>TOTAL</b>	<b>81.6</b>	<b>29.5</b>	<b>173.8616</b>	<b>7</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>291.9616</b>	<b>0</b>	<b>59.5</b>	<b>43.5</b>	<b>30</b>	<b>133</b>	<b>56</b>	<b>121</b>	<b>90</b>	<b>691.9616</b>

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CURRAGH RESOURCES  
 Tailings Abandonment Plan Development  
 RE: SRK REPORT 60602  
 REVISED: 25-May-87  
 (\$'000's)

	1987							1988				1989	1990	1991	TOTAL	
	June	July	Aug	Sept	Oct	Nov	Dec	Total	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total	Total		Total
A) Test Plot																
- Final Design and Set-up	25							25					0			25
- Construction																
1. Manholes																
- Tanks (6 @ \$6000)	36							36					0			36
- Installation (6 @ \$2000)								0					0			0
- Foundations (Incl Floors)		7						7					0			7
- Lids and Windows (6 @ \$2000)		2						2					0			2
- Access Bridges & Ladders (@ \$150)		1.5						1.5					0			1.5
- Insulation (6 @ \$1000)		3						3					0			3
2. Earthworks (5200m3 @ \$6.75)								0					0			0
3. Liner																
- 2mm HDPE (4300m2 @ \$12.50)			53.75					53.75					0			53.75
- Sheathing (120m2 @ \$10.00)								0					0			0
4. Miscellaneous																
- Sand Layers								0					0			0
- Drainage Pipe		1.5						1.5					0			1.5
- Tailings								0					0			0
- Slimes								0					0			0

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 (\$'000's)

	1987							1988					1989	1990	1991	TOTAL
	June	July	Aug	Sept	Oct	Nov	Dec	Total	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total	Total	Total	
5. Instrumentation Purchase																
- Thermistors			7.12					7.12					0			7.12
- Piezometers			6.823					6.823					0			6.823
- Lysimeters			9.511					9.511					0			9.511
- Hor Solids Samplers			6.152					6.152					0			6.152
- Moisture/Density Probe			11.7					11.7					0			11.7
- Instrument Hangers			7					7					0			7
- Meteorological Station			3					3					0			3
- Install Mat'ls/Supplies			6					6					0			6
- Field Test Equipment			10					10					0			10
- Freight			3					3					0			3
6. Instrumentation Install Costs								0					0			0
7. Gasoline Pump and Gen Purchase			4					4					0			4
8. Contingency	3.6	1.5	12.8056	0	0	0	0	17.9056					0			17.9056
Subtotal Construction	39.6	16.5	140.8616	0	0	0	0	196.9616					0			196.9616
- Site Lab			10					10					0			10
- Water Sampling								0		5	5		10	10	10	30
- Laboratory Testing			5	5				10		7.5	7.5		15	15	15	55
- Data Evaluation								0			5	5	10	20	10	40
- Vehicle	2	3	3	2				10					0			10

FILE:"MARV/TAILSAB"

CURRAGH RESOURCES  
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 REVISED: 25-May-87  
 (\$'000's)

	1987							1988					1989	1990	1991	TOTAL
	June	July	Aug	Sept	Oct	Nov	Dec	Total	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total	Total	Total	
<b>B) Surface Water</b>																
- Sampling							0					0			0	
- Laboratory Testing							0			2		2	2	2	6	
- Data Evaluation							0					0		5	5	
<b>C) Groundwater</b>																
- Wells (2) installation							0		25			25			25	
- Sampling							0					0			0	
- Laboratory Testing							0			2		2	2	2	6	
- Data Evaluation							0					0		5	5	
<b>D) Tailings and Subsoils Characterisation</b>																
- Wells (3) installation							0		12			12			12	
- Sampling		3					3					0			3	
- Laboratory Testing	12						12			2		2	2	2	18	
- Data Evaluation							0			5		5	5	5	10	

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 Tailings Abandonment Plan Development  
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 (\$'000's)

	1987							1988					1989	1990	1991	TOTAL	
	June	July	Aug	Sept	Oct	Nov	Dec	Total	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Total	Total	Total		Total
E) Fisheries - Study								0		10	15	25	50				50
F) Interim Plan (Temp Closure)		10	15					25					0				25
G) Computer Modelling													0		40	40	80
H) Final Abandonment Plan													0		25	50	75
<b>TOTAL</b>	<b>81.6</b>	<b>29.5</b>	<b>173.8616</b>	<b>7</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>291.9616</b>	<b>0</b>	<b>59.5</b>	<b>43.5</b>	<b>30</b>	<b>133</b>	<b>56</b>	<b>121</b>	<b>90</b>	<b>691.9616</b>

