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PHASE II

STUDY ON THE FEASIBILITY OF THE EXTRACTION OF GOLD FROM TORCO TAILINGS AT AKJOUJT / MAURITANIA

UNIDO Project No. DP/MAU/85/005

Final Report

prepared by

KHD HUMBOLDT WEDAG AG

Cologne, January 1987

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Introduction

The submitted report presents the Final Study on the extraction of gold from the TORCO tailings in Akjoujt/Mauritania by the cyanide heap leaching process.

Prior to this study a preliminary design and cost analysis on the same subject had been elaborated by KHD and submitted to UNIDO and to Société Arabe Minière d'Inchiri (SAMIN) in October 1986.

The main objective of this provisional assessment of investment and operation costs was to help SAMIN to compare the technical results of the heap leaching technology with those obtained by the agitating cyanidation - a process which was under review some years ago.

In addition, the preliminary analysis was carried out with the aim to obtain first indications as to the profitability of the project.

A thorough discussion of the preliminary cost and design analysis was held in Paris on October 14th, 1986 in the presence of representatives of UNIDO, SAMIN and KHD.
It was understood that the preliminary estimates still needed to be more refined before decisions on the investment proposal could be taken by the project promoter.

The presented Final Report incorporates the assumptions agreed upon in the above mentioned economic tri-partite meeting, especially regarding

- financing
- taxation
- lifetime of plant
- investments in infrastructure
- cost of personnel

and is based on the final laboratory results and detailed engineering work for an assessment of the investment and production costs.

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1 Executive Summary

1.1 Project Background and History

1.1.1 Origin of TORCO Tailings

The ore deposit at Akjoujt / Mauritania is a copper sulphide ore-body with an oxidized cap. For the extraction of copper contained in the oxidized part of the deposit a very unique process - the so-called TORCO-process - was applied over several years in the past.

The name "TORCO" derives from the abbreviation of the words "Treatment of Refractory Copper Ores". This process has been developed in particular for the treatment of alumino-silicate copper ores which cannot be treated economically by flotation or hydrometallurgical processes.

The TORCO process consists of the following operation steps:

- preheating of the fine-grained material in a fluidized-bed reactor under oxidizing conditions
- treatment of the hot calcine with coal ore coke and sodium chloride in a segregation furnace in a reducing atmosphere

The final product of this operation contains elemental copper which is segregated on the surface of the carbon. The elemental copper is subsequently recovered by flotation.

Depending on the composition of the ore, the residues of the TORCO process, in the following called "TORCO tailings", contain precious metals.

2,5 million tons of such TORCO tailings with approximately 3 grams per ton of gold have been dumped in the past by the predecessors of SAMIN.

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1.1.2 Project Promoter

SAMIN as the lawful owner of the gold containing TORCO tailings in Akjoujt intends to commence with the gold extraction still in 1987 and further wishes to resume the copper mining activities.

The required research work for the gold extraction from the very peculiar raw material was completely sponsored by UNIDO.

The studies performed in the past on this subject mainly comprised:

- determination of the available quantity of TORCO tailings
- determination of the average gold-, silver- and copper contents of the TORCO tailings
- laboratory investigations and pre-feasibility study on the gold extraction from TORCO tailings by agitating cyanidation followed by gold absorption on activated carbon
- laboratory investigations and economic study on gold extraction by cyanide heap leaching of TORCO tailings followed by gold adsorption on activated carbon (presented report)

1.1.3 Market Orientation

Until recently, the gold market had been characterized by the wide-spread view that gold had performed not so well as an investment asset. However, gold has actually advanced in an intermittent and gradual fashion over the past two years. With gold recently trading above US-Dollar 400/ounce, it has appreciated more than 40 % from its low point near US-Dollar 280/ounce in February 1985. Gold mining activities have, therefore, been expanding in recent years all over the world.

The gold mine production of the non-communist countries now is in the range of 1,200 t per year. This amount is mainly supplied to or consumed by

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- jewellery
- electronic industries
- dentistry
- other industry
- coin hoarders
- bar hoarders.

In comparison with the world gold production, the Mauritanian gold resource and the projected annual capacity of 790 kg gold in bullion are very modest. It is assumed that the total gold production will be sold abroad.

1.2 Market and Plant Capacity

Faith in gold as a store of wealth is as old as the knowledge of extracting the yellow metal. In addition, gold plays a fundamental role still today, both as reserve asset of the central banks and as a universal medium of payments.

As the market is not sensible to such small quantities of gold which will be produced in Mauritania, the market absorption capacity for the Mauritanian gold can be considered unlimited.

Within 1985, the Western market absorbed approximately 200,000 kg gold coming from the Soviet Union; in addition, unknown quantities came from the P.R. of China and the D.P.R. of Korea to the Western market !

Growth in jewellery and industrial demand will certainly continue so that concerns about a gold market surplus or a slump of the gold price are not justified at the time being.
Consequently, it is assumed that the total Mauritanian gold production can be sold with ease.

The gold extraction plant will have a capacity of treating 310,000 tpy of TORCO tailings with an average gold content of 3 g/t. Assuming a recovery rate of 85 %, the yearly gold production could reach 790 kg which equals 25,500 oz.
The gold will be contained in a so-called bullion which represents an alloy mainly consisting of gold and copper. For economic reasons the bullion should be refined in a European gold refinery.

1.3 Materials and Inputs

According to the previous studies, the total amount of TORCO tailings available at the Akjoujt site equals 2.5 million tons.

The gold extraction plant will be designed to treat 310,000 tpy from this material. For this process the following utilities and materials will be required and the composition of the material is the following:

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Analysis of received sample for the study on heap leaching (1986)

SiO_2	19.12 %	As	725 ppm
Al_2O_3	1.43 %	Co	0.248 %
Fe	52.90 %	Cu	0.84 %
Mn	1.56 %	Ni	100 ppm
MgO	6.78 %	Pb	528 ppm
CaO	0.81 %	Au	2.571 ppm *
Na	0.38 %	Ag	traces *
S	840 ppm		
Cl	643 ppm		

* see page 19 a

Utilities

- electric power	2,60 kWhr per tonne 800,000 kWhr per year
- fresh water	one cu meter per tonne 310,000 cu meter per year
- lining material for leach pads and ponds	45,000 sq meters per year

Main consumables

- cement	10.0 kg per tonne 3,100 tonnes per year
- sodium cyanide	2.0 kg per tonne 620 tonnes per year
- Nalco-wetting agent	0.04 kg per tonne 12.0 tonnes per year
- activated carbon	5 grams per tonne 1,600 kg per year
- sodium hydroxide	2,000 kg per year
- sodium carbonate	2,000 kg per year
- muriatic acid	16,000 liters

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1.4 Location and Site

The Akjoujt copper ore mine is located in the Sahara desert 260 km north-east of Nouakchott, the capital of Mauritania. The climate is arid, over the whole year only a few rainfalls occur.

As previously stated, the oxide ore was treated in a TORCO plant which was closed down for economic reasons. Major buildings of this TORCO plant including power station, workshops and offices still exist at the Akjoujt site. During the operation time of the TORCO plant, Akjoujt could be reached from Nouakchott by road. Now this road is in an extremely bad condition and is partly buried in sand.

The gold heap leaching plant will be erected 3 km away from the town of Akjoujt in the immediate vicinity of the old TORCO plant.

1.5 Project Engineering

The present leaching practice for gold containing ores usually involves cyanidation by agitation or percolation in heaps. The first method to process TORCO tailings was already investigated in the past. The metallurgical and economic results of this process were presented for the purpose of a pre-feasibility study to UNIDO and the Mauritanian government in 1983.

Since in the last few years heap leaching has obtained favor, principally for its merit of very low capital and operation costs, a new study on heap leaching TORCO tailings had been elaborated on behalf of UNIDO.

In this process ore is piled into a heap using mechanical earth-moving equipment. In the case of TORCO tailings the material has to be agglomerated prior to piling. The agglomerated material is leached by spraying the heap with a sodium cyanide containing solution. This liquor percolates down through the pile leaching the gold on its way and is collected for recovery of gold using activated carbon.

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The process is something of a compromise in that recoveries are not as high as when applying the agitating cyanidation, but without the requirements for large tanks, heap leaching of agglomerated TORCO tailings is undeniable a "cheap" process.

The presented Final Report gives the engineering design, the assessment of capital and operation costs as well as a profitability calculation for the gold heap leaching operation at Akjoujt / Mauritania. The operation will be designed for an ultimate annual treatment of 310,000 tonnes of TORCO tailings.

The method of treatment evaluated in this report involves

- discing, hauling and transportation
- agglomeration with chemical reagents
- stacking on a prepared surface
- heap leaching
- recovery of gold from the solution
- production of dore material

1.6 Plant Organization and Overhead

The plant will be integrated in a partly existing infrastructure as far as water and energy supply and general administration are concerned.

The future production activities in the gold extraction plant are well definable and can be divided as follows:

- discing, hauling, transportation of tailings
- agglomeration of tailings
- stacking of tailings
- heap leaching of tailings

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- adsorption, desorption and recovery of gold.

The service centres will be divided into the departments:

- repair and maintenance

- water and energy supply

- sampling and laboratory

The administration of the gold extracting plant will not be divided from the copper mining and beneficiation activities of SAMIN in the future. For the heap leaching plant only a small administration is required for accounting, payroll and general project record keeping.

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1.7 Manpower

The required company personnel, including professional staff and operating labor, is listed below. This workforce will be sufficient to conduct all project unit operations:

Professional and clerical staff

- 1 General Operation Manager
- 1 Chief Metallurgist / Project Engineer
- 1 Chemist / Assayer
- 1 Bookkeeper
- 1 Secretary

Operating Personnel

- 4 Operators for the adsorption-, desorption- and refinery plant
- 2 Laboratory assistants
- 3 Operators for agglomerating and stacking
- 6 Operators for the mobile equipment (trucks, dozer and endloader)
- 5 Operators for heap leaching

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20 Total operating workforce

1.8 Implementation Scheduling

Based on the experience of other, similar projects but considering the particular local conditions, the gold extraction from the TORCO tailings could start after approximately 13 months after coming into force of a contract between SAMIN and one or more companies which execute the plant engineering and deliver the equipment as well as perform erection and conduct the civil works.

For the plant engineering approximately 9 months are required.

With a delay of one month, parallel to the engineering work delivery of the equipment could start.

Erection of the mechanical and electrical equipment is supposed to start in the 10th month after signing the contract and can be finished within the 13th month.

1.9 Financial and Economic Evaluation

The total initial investment during the construction phase amounts to US-D 6,262,270.00.

It is assumed that US-D 1,733,100.00 of local equity and a local loan of US-D 4,043,900.00 will be available in 1988, the year of construction. Thus, 30 % of total funds will be financed by equity.

Total production costs amount to approximately US-D 4,000,000.00 in the first year of production and remain almost constant in the following years.

As of the second year of production the specific production costs for gold bullion amount to 6,760 US-D per kg, or 50 % of the assumed sales value.

The pay back period of the project is less than 2 years and the Internal Rate of Return on Total Investment amounts to 66.52 % at a discounting rate of 15 %.

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1.10 Conclusions

Search for the best means of gold extraction from TORCO tailings has led to intensive studies in which two different technical paths were followed:

A Agitating Cyanidation (study finished in 1983)

B Heap leaching

All technical and economic investigations on subject B are included in the presented Final Study.

For both technologies the most important factors for the development of such projects were carefully considered:

- availability of raw material
- average gold content of the raw material
- gold recovery as a function of operating parameters

It was found that the most influential factor "recovery" is not very different for both methods. It could be proved in laboratory tests that by heap leaching of agglomerated TORCO tailings gold recovery reaches 85 %. This yield is rather high in comparison with other heap leaching operations and can even compete with extraction rates from agitating operations.

The most significant advantage of heap leaching TORCO tailings are the lower capital and operation costs and the shortened plant construction time compared to agitating leaching methods.

From the environmental viewpoint the controllability is another important characteristic of heap leaching TORCO tailings. According to the laboratory results, the leach solution can be completely recycled. The final leached tailings will be washed and remain on the impermeable plastic layer.

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The primary disadvantage of heap leaching TORCO tailings is the necessity of agglomerating the material prior to leaching.

The slower recovery rate in comparison with the agitating leaching process can be compensated by operational arrangements.

The main conclusion of the study is that both for the company SAMIN and for the Government of Mauritania the project is very interesting from the economic viewpoint.
As it can be shown, the project creates large amounts of foreign currency and should therefore be implemented as soon as possible.

The total initial investment amounts to

6,262,270.00 million US-Dollar.

85 % of initial fixed investments are due in foreign currency and about 65 % of total production costs of about 4,000,000.00 US-Dollar have to be paid in foreign currency.

According to the assumptions made, the specific production costs for gold bullion will only amount to 50 % of the sales value.

2 Cyanide Laboratory Tests for the Evaluation of the Effectiveness of Heap Leaching

2.1 General Conclusions

The TORCO tailings can be agglomerated to form pellets with sufficient green strength and wet strength after curing to be placed and leached in 6 meter high heaps. Locked cycle tests (see figure 3) indicate that gold recovery from these pellets will range from 83 to 90 percent in 35 days of leaching, and will average 88 percent or higher in a 90-day extended leach period in laboratory columns. Field heap leach recoveries are projected to be approximately 85 percent. Locked cycle tests do not show any degradation of leach effectiveness which indicates that solutions can be re-used indefinitely (this is the typical procedure with heap leach operations, but exploratory tests were justified because of the relatively high levels of soluble copper in the TORCO tailings).

2.1.1 Preliminary Bottle Roll Tests

Agitated cyanide bottle roll tests were run on portions of the as-received material. Gold recovery in one test was 90.1 percent in 24 hours of leaching. A second test with lower cyanide levels showed a recovery of 74.0 percent. A portion of the same sample was pulverized and tested in a bottle roll test. Apparent recovery was 83 percent, but total dissolved gold and copper levels were higher.

Conclusions from these tests were:

- most of the gold in the TORCO tailings is soluble from the material at its existing size
- soluble copper levels, percentage of soluble gold and cyanide consumption increase with higher cyanide levels. This is a common behavior with materials containing soluble copper.

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2.1.2 Locked Cycle Bottle Roll Tests

A series of bottle roll tests were also run in locked-cycle to see the effect of copper buildup in solutions on gold recovery. Cyanide strength (as measured by titration with silver nitrate at pH 10.5) was maintained near 0.70 grams NaCN per litre. The results of these tests are presented in figures 6 through 8. Gold recovery in the tests averaged 81.9 percent. The initial test showed higher gold recovery (89 percent) but the next five cycles appeared to have stable gold recovery even though dissolved copper increased from 1001 ppm in solution to 2180 ppm. Cyanide consumption was stable throughout the six cycles, with about 2.8 kg NaCN per tonne of ore.

The conclusion from these preliminary locked-cycle bottle roll tests was that there is no solution component which causes significant chemical leaching problems.

2.1.3 Preliminary Column Leach Test

After thorough blending, a portion of the incoming sample weighing 36 kg was oven-dried and weighed again (test 6760). Moisture content was 11.2 percent.

A portion of the incoming sample was also tested for percolation and leach rates by placing 15 kg of material in a 9 cm diameter column, 1.3 meter high (test 7448). Gold recovery is shown in figure 2. Gold recovery rate was slow and the column percolation rate was less than the rate considered necessary for effective leaching. It was therefore concluded that agglomeration was needed for successful leaching.

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2.1.4 Agglomeration Procedures and Reagents

Normal agglomerating procedures involve adding cement and / or lime and agglomerating with water or diluted cyanide solution. This typically makes firm pellets which can be stacked directly on the heap. Due to the thixotropic properties of the TORCO tailings, agglomerating was however very difficult even at relatively high cement levels.

To explore the problem, a series of nearly 50 tests were run on small (1 kg) samples of the feed material using different combinations of agglomerating agents including chemical additives and "physical" modifiers such as clay.

An effective and relatively low-cost combination of reagents was developed - 10 kg cement per tonne and 0.04 kg Nalco 8814 as wetting agent. The resulting pellets form well and exhibit sufficient early strength so that they can be placed directly into the heap. After curing, they are strong enough to be leached in relatively high heaps (testing took place at 1.5 meters with no apparent degradation, and six meter high heaps are expected to perform satisfactorily).

Figure 10 shows the agglomerating conditions for the column tests.

2.1.5 Locked Cycle Column Leach Tests

A series of four column tests were run using 75 kg of agglomerated pellets in 20 cm diameter columns 1.5 meters high (tests 7149 - 7531). The tests were run sequentially using the same leach solution.

Results are given in figure 13 and graphically in figure 3. Gold recovery after 35 days of leaching ranged from 83 to 88 percent and averaged 86.1 percent. Cyanide consumption ranged from 1.5 to 2.1 kg NaCN per tonne of ore. Neither gold recovery nor cyanide consumption appeared to be affected by re-use of the same leach solution throughout the tests.

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Test 6888 as reported in figure 1 indicates that gold recovery continues beyond the 35 days used for the locked cycle tests. In 6888, gold recovery increases from 74 percent in 35 days to 89 percent in 90 days. In the locked cycle tests, gold recovery was continuing when the tests were ended (for instance, recovery in the final 8 days of the fourth cycle was in the order of ten percent per month). The results indicate that ultimate gold recovery could be expected to exceed the levels seen in the relatively short locked cycle tests. We feel that a recovery of 85 percent is reasonably attainable in field production leaches when processing material similar to the bulk sample.

In the locked cycle tests, copper levels in solution gradually climbed and peaked at about 3000 ppm half way through the fourth cycle. Copper levels rose and fell during all the tests. In the second cycle, they peaked at 1800 ppm and ended at 1100 ppm. In the third cycle they peaked at 2100 ppm and ended at 1400 ppm. In the fourth cycle they peaked at 3000 and ended at 1900.

The level of free (directly titratable) cyanide was maintained at a somewhat higher level in the fourth cycle (0.62 grams NaCN per liter compared with 0.35 for cycles 2 and 3). The higher levels of copper probably reflected that. The overall evidence is that copper levels in solution appear to reach a stable level. Even though the level of copper exceeds the amount needed to complex all available cyanide, there appears to be no adverse effect on gold recovery by re-use of solution.