	Internal	External	TOTAL
	-----	-----	-----
A) Test Plot			
- Final Design and Set-up		25	25
- Construction			
1. Manholes			
- Tanks (6 @ \$6000)		36	36
- Installation (6 @ \$2000)	12		12
- Foundations (Incl Floors)		7	7
- Lids and Windows (6 @ \$2000)	4	2	6
- Access Bridges & Ladders (@ \$150)	3	1.5	4.5
- Insulation (6 @ \$1000)	3	3	6
2. Earthworks (5200m <sup>3</sup> @ \$6.75)	35.1		35.1
3. Liner			
- 2mm HDPE (4300m <sup>2</sup> @ \$12.50)		53.75	53.75
- Sheathing (120m <sup>2</sup> @ \$10.00)	1.2		1.2
4. Miscellaneous			
- Sand Layers	2.5		2.5
- Drainage Pipe	1	1.5	2.5
- Tailings	5		5
- Slimes	5		5
5. Instrumentation Purchase			
- Thermistors		7.12	7.12
- Piezometers		6.823	6.823
- Lysimeters		9.511	9.511
- Hor Solids Samplers		6.152	6.152
- Moisture/Density Probe		11.7	11.7
- Instrument Hangers		7	7
- Meteorological Station		3	3
- Install Mat'ls/Supplies		6	6
- Field Test Equipment		10	10
- Freight		3	3
6. Instrumentation Install Costs	12		12
7. Gasoline Pump and Gen Purchase		4	4
8. Contingency	10	17.9056	27.9056
Subtotal Construction	93.8	196.9616	290.7616
- Site Lab	10	10	20
- Water Sampling	10	30	40
- Laboratory Testing	10	55	65
- Data Evaluation		40	40
- Vehicle		10	10
B) Surface Water			
- Sampling	10		10
- Laboratory Testing		6	6
- Data Evaluation		5	5
C) Groundwater			
- Wells (2) installation		25	25
- Sampling	10		10

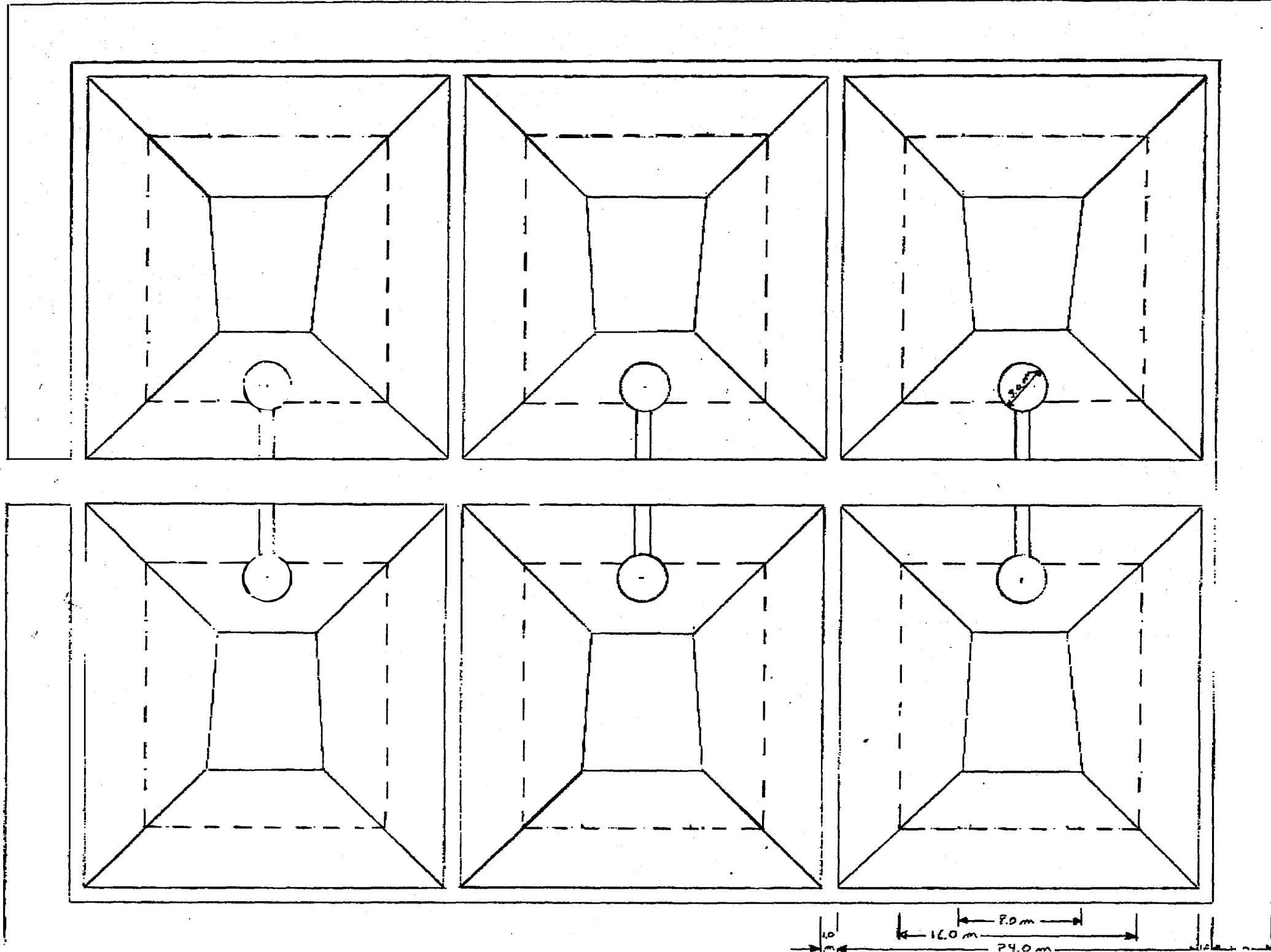
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C U R R A G H R E S O U R C E S  
Tailings Abandonment Plan Development  
RE: SRK REPORT 60602  
REVISED: 25-May-87