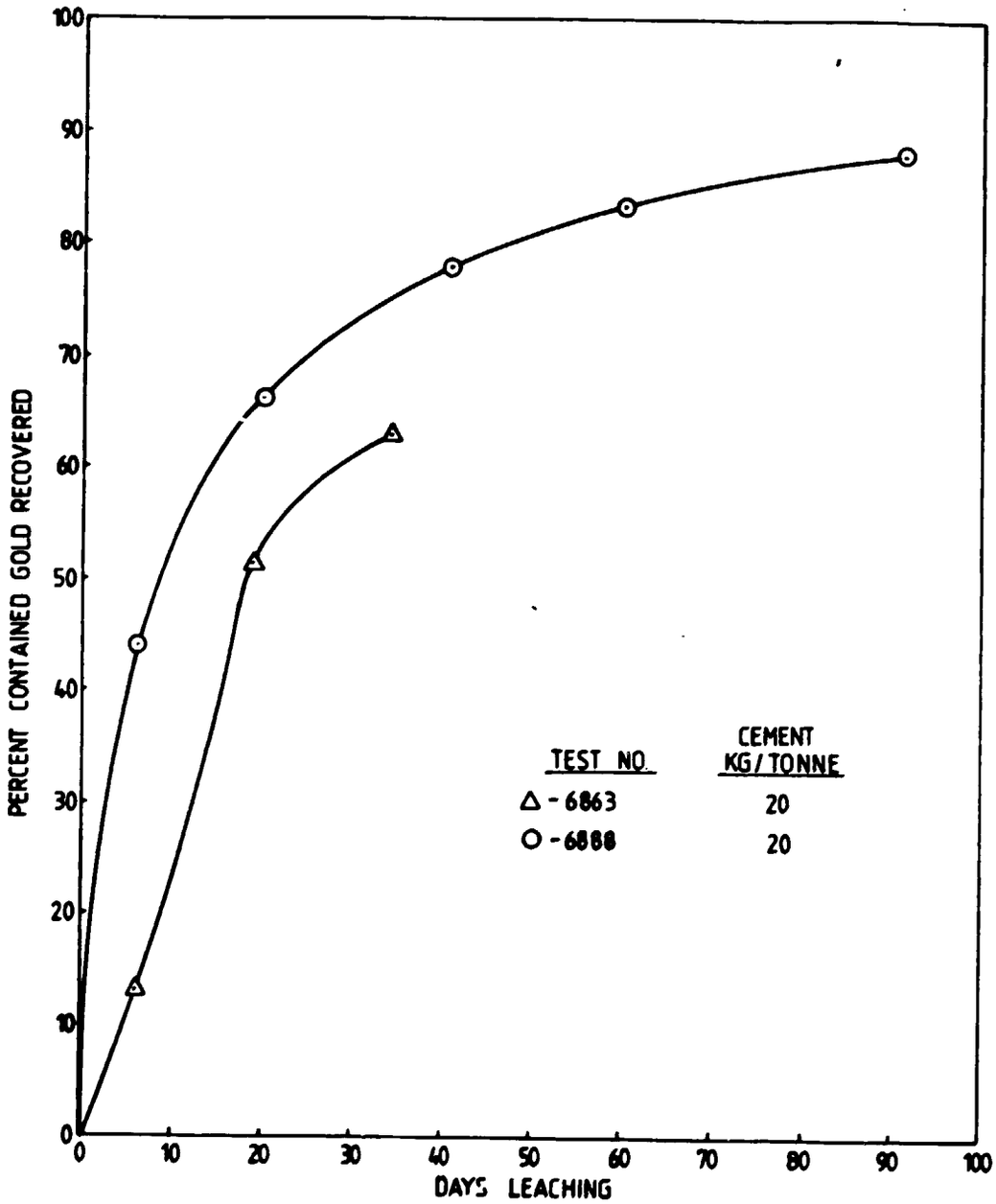

FIGURE 1. TORCO TAILINGS BULK SAMPLE
AGGLOMERATED COLUMN LEACH TESTS
GOLD RECOVERY VERSUS DAYS LEACHING

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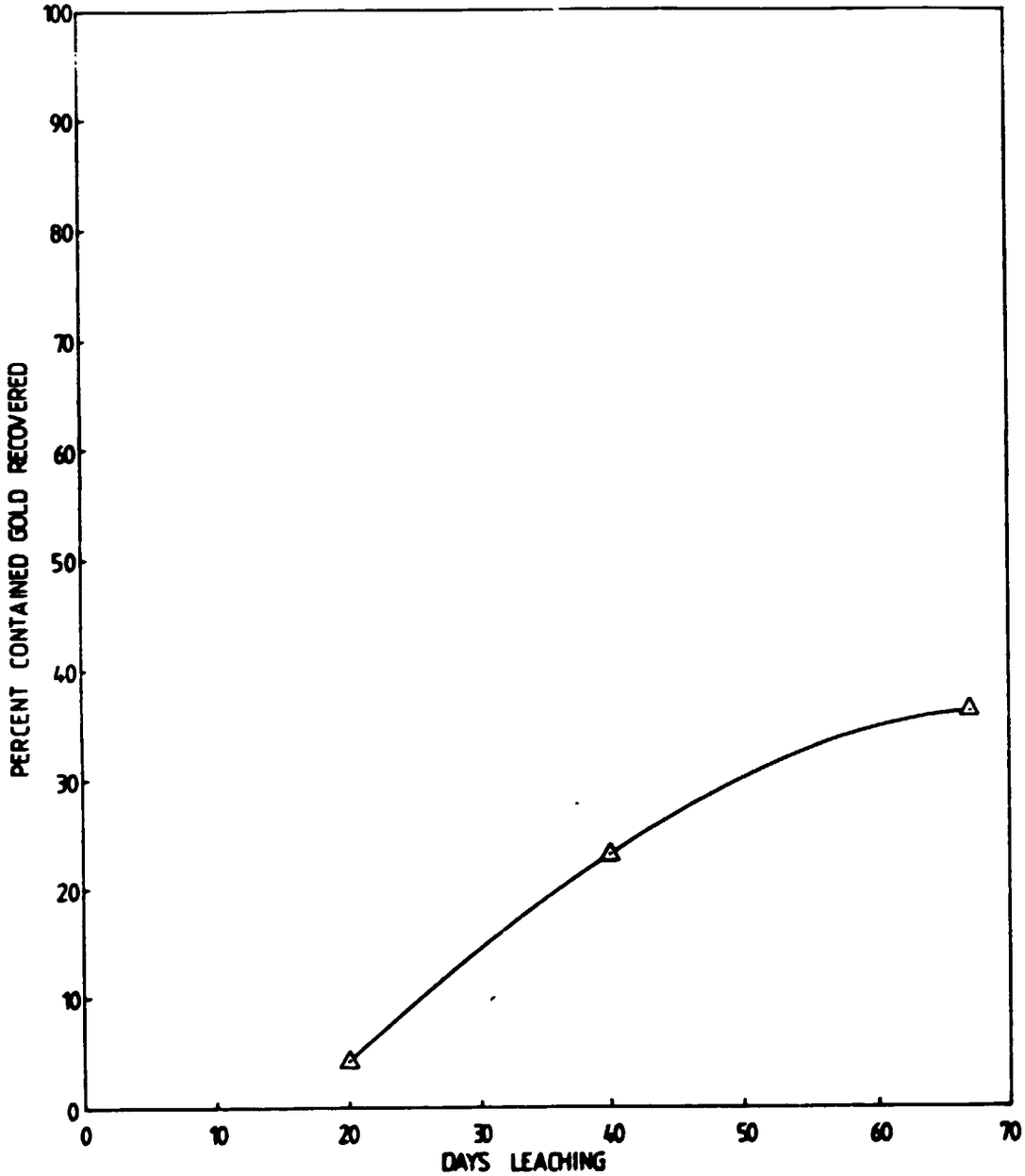

FIGURE 2. TORCO TAILINGS BULK SAMPLE
UNAGGLOMERATED COLUMN TEST NO. 7448
GOLD RECOVERY VERSUS DAYS LEACHING

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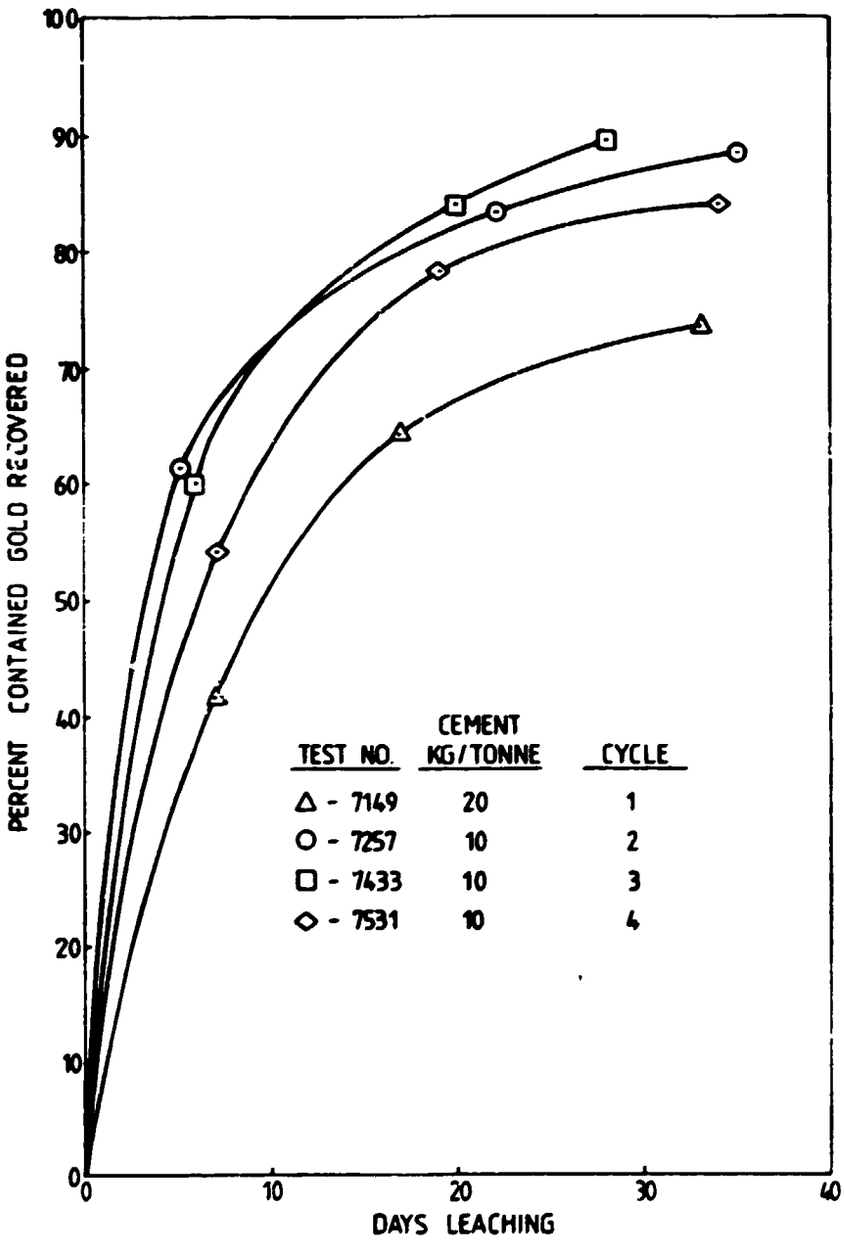

FIGURE 3. TORCO TAILINGS BULK SAMPLE
LOCKED CYCLE AGGLOMERATED COLUMN TESTS
GOLD RECOVERY VERSUS DAYS LEACHING

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2.2 Laboratory Test Results

2.2.1 Sampling Procedures and Test Material

According to a study performed by KHD in 1982, the gold content of the TORCO tailings amounts in average to 3.606 g/t; however, it varies in a wide range. For previous tests evaluating the efficiency of the agitating cyanidation process, material from an average sample of 236 boreholes (346 kg) was used. The gold content of this material amounted to 3 g/t.

For the heap leaching tests however, 2 tons of material was required and therefore a new sample had to be taken. As the concentration profile of the TORCO tailing deposit was carefully established and depicted in the first study of 1982, new samples with similar gold concentration could be taken at points of known concentration. According to a request by KHD, SAMIN took the samples at 4 different points (Nos. 33, 34, 39 and 40) where the gold content was supposed to be around 3 g/t. This material was packed in plastic lined drums and airfreighted to Cologne. These drums were treated as one bulk sample for testing.

The gold content assayed was lower than expected and amounted to 2.5 g/t (see page 19 a). It has to be emphasized that this concentration is an incidental finding and does not represent the average gold concentration of the total quantity of the TORCO tailings. Therefore, the concentration of 2.5 g/t was disregarded in respect to the calculation of the profitability (chapter 13). It was agreed by all parties that a concentration of 3 g/t should be used as basis for the profitability calculation of the presented study.

2.2.2 Sample Preparation

The sample preparation procedure used is as follows:

1. mix the material from the five drums by taking one shovelful of material from each drum and placing into an empty drum with a plastic liner

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2. after the first drum is full, repeat step one until all five original drums are empty

3. take one of the five drums of mixed sample and split in half, store half

4. take the remaining half split from step 3 and split into quarters

5. take one of the quarter splits from step 4, weigh and then place in oven to dry, weigh the dried material and determine percent moisture in the sample

6. take another of the quarter splits from step 4 and split into 1 kg samples

7. take two of the 1 kg portions from step 6 and pulverize each one, split out two pulps from each 1 kg portion and submit for fire assay

8. take two of the 1 kg portions and use for cyanide bottle roll tests

9. wet screen one of the 1 kg portions at 65M, 100M and 200M, record the weight of each size fraction

10. use the remaining 1 kg portions for agglomeration tests to optimize agglomerating agents.

Figure 4 presents the results of the wet screen analysis and the results of the head assays run on the pulverized head samples.

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FIGURE 4. TORCO TAILINGS BULK SAMPLE
SAMPLE 6750
WET SCREEN ANALYSIS AND FIRE ASSAYS

SIZE FRACTION	WEIGHT GRAMS	WEIGHT PERCENT
+65 M	132.9	13.40
-65M + 100M	104.3	10.52
-100M + 200M	365.3	36.84
-200M	389.1	39.24

HEAD ASSAYS:	Au g/t	Ag g/t	Cu %	Zn ppm
	2.160	1.37	0.79	26
	2.468	Tr	0.76	26
	2.743	13.71*	0.75	25
	2.606	Tr	0.72	--
	2.468	Tr	--	--
	3.291	Tr	--	--
	2.743	Tr	--	--
	2.057	Tr	--	--
Average:	2.571	Tr	0.76	26

Percent Moisture: 11.16 % (As-Received Material)

* - Not included in average.

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2.2.3 Cyanide Bottle Roll Tests

Agitated cyanide bottle roll tests were run on portions of the as-received tailings and on a portion of pulverized tailings.
The procedure used for these tests is as follows:

1. place 500 grams of tailings into a 2 liter polybottle and add 1000 ml of distilled water

2. check the pH and adjust to pH 10.0 - 10.5 with hydrated lime, if necessary

3. for the tests on as-received material, add 0.5 grams of sodium cyanide (equivalent to 0.5 gpl NaCN) to one of the tests and 1.0 grams of sodium cyanide (equivalent to 1.0 gpl NaCN) to the other test. For the test on pulverized material, add 2 grams NaCN (equivalent to 2.0 gpl NaCN)

4. check solution after 2, 4, 8 and 24 hours for pH, NaCN, Au, Ag and Cu. Maintain the pH above 10.0 and NaCN at the initial starting concentration

5. filter, wash and dry tailings, prepare two pulps from the tailings and submit for fire assay.

Figure 5 presents the results of the cyanide bottle roll tests. In the tests on as-received tailings, gold recovery was 74 percent in the test run at 1.0 gpl NaCN. Gold recovery in the test run on pulverized tailings using 2.0 gpl NaCN solution was 85 %,

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FIGURE 5. TORCO TAILINGS BULK SAMPLE
CYANIDE BOTTLE ROLL TESTS

TEST NO.	SIZE OF MATERIAL	TIME HOURS	pH	NaCN gpl Free/Total	METAL RECOVERED Au g/t	Ag g/t	Cu ppm[1]
6803A	As-Received	2	10.1	0.20/0.20	0.960	Tr	271
		4	10.2	0.15/0.15	1.200	Tr	315
		8	10.4	0.20/0.20	1.646	Tr	482
		24	10.5	0.35/0.35	1.954	Tr	609
				TAILS ASSAYS:	0.686	2.40	
					0.686	Tr	
				CALCULATED HEAD:	2.640		
				PERCENT RECOVERY:	74.02		
				CHEMICAL CONSUMPTION:	1.22 kg/tonne NaCN		
					0.62 kg/tonne $Ca(OH)_2$		
6803B	As-Received	2	10.4	0.35/0.35	1.680	Tr	363
		4	10.5	0.65/0.65	1.783	1.03	429
		8	10.7	0.50/0.50	2.229	Tr	677
		24	10.9	0.65/0.65	2.331	Tr	855
				TAILS ASSAYS:	0.240	3.09	
					0.274	Tr	
				CALCULATED HEAD:	2.588		
				PERCENT RECOVERY:	90.07		
				CHEMICAL CONSUMPTION:	1.72 kg/tonne NaCN		
					0.64 kg/tonne $Ca(OH)_2$		
6782	Pulverized	2	10.6	0.40/0.40	1.371	Tr	811
		4	10.8	2.25/2.25	2.126	0.34	1030
		8	10.8	2.05/2.05	2.331	0.34	1240
		24	10.8	1.70/1.70	2.366	0.34	1290
				TAILS ASSAYS:	0.411	Tr	
					0.548	Tr	
				CALCULATED HEAD:	2.846		
				PERCENT RECOVERY:	83.13		
				CHEMICAL CONSUMPTION:	5.42 kg/tonne NaCN		
					0.24 kg/tonne $Ca(OH)_2$		

1 - Copper in leach solution.

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2.2.4 Locked Cycle Bottle Roll Tests

In order to determine the effect of copper buildup in the leach solutions, a series of six locked cycle bottle roll tests were run. The procedure used for this series of tests is as follows:

Cycle 1:
---

1. place 500 grams of as-received material into a 4 liter polybottle

2. add 1000 ml of distilled water and check pH, adjust to pH 10.5 with hydrated lime, if necessary

3. add 1.0 gram of NaCN (equivalent to 1.0 gpl NaCN) and place on rolls

4. check solution after 2, 4, 8, 24 and 48 hours for pH, Au, Ag and Cu. Add sodium cyanide and hydrated lime as required to bring solution up to pH 10.0 - 10.5 and NaCN to 1.0 gpl.

5. filter the tailings and then wash with distilled water

6. dry the tailings, pulverize and split out two pulps for fire assay

7. take the filtrate and run through column containing 10 grams of virgin activated carbon to remove the gold in solution

Cycles 2 - 6
---

8. take 500 grams of as-received material and place into a 4 liter polybottle

9. take 1000 ml of the filtrate from the previous test that has been run through activated carbon and check pH, NaCN, Au Ag and Cu

10. add the 1000 ml of solution from step 9 to the polybottle with the sample. Add the same amount of hydrated lime used in step 2 and any sodium cyanide needed to bring the concentration back up to 1.0 gpl NaCN.

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11. check solution after 2, 4, 8, 24 and 48 hours for pH, Au, Ag and Cu. Add sodium cyanide and hydrated lime as required to bring solution up to pH 10.0 - 10.5 and NaCN to 1.0 gpl.

12. filter the tailings and then wash with distilled water

13. dry the tailings, pulverize and split out two pulps for fire assay

14. take the filtrate and run through column of virgin activated carbon to remove the gold in solution

15. repeat steps 8 through 14 until a total of 6 tests have been run in series.

Figures 6 through 8 present the results of the locked cycle bottle roll tests. The first test in the series (7237 A) showed the highest gold recovery at 89 percent with the remaining five tests (cycles 2 - 6) averaging 80 percent gold recovery.

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FIGURE 6. TORCO TAILINGS BULK SAMPLE
LOCKED CYCLE CYANIDE BOTTLE ROLL TESTS
AS-RECEIVED MATERIAL

TEST NO.	CYCLE NO.	TIME HOURS	pH	NaCN gpl Free/Total	METAL RECOVERED Au g/t	Ag g/t	Cu ppm[1]
7237A	1	0	10.5	..00/1.00	0	0	0
		3	10.8	0.15/0.15	1.646	Tr	39[illegible]
		4	10.8	0.15/0.15	1.714	Tr	39[illegible]
		8	11.0	0.40/0.40	2.126	Tr	678
		24	11.0	0.55/0.55	2.331	Tr	889
		48	11.1	0.60/0.60	2.366	Tr	1001
				TAILS ASSAYS:	0.274	Tr	
					0.309		
				CALCULATED HEAD:	2.658		
				PERCENT RECOVERY:	89.01		
				CHEMICAL CONSUMPTION:	4.49 kg/tonne NaCN		
					0.30 kg/tonne $Ca(OH)_2$		
7237B	2	0	10.8	1.00/1.00	0.857	Tr	840
		2	10.4	0.40/0.40	0.789	Tr	975
		4	10.5	0.60/0.60	1.166	Tr	1200
		8	10.5	0.85/0.85	1.851	Tr	1350
		24	10.5	0.70/0.70	1.920	Tr	1460
		48	10.7	0.80/0.80	2.126	Tr	1610
				TAILS ASSAYS:	0.617	Tr	
					0.720		
				CALCULATED HEAD:	2.795		
				PERCENT RECOVERY:	76.06		
				CHEMICAL CONSUMPTION:	3.34 kg/tonne NaCN		
					0.28 kg/tonne $Ca(OH)_2$		

Tr signifies trace.