- Laboratory Testing		6	6
- Data Evaluation		5	5
D) Tailings and Subsoils Characterisation			
- Wells (3) installation		12	12
- Sampling	10	3	13
- Laboratory Testing		18	18
- Data Evaluation		15	15
E) Fisheries			
- Study		50	50
F) Interim Plan (Temp Closure)		25	25
G) Computer Modelling		80	80
H) Final Abandonment Plan		75	75
TOTAL		153.8	691.9616 845.7616

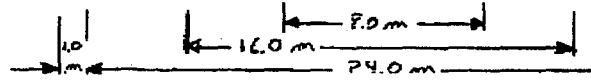
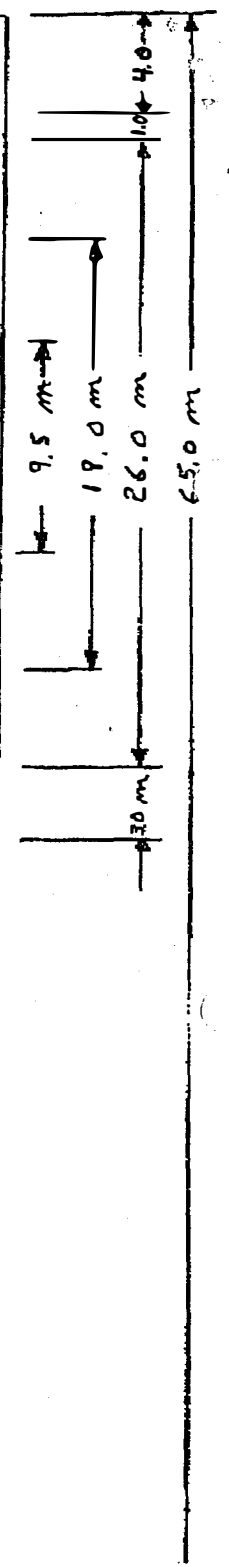
**APPENDIX IV**

ST FACILITY  
X CHAMBERS



25 3987

1/4 inch = 32 m  
AM



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CURRAGH RESOURCES  
Tailings Abandonment Plan Development  
RE: SRK REPORT 60602  
REVISED: 25-May-87

1987

	June	July	Aug	Sept	Oct	Nov	Dec	Total
- Data Evaluation								0
C) Groundwater								
- Wells (2) installation								0
- Sampling								0
- Laboratory Testing								0
- Data Evaluation								0
D) Tailings and Subsoils Characterisation								
- Wells (3) installation								0
- Sampling		3						3
- Laboratory Testing		12						12
- Data Evaluation								0
E) Fisheries								
- Study								0
F) Interim Plan (Temp Closure)		10	15					25
G) Computer Modelling								
H) Final Abandonment Plan								
TOTAL	81.6	29.5	173.8616	7	0	0	0	291.9616