1 - Copper in leach solution.

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FIGURE 7. TORCO TAILINGS BULK SAMPLE
LOCKED CYCLE CYANIDE BOTTLE ROLL TESTS
AS-RECEIVED MATERIAL

TEST NO.	CYCLE NO.	TIME HOURS	pH	NaCN gpl Free/Total	METAL RECOVERED Au g/t	Ag g/t	Cu ppm[1]
7237C	3	0	10.5	1.00/1.00	0.206	Tr	1260
		2*					
		4	10.5	0.45/0.45	0.789	Tr	1400
		8	10.5	0.70/0.70	1.303	Tr	1580
		24	10.5	0.80/0.80	1.989	Tr	1890
		48	10.4	0.90/0.90	2.503	Tr	1870
				TAILS ASSAYS:	0.480	Tr	
					0.549		
				CALCULATED HEAD:	3.018		
				PERCENT RECOVERY:	82.94		
				CHEMICAL CONSUMPTION:	2.34 kg/tonne NaCN		
					0.28 kg/tonne $Ca(OH)_2$		
7259A	4	0	10.6	0.95/0.95	0.411	Tr	1360
		2*					
		4	9.6	0.30/0.30	0.514	Tr	1460
		8	10.6	0.75/0.75	1.269	Tr	1810
		24	10.6	0.70/0.70	1.920	Tr	1920
		48	10.6	0.90/0.90	2.126	Tr	1880
				TAILS ASSAYS:	0.549	Tr	
					0.549		
				CALCULATED HEAD:	2.675		
				PERCENT RECOVERY:	79.48		
				CHEMICAL CONSUMPTION:	2.76 kg/tonne NaCN		
					0.28 kg/tonne $Ca(OH)_2$		

Tr signifies trace.

1 - Copper in leach solution.

* - No 2 hour sample taken.

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FIGURE 8. TORCO TAILINGS BULK SAMPLE
LOCKED CYCLE CYANIDE BOTTLE ROLL TESTS
AS-RECEIVED MATERIAL

TEST NO.	CYCLE NO.	TIME HOURS	pH	NaCN gpl Free/Total	METAL RECOVERED Au g/t	Ag g/t	Cu ppm[1]
7259B	5	0	10.4	1.00/1.00	0.069	Tr	1350
		2	10.6	0.40/0.40	0.891	Tr	1650
		4	10.6	0.70/0.70	1.269	Tr	1690
		8	10.6	0.60/0.60	1.509	Tr	1840
		24	10.7	0.85/0.85	2.023	Tr	1980
		48	10.7	0.80/0.80	2.194	Tr	2000
				TAILS ASSAYS:	0.343	2.40	
					0.549		
				CALCULATED HEAD:	2.640		
				PERCENT RECOVERY:	93.11		
				CHEMICAL CONSUMPTION:	3.34 kg/tonne NaCN		
					0.28 kg/tonne $Ca(OH)_2$		
7259C	6	0	10.4	1.00/1.00	0.206	Tr	1610
		2	10.4	0.50/0.50	0.823	Tr	1880
		4	10.5	0.80/0.80	0.926	Tr	2040
		8	10.5	0.80/0.80	1.406	Tr	2150
		24	10.5	0.80/0.80	1.989	Tr	2160
		48	10.5	0.70/0.70	2.126	Tr	2180
				TAILS ASSAYS:	0.549	2.40	
					0.480		
				CALCULATED HEAD:	2.640		
				PERCENT RECOVERY:	80.53		
				CHEMICAL CONSUMPTION:	2.79 kg/tonne NaCN		
					0.28 kg/tonne $Ca(OH)_2$		

Tr signifies trace

1 - Copper in leach solution.

2.2.5 Agglomeration Tests

Prior to setting up large column tests, a series of tests were conducted on 1 kg samples to determine the agglomerating conditions required to form stable pellets for leaching. The first series of tests were run using either cement (Portland type 2) or hydrated lime or a combination of both using plain tap water. In all test runs using just these two agglomerating agents, even with cement levels of 20 kg cement per tonne of ore, the pellets formed were thixotropic and broke down rapidly.
Several tests were run with the addition of clay to act as a stabilizing agent. While this was successful, the amount of clay required appeared to be uneconomic.

A series of tests were then conducted using a common liquid household detergent added to the water to act as a wetting agent. The results of these tests showed that the addition of a wetting agent allowed stable pellets to be produced with cement added as the binding agent. Based on the results of these preliminary tests, the first two large scale column tests (nos. 6863 and 6888) were carried out on samples agglomerated with 20 kg cement per tonne of tailings using an agglomerating solution containing 2 gpl of the dishsoap (0.40 kg soap per tonne of ore).

A series of small column tests were run using the commercial detergent called "LOC". This product is sold as a detergent but is also used as a wetting agent for ores. The results of these tests showed that stable pellets could be formed with 15 kg cement per tonne using 0.1 grams LOC per liter of agglomerating solution (0.02 kg LOC per tonne of ore).

Another series of tests were conducted with the wetting agents Nalco 7852, 8801, 8814 and 8815 in order to determine optimum conditions for agglomeration. The results of these tests showed that by using a concentration of 0.25 gpl of Nalco wetting agent 8814 in the agglomerating solution (equal to 0.05 kg Nalco 8814 per tonne of ore), stable pellets could be produced using only 10 kg cement per tonne of ore. Based on the results of this series of tests, the material used for the last three locked-cycle tests was agglomerated using this set of conditions.

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2.2.6 Column Leach Tests

All column leach tests were run as continuously-drained drip leach tests. This type of test most accurately reflects actual heap leach conditions. The equipment used for these tests is shown schematically in figure 9. The agglomerated column leach tests were run in plexiglas columns 20 cm in diameter. The test with unagglomerated materal (7448) was run in a 9 cm diameter column.

2.2.6.1 Leach Test Procedure

The tailings to be leached were placed into the leach column as shown in figure 9. During a 24-hour "leach" period, alkaline cyanide solution was continuously distributed onto the ore. Flowrate of solution dripping onto the tailings was controlled with a peristaltic pump to approximately 10 - 12 liters per hour per square meter of heap (column) surface. This is within the range of normal application rates of leach solution on production heaps.

The solution exiting the leach column was collected in the bottom (floor) tank. Leach solutions were checked during each cycle for pH, NaCN, Au and Ag. Copper was checked periodically. The solution was then passed through a bottle of activated carbon over a period of 24 hours to recover the gold and silver in solution. During this period the column was dormant. After passing through the bottle of activated carbon, the solutions were rechecked for pH, NaCN, Au and Ag. Sodium cyanide and hydrated lime were then added, if necessary, to maintain the solution at the desired levels. The leach solution was then recycled to the ore for another 24-hour leach period. This 24 hour leach/dormant cycle was used for the duration of the test.

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The charge of activated carbon was changed three to five times during the tests and assayed to determine the amount of gold and silver recovered from the ore. Essentially no silver was recovered from the samples. In some cases, the samples showed silver by fire assay, however in all cases the silver content was below the 12 grams per tonne normally considered to be the lower limit of accuracy of a silver fire assay. Figures 12 and 13 present the results of the carbon assays.

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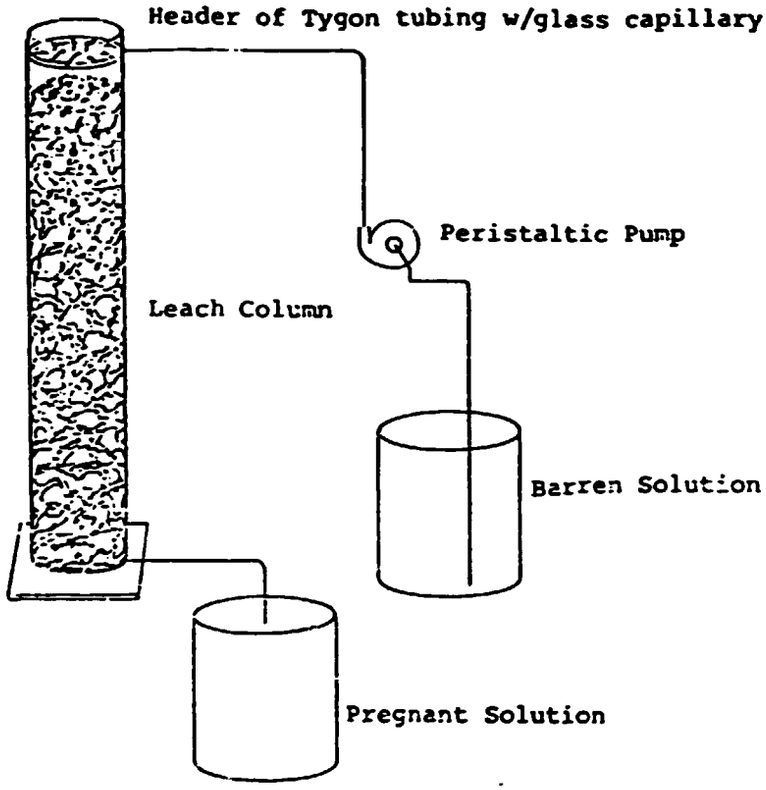
FIGURE 9. COLUMN TEST APPARATUS



CARBON RECOVERY SYSTEM

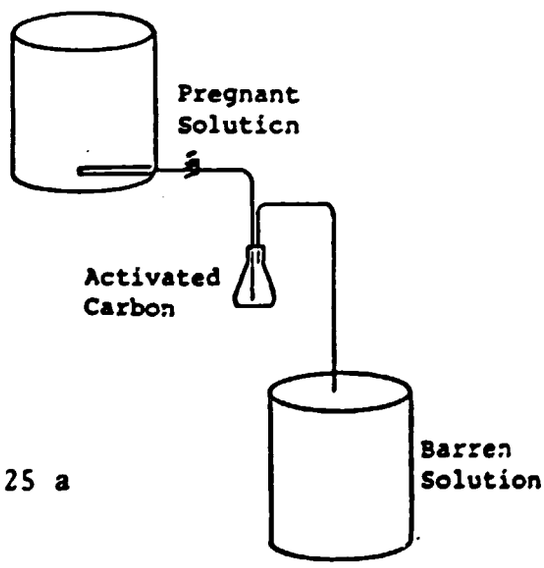


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FIGURE 10. TORCO TAILINGS AGGLOMERATED COLUMN TESTS
AGGLOMERATING CONDITIONS

TEST NO.	WEIGHT TAILINGS KG	CEMENT ADDED KG/TONNE	AGGLOMERATING SOLUTION gpl NaCN	WETTING AGENT	CONCENTRATION WETTING AGENT gpl	LITERS OF SOLUTION USED
6863	76	20	0.0	Ivory Soap	2.0	16.80
6888	76	20	1.0	Ivory Soap	2.0	16.95
7149	75	20	1.0	Ivory Soap	2.0	16.32
7257	75	10	5.0	Nalco 8814	0.25	17.40
7433	75	10	5.0	Nalco 8814	0.25	17.52
7531	75	10	5.0	Nalco 8814	0.25	16.53

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FIGURE 11. TORCO TAILINGS BULK SAMPLE
CYANIDE COLUMN LEACH TESTS
COLUMN TEST EFFLUENTS

	INITIAL EFFLUENT			
TEST NO.	pH	NaCN gpl Free/Total	COLOR	CLARITY
6863	11.9	0.05/0.05	Colorless	Clear
6888	12.1	0.05/0.05	Colorless	Clear
7149*	11.7	0.04/0.04	Colorless	Clear
7257*	11.6	0.34/0.34	Lt. Blue	Clear
7433*	11.4	0.53/0.53	Lt. Blue	Clear
7531*	11.8	0.61/0.61	Med. Blue	Clear
7448**	8.2	0.04/0.04	Colorless	Clear

	FINAL EFFLUENT			
TEST NO.	pH	NaCN gpl Free/Total	COLOR	CLARITY
6863	12.1	0.34/0.34	Lt. Blue	Clear
6888	11.8	0.79/0.79	Lt. Blue	Clear
7149*	11.8	0.22/0.22	Lt. Blue	Clear
7257*	11.5	0.40/0.40	Colorless	Clear
7433*	11.1	0.43/0.43	Colorless	Clear
7531*	11.6	0.61/0.61	Colorless	Clear
7448**	8.7	0.00/0.00	Colorless	Clear

* - Locked cycle column tests.

** - Unagglomerated column test.

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FIGURE 12. TORCO TAILINGS BULK SAMPLE
CYANIDE COLUMN LEACH TESTS
METAL RECOVERY AND CHEMICAL CONSUMPTION

TEST NO.	DAYS LEACHING	METAL RECOVERED Au g/t	Ag g/t	PERCENT GOLD RECOVERED	CHEMICAL CONSUMPTION kg per tonne NaCN	$Ca(OH)_2$	COPPER IN LEACH SOLUTION ppm
6863[1]	6	0.343	Tr	13.10	0.32	0.08	5
	19	0.994	Tr	37.95	0.43	0.00	273
	34	0.309	Tr	11.80	0.24	0.00	436
	TOTAL:	1.646	Tr	62.85	0.99	0.08	
	TAILS ASSAY:	0.973	1.59				
	CALCULATED HEAD:	2.619	1.59				
6888[1]	6	1.131	Tr	44.21	0.59	0.02	156
	20	0.549	Tr	21.46	0.59	0.00	582
	41	0.274	Tr	10.71	0.51	0.00	980
	60	0.171	Tr	6.68	0.42	0.00	1250
	91	0.120	Tr	4.69	0.45	0.00	1410
	TOTAL:	2.245	Tr	87.75	2.56	0.02	
	TAILS ASSAY:	0.317	0.39				
	CALCULATED HEAD:	2.562	0.39				
7448[2]	20	0.103	Tr	3.84	1.23	0.77	80
	40	0.514	Tr	19.16	0.83	0.47	681
	67	0.377	Tr	14.05	0.77	0.43	980
	TOTAL:	0.994	Tr	37.05	2.83	1.67	
	TAILS ASSAY:	1.689					
	CALCULATED HEAD:	2.683					

Tr signifies trace.

1 - Agglomerated test. See Figure 10 for agglomerating conditions.

2 - Unagglomerated column leach test.

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FIGURE 13. TORCO TAILINGS BULK SAMPLE
LOCKED-CYCLE CYANIDE COLUMN LEACH TESTS
METAL RECOVERY AND CHEMICAL CONSUMPTION

TEST NO.	DAYS LEACHING	METAL RECOVERED Au g/t	Ag g/t	PERCENT GOLD RECOVERED	CHEMICAL CONSUMPTION kgs per tonne NaCN	$Ca(OH)_2$
7149 Cycle 1	7	1.046	Tr	40.61	0.59	0.03
	17	0.600	Tr	23.29	0.45	0.00
	33	0.480	Tr	18.63	0.46	0.00
	TOTAL:	2.126	Tr	82.53	1.50	0.03
	TAILS ASSAY:	0.450	Tr			
	CALCULATED HEAD:	2.576	Tr			
7257 Cycle 2	5	1.646	Tr	60.12	1.42	0.00
	22	0.634	Tr	23.16	0.50	0.00
	35	0.137	Tr	5.00	0.19	0.00
	TOTAL:	2.417	Tr	88.28	2.11	0.00
	TAILS ASSAY:	0.321	0.60			
	CALCULATED HEAD:	2.738	0.60			
7433 Cycle 3	6	1.543	Tr	59.78	1.37	0.00
	20	0.614	Tr	23.79	0.38	0.01
	28	0.137	Tr	5.31	0.24	0.03
	TOTAL:	2.294	Tr	88.88	1.99	0.04
	TAILS ASSAY:	0.287	Tr			
	CALCULATED HEAD:	2.581	Tr			
7531 Cycle 4	7	1.474	Tr	53.85	1.27	0.03
	19	0.651	Tr	23.79	0.21	0.00
	34	0.171	Tr	6.25	0.20	0.00
	TOTAL:	2.296	Tr	83.89	1.68	0.03
	TAILS ASSAY:	0.441				
	CALCULATED HEAD:	2.737				

Tr signifies trace.

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2.2.7 Test Details

2.2.7.1 Start-up of Tests

The initial leach solution for all seven column leach tests contained 1.0 gram sodium cyanide per liter. The initial solution for tests 6863, 6888, 7149 and 7448 also contained 0.5 gram hydrated lime per liter of solution (the amount of hydrated lime used in the tests was negligible and only cement will be used in production systems). Initial effluents from the six tests with agglomerated material ranged in pH from 11.4 to 12.1 and in cyanide content from 0.04 to 0.61 gpl free sodium cyanide. The initial effluent from the test on unagglomerated tailings (test no. 7448) had a pH of 8.2 and contained 0.04 gpl free sodium cyanide. These data are presented in figure 11.

2.2.7.2 Solution Clarity and Color

The initial effluents from all seven tests were clear and colorless or light blue in color. The color and clarity of the initial and final effluents from each test are presented in figure 11.

2.2.7.3 Cyanide Strength and Alkalinity

The initial leach solution for each of the column leach tests contained 1.0 gram sodium cyanide per liter. Cyanide strength of onflow solutions was adjusted to 1.0 gram NaCN per liter before recycling the leach solutions for the duration of the tests.

Hydrated lime was used to maintain the leach solutions above pH 10.0. In the tests on agglomerated tailings, hydrated lime was only required for conditioning any makeup water added to the tests as the cement used for agglomeration helped to maintain the pH above 11.0 for the duration of the tests.

Cyanide consumption in the six agglomerated column tests averaged 1.66 kgs sodium cyanide per tonne of ore and ranged from 0.99 t0 2.11 kg per tonne of ore. Previous laboratory / field scale-up experience has shown that chemical consumption in field heaps after

60 days is typically less than 30-day consumption in laboratory tests. Based on this observation, 60-day cyanide consumption in field heaps is projected to be less than 2.00 kg sodium cyanide per tonne.

Lime consumption in the six tests with agglomerated material averaged only 0.03, with the cement used for agglomeration being sufficient to maintain the protective alkalinity of the leach solutions above pH 10.0.

Test 7448 was run on a 15 kg portion of unagglomerated tailings for a period of 67 days. The observed flowrate was below the design rate and the permeability completely insufficient.

2.2.7.4 Rate of Gold Recovery

Figures 1, 2 and 3 present graphs of the gold recovery versus days of leaching for each of the seven column tests. Test 7448 on the unagglomerated sample showed the slowest rate of recovery and lowest overall recovery.

The rate of recovery in the tests with agglomerated material was moderate, with all seven tests still showing gold recovery continuing when the tests were ended. In the locked cycle test series, agglomerating with high strength cyanide solution initially resulted in higher gold recoveries and faster recovery rates.

2.2.7.5 Tailings Analysis

At the completion of the column tests the tailings were removed from the columns and dried in an oven. The dried tailings were then put through a 10 mesh screen to break up the agglomerates and the sample was split into quarters. Two 500 gram portions were then split out from each quarter, pulverized and one pulp from each portion submitted for fire assay.

Figures 14 through 20 present the results of the tailings assays.

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FIGURE 14. TORCO TAILINGS COLUMN TEST 6863
TAILINGS FIRE ASSAYS

SPLIT	Au g/t	Ag g/t*
A	1.029	Tr
	1.029	1.71
B	0.823	0.69
	1.063	1.37
C	0.891	2.06
	0.994	3.77
D	1.029	2.74
	0.926	0.34
AVERAGE:	0.973	1.59

*Tr signifies trace.

FIGURE 15. TORCO TAILINGS COLUMN TEST 6888
TAILINGS FIRE ASSAYS

SPLIT	Au g/t	Ag g/t
A	0.446	Tr
	0.309	Tr
B	0.377	Tr
	0.206	Tr
C	0.377	Tr
	0.206	2.06
D	0.411	Tr
	0.171	1.03
AVERAGE:	0.313	0.39

Tr signifies trace.

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FIGURE 16. TORCO TAILINGS COLUMN TEST 7149
TAILINGS FIRE ASSAYS

SPLIT	Au g/t	Ag g/t*
A	0.514	Tr
	0.411	Tr
B	0.446	Tr
	0.411	Tr
C	0.514	Tr
	0.411	Tr
D	0.480	Tr
	0.411	Tr
AVERAGE:	0.450	Tr

*Tr signifies trace.

FIGURE 17. TORCO TAILINGS COLUMN TEST 7257
TAILINGS ASSAYS

SPLIT	Au g/t	Ag g/t*
A	0.274	1.37
	0.309	Tr
B	0.343	Tr
	0.343	Tr
C	0.411	3.43
	0.309	Tr
D	0.274	Tr
	0.309	Tr
AVERAGE:	0.321	0.60

* Tr signifies trace.

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FIGURE 18. TORCO TAILINGS COLUMN TEST 7433
TAILINGS FIRE ASSAYS

SPLIT	Au g/t	Ag g/t*
A	0.274	Tr
	0.309	Tr
B	0.274	Tr
	0.309	Tr
C	0.274	Tr
	0.343	Tr
D	0.206	Tr
	0.309	Tr
AVERAGE:	0.287	Tr

*Tr signifies trace

FIGURE 19. TORCO TAILINGS COLUMN TEST 7448
TAILINGS FIRE ASSAYS

SPLIT	Au g/t	Ag g/t*
A	1.611	Tr
	1.646	Tr
B	1.577	Tr
	1.646	Tr
C	1.886	Tr
	1.783	Tr
D	1.851	Tr
	1.509	Tr
AVERAGE:	1.689	Tr

*Tr signifies trace.

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FIGURE 20. TORCO TAILINGS COLUMN TEST 7531
TAILINGS FIRE ASSAYS

SPLIT	Au g/t	Ag g/t*
A	0.343	Tr
	0.411	Tr
B	0.754	Tr
	0.411	Tr
C	0.377	Tr
	0.411	Tr
D	0.274	Tr
	0.549	Tr
AVERAGE:	0.441	Tr

*Tr signifies trace.

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2.2.8 Assaying Procedure

2.2.8.1 Heads of Tailings

The samples for fire assay were submitted to two independent commercial laboratories for assaying.

2.2.8.2 Carbon Assays

The loaded activated carbon was dried and weighed. Two samples were split out and assayed and the remainder saved for reference. The carbon for assay was roasted to convert it to ash and then conventionally fire assayed.

2.2.8.3 Solution Assays

Approximate solution assays were made every cycle on an atomic adsorption spectrophotometer using gold and silver standards which had been calibrated by fire assay. The solution assays were used merely to check on the progress of leach since actual recoveries were based on fire assays of the activated carbon.

Final leach solutions were checked by atomic adsorption methods and found to contain negligible amounts of gold and silver.

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3 General Design Parameters

3.1 Metallurgical Basis of Design Concept

The project is designed to process 310,000 tpy (at 100 percent utilization rate) of TORCO tailings by heap leaching methods. The real usage of the capacity (rate of availability), however, is assumed to be lower and will probably be only 64 percent within the first year of production and 80 percent in the following years.

The tailings to be treated come from a refractory copper oxide ore which was previously treated by the TORCO process at Akjoujt / Mauritania.

The reserves of the so-called TORCO tailings and the gold content were previously determined with 2.5 million tonnes and 3 grams per tonne respectively.

Laboratory column leach tests indicate that the tailings will leach well when agglomerated with cement (10 kg per tonne) and a diluted solution of NaCN and a wetting agent (Nalco 8814 or equivalent). The tests suggest that an industrial plant could recover 85 percent of contained gold in 90 days of leaching.

The tailings contain a maximum of 0.16 percent soluble copper which will consume cyanide, but not to an uneconomical degree based on current gold prices. Pending operating experience, a portion of the process solution may periodically be discharged and replaced to prevent poor leaching behavior due to copper buildup in solution. However, this sub-process is not thought to be necessary and, therefore, not included in this study.

3.2 Description of Production Systems

A generalized process flowsheet is presented in drawing no. 801-31-180 UA.

The tailings will be disced at the site of the deposit by an agricultural disc plow followed by a roller. Both machines will be towed by an agricultural tractor. The "delumped" and disaggregated tailings

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will be taken by a front-end loader and loaded on trucks for the transport to a feed bin. The material will then be transferred to a rotating drum for agglomeration with cement, NaCN and a wetting agent.

The fresh agglomerates will be transferred by sectional conveyors and a radial stacker which will pile up the material on a 6 m high heap. The heap will be built on a plastic sheet (pad) and this pad will be protected by a sand cover in areas where the stacking equipment operates.

Agglomerates will be leached for 45 days in a primary cycle, then leached for 45 days in a secondary cycle. The pads, ponds and solution ditches will be arranged so that solutions from different heap segments will flow to different storage ponds in a countercurrent flow. After leaching is completed (several cycles may be required), the heaps will be washed and abandoned.

Each heap module will measure 106.5 by 45 meters and will contain 38,700 tonnes of material (equivalent to 45 calendar days of production). The total area under leach will be equal to two heap modules and will cover approximately 9600 square meters including two sideslopes.
Process solution will be applied at the rate of 10 liters per hour per square meter, or 48 cubic meters per hour per heap module.

Gold will be recovered in a carbon adsorption-desorption-recovery (ADR) plant. In the adsorption section of the recovery plant the pregnant leach solution will be contacted with 6 x 12 mesh activated carbon in an upflow, fluidized system. In the desorption section the carbon will be stripped using a pressurized high-temperature caustic solution. The gold-bearing strip solution will flow to an electrolytic cell for recovery of the gold.

At peak capacity, 540 kg of carbon can be processed in the stripping plant each day.

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3.3 Design Parameters

Operating days per period

agglomer. + stacking	26 days/month; 12 months/year
leaching	30 days/month; 12 months/year

Production rate	310,000 tonnes per year
	25,800 tonnes per month
	1,000 tonnes per day
	(agglomerating & stacking)
	860 tonnes per day
	(leaching)

Gold recovery

ore head grade	3.00 gram gold / tonne *
recovery	2.55 gram gold / tonne (85 %)

Heap height	6 meters
Heap bulk density	1.44 dry tonnes/cubic meter
Duration of leach cycle	45 days
Number of leach cycles	2 process cycles plus wash
Heap flowrate	10 liters/hour/sq meter
	48 cubic meters/heap/hr
Plant operating flowrate	48 cubic meters / hour
Plant capacity flowrate	58 cubic meters / hour

Fresh water requirements

adsorption by ore	7.2 cubic meters / hour
leaching + washing	22.1 cubic meters / hour
pond evaporation	0.4 cubic meters / hour
estimated camp usage	5.1 cubic meters / hour
t o t a l	34.8 cubic meters / hour

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* see page 18

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3.4 Reagent Requirements

Lab test data indicate that the following levels of reagent addition should be used for design of field operation:

cyanide added at agglomeration	2.00 kg/tonne
cyanide added at intermediate pond	0.00 kg/tonne
cement added at agglomeration	10.00 kg/tonne
Nalco 8814 wetting agent added at agglomeration	0.04 kg/tonne
solution added at agglomeration	250.00 kg/tonne
project cyanide consumption	2.00 kg/tonne

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4 Material Handling Design and Capital Costs

4.1 Feed Reclamation

The tailings deposit has an irregular hard (naturally cemented) top surface. The material in the interior of the deposit is expected to vary from hard and dry to sandy and wet.

The design of the feed reclamation is based on the assumption that the tailings can be removed in layers and that any further comminution prior to agglomeration is not necessary.

A disc plow combined with a roller is required for cutting and breaking of the material in a single operation. This disc plow and the roller will be attached to a tractor, which is further equipped with a grader and a shovel to achieve a multipurpose availability.

The tailings will then be taken by a front-end loader and loaded on trucks for the transport to a feed bin.

In addition, an emergency stockpile should be kept to feed the plant out of this stockpile with the front-end loader in case of unforeseen breakdowns.

For the initial preparation of the tailings it is necessary to grade the surface with a dozer. This dozer can also be used in the plant for other purposes, for example road construction and maintenance and grading of the surface for the leaching area.

The degree of "delumping" is critical to the success of agglomeration and leaching. The finished pellets will feature a diameter of 6 mm to 15 mm; however, they will be stable only if they are formed from ore material which largely consists of fine disaggregated particles. Pellets which contain natural "lumps" of material larger than 4 mm will partially break apart in the heaps. A large amount of breakage is expected and can occur without significant effect, but if the breakage becomes too severe then heap permeability and gold recovery levels will decline.

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Based on experience with similar mining (disc plowing) techniques on tailings in Australia and high-clay ores in Costa Rica, it is felt that the attainment of a correct combination of mining and agglomeration techniques will be a fairly simple procedure. Continued quality control of mining operations to meet the target for the lump size of feed material will be very important.

Preparing, "mining", hauling and feeding the tailings will require the following items of new equipment:

1 disc plow with roller
1 tractor
1 front-end loader
3 15 t trucks

The investment for this mining equipment amounts to US-Dollar 700,000 including freight and insurance.

In addition, auxiliary mobile equipment is needed also for other departments of the plant. The assumption is made that the following equipment is not available in Akjoujt for the time being and has therefore to be bought:

1 dozer
1 15 t truck
1 2.5 cu meter front-end loader
1 2 t forklift
1 1 t pick-up truck

For this equipment US-Dollar 540,000 including freight and insurance have to be spent.

4.2 Agglomeration

Agglomeration is a process in which fine feed material is mixed with reagents and moistened, then formed into small rounded pellets by a tumbling action. Once proper moisture is achieved, some "agglomeration" takes place at belt transfer points and other places where the material is agitated. Correct agglomeration requires a rolling action to densify the pellets, and this is accomplished in an agglomerating drum.

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The laboratory test program on the TORCO tailings indicates that they will easily form agglomerates. Addition of 10 kg Portland cement per tonne of tailings will provide sufficient strength so the agglomerates will retain their permeability during heap leaching. It is also necessary to add a wetting agent.

Laboratory testing also indicates that introduction of high-strength cyanide solution into the agglomerating drum increases rate and overall level of gold recovery. For this reason, most of the cyanide used in the process will be added to the ore during agglomeration.

The agglomeration and reagent addition process will consist of the following activities:

4.2.1 Ore Feed

For proper operation of the agglomeration systems, ore feed rate must be constant. The ore will be fed from a hopper equipped with a continuous conveyor belt at the bottom. The belt speed will be controlled by a variable speed drive.

4.2.2 Cement Addition

Cement will be fed onto the conveyor belt by a dosing screw from the base of a bulk cement storage silo.

The silo will be filled by a bulk pneumatic truck.

4.2.3 Dosage of Cyanide Solution

Cyanide solution for agglomeration will be fed to the drum at a rate up to 600 liters per minute. This solution will be delivered by a separate process pump located in the barren pond. Solution will be introduced into the ore through spray heads located in pipes in the agglomerating drum. The amount of solution fed will be controlled manually by an operator at the discharge end of the drum.

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4.2.4 Wetting Agent

Wetting agent will be delivered to the site as a concentrated liquid in 200-liter drums.

Wetting agent will be added to the system by pumping through a high-pressure metering pump into the flowstream of solution before it is sprayed into the drum. Control of this feed and pumping system will be manual. Approximately 0.04 kg of wetting agent will be used per tonne of ore, equal to 40 kg per day.

4.2.5 Sodium Cyanide Addition

Sodium cyanide will be delivered to the site in 100 kg drums. The drums will be manually positioned, then dumped using a small winch hoist into a 2000 l agitated tank. Solution in the tank will be ten percent sodium cyanide, plus a small amount of sodium hydroxide for pH control.

4.3 Heap Construction

Since the agglomerated material must be carefully handled, the method of continuous conveyor handling has to be applied.

The heap construction is done by a radial conveyor stacker.

A 20-meter radial stacking conveyor with a 6.0-meter extendable/retractable tip will be used. This stacker will allow stacking up to 7.5 meters in height.

Design of the conveyor stacker is critical and selection of off-the-shelf standard stackers should be avoided.

Details of conveyor layout are shown in the drawings nos. 801-11-298 UA and 801-11-300 UA.

Agglomerated material will be transferred from the discharge of the agglomerating drum to the radial stacker using a transfer conveyor and a series of moveable conveyor belts.

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The transfer conveyor will discharge to one of two 100-meter conveyors placed in series. These two conveyors will be located parallel to and along the upslope side of the heap. They will be mounted on skids so they can be positioned by pulling with a moveable winch.

These long conveyors will feed a set of eleven 20-meter portable conveyors which will feed the radial stacking conveyor.

All of the 20-meter conveyors will be wheel-mounted for ease of relocation. They will be connected together with cable into a linear string so that they can be retracted in one operation.

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The installation for agglomeration, reagent addition and heap construction will include the following items of new equipment:

	US-Dollar
feed hopper / belt feeder	67,000.00
ramp and containment wall	10,000.00
cement silo and dosing screw	55,000.00
agglommeration solution system and plumbing	3,000.00
wetting reagent metering pump	2,000.00
NaCN addition system	5,000.00
feed / discharge conveyors	32,000.00
agglomerating drum	178,000.00
approx. 500 meters sectional conveyors	373,000.00
radial stacker	55,000.00
electric control unit	343,000.00
belt weightometer	20,000.00
equipment sub-total	1,143,000.00
installation / assembly 30 %	340,000.00
estimated freight / insurance	285,000.00
total installed cost	1,768,000.00

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5.0 Site Layout, Pad and Pond Design and Installation

5.1 General Layout

The layout of the leach pad area, ponds and plant site is shown in the attached drawing no. 801-11-298 UA.

The site was chosen because it is close to existing infrastructure and has a moderate slope which allows for drainage of the heaps. The site is approximately 1500 meters south of the TORCO tailings deposit and adjacent to the old TORCO process plant. The leach pad occupies an area of 475 x 740 meters which is sufficient to contain 2.5 million tonnes of stacked tailings. The local relief in the area is uniform sloping downward at an average grade of 1 percent to the northeast.

The final heaps will be built in two segments, each containing 1.25 million tonnes of tailings. Each 1.25 million tonne segment will be constructed with a continuous smooth top surface measuring 198 meters in an upslope-downslope direction and 720 meters across slope. As new material is stacked, each heap segment will be extended across slope in 45 meter wide modules.

Each of the 198 by 45 meter heap modules will be built during a 90-day production period. The downslope and upslope halves of each segment will be separated by an internal berm (described below) and will be leached in separate 45-day production heaps. Each 45-day production heap will contain 38,700 tonnes and measure 106.5 by 45 meters (including one sideslope).

5.2 Initial Leach Pad Installation

At the start of operations, sufficient leach pad material will be installed for the first year's operation. This requires a pad of 205 x 223 meters; the heaps are surrounded by a five meter border to minimize cyanide overspray loss.

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5.3 Berms

Two types of solution control berms will be constructed upon the pad surface. The berms are depicted in the attached drawing no. 801-11-301 UA.

The first type of berm will be used to isolate each heap segment from adjacent (across slope) heaps so that leach solutions in the various leach and wash stages can be kept separate. These longitudinal berms run up-slope/downslope and will be constructed by placing a 60 cm high mound of earth on top of the prepared ground surface below the PVC liner.

A second type of berm, called lateral berm, runs across slope and will be used within the heap segments to separate solutions from adjacent leach "modules" covering 45 days of ore production. These berms will be built using the same techniques as the longitudinal berms.

5.4 Solution Collection Ditches

Solution is transported in a ditch at the downslope edge of the pad into one of three ponds. This ditch is 0.5 meters deep, 2.5 meters wide at the base and 3.5 meters wide at the top.

The ditch contains two pipes which transport solution flowing from the heap modules into the pregnant or intermediate solution storage ponds. Short connecting ditches are placed between the pads and the main ditch. Short connecting pipes in these ditches can be easily re-connected into either of the two solution transfer pipes.

Solution flowrates into the pregnant and intermediate ponds will be monitored. These monitoring devices will be mounted in the ditches just before they enter the respective ponds. Solution samples will also be taken at this location.

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5.5 Drainage Base and Protective Cover

To ensure good drainage of solution from below the ore heaps and to prevent excessive hydrostatic head from building up on the plastic sheet, 50 mm perforated polyethylene pipe (agricultural drain pipe) will be installed on the PVC leach pad on six meter centers. This requires 7,800 meters of pipe for the first year's operation.

A cover of crushed rock will also be needed to protect the PVC pad in the area subject to vehicle traffic, especially where the stacker conveyor operates. Also, relatively heavy equipment such as front-end loader will drive across the pad surface when re-positioning the sectional conveyors. This "roadway" will occupy the central 25 meters of each 45 meter wide heap segment. The pads and pipe in this area will be protected with a textile cover (Geotextile) and 0.3 meters of crushed ore, sand or agglomerates made with extra cement.

5.6 Pad Installation Procedures and Costs

Installation of the pads, berms, ditches and drains will include the following activities:

1. rough grade the surface to obtain a natural but uniform slope. Fill small depressions where necessary

2. where fill is required, moisten the fill material to approximately 15 percent moisture and compact the fill in 0.25 meter layers

3. to construct the berms, spread out a layer of fine soil material, moisten and mix so that it contains approximately 20 percent moisture. Reclaim this material with a road grader or front-end loader and form berms. Compact the berms with a vibratory compactor

4. hand-rake and inspect the final surface. Remove rocks larger than 15 mm, plant residues and other foreign matter. Fine grade and compact the surface

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5. cut, grade and compact solution ditches

6. install a plastic pad sheet of 0.75 mm PVC for the heap pad and 0.90 mm plastic lining material (Hypalon) for the solution ditches and ponds

7. install and position solution transfer pipes in the lined solution ditches

8. install drain pipes on the top surface of the pad

9. cover the drain pipes with 0.3 meters of protective gravel or agglomerated ore

The pad, pond and ditch liners will be installed by a crew of 12 men. The liner material will be delivered to the site in factory-fabricated panels of approximately 1000 square meters each. These panels will be positioned over a section of prepared surface, then field-welded to the adjacent panels using a solvent cement.

The installed cost for the first year's pad (48,000 square meters of PVC) and solution ditches (3,000 square meters of Hypalon) is estimated below.

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	US-Dollar
Liner material	
48,000 sqm 0.75 mm PVC	122,000.00
3,000 sqm 0.90 mm Hypalon	17,000.00
20,000 sqm Geotextile	24,000.00
7,800 m perforated drain pipe	9,000.00
750 m solution transfer pipe	50,000.00
6,000 cum crushed rock	30,000.00
glue and installation tools	15,000.00
Equipment	
water truck: 12 days	
200.00 US D/day	2,400.00
dozer, D-8: 18 days	
560.00 US D/day	10,800.00
endloader: 30 days	
250.00 US D/day	7,500.00
(dozer and end-loader operating cost only, equipment required for the project)	
haul truck: 12 days	
300.00 US D/day	3,600.00
road grader: 15 days	
500.00 US D/day	7,500.00
vibratory compactor: 15 days	
500.00 US D/day	7,500.00
misc equipment	8,700.00
Site preparation / materials sub-total	315,000.00
Installation labor	25,000.00
Shipping / insurance for liner material	25,000.00
Equipment mob / de-mobilization	10,000.00
total installed first year's pads	375,000.00

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5.7 Pond Sizes and Designations

The layout of the heaps and ponds is shown in the attached drawings nos. 801-11-298 UA and 801-11-300 UA. There are four initial ponds: barren, intermediate, pregnant and fresh water. The capacity of the ponds will be sufficient to contain working solution volume and run-off for two leach cycles plus 30 mm of rainfall over the entire first year heap area. The total pond volume (not including the wash pond), divided equally among the three ponds is 4500 cubic meters.

Each of the three process ponds (1500 cubic meters) will have top edge dimensions of 27 by 27 meters. They will be excavated four meters deep in alluvial material with pond sideslopes at 2 : 1. The wash pond volume is 800 cubic meters. It will have top edge dimensions of 22 by 22 meters and will be three meters deep.

All ponds will be lined with 0.90 mm plastic sheet (reinforced Hypalon) and will contain a leak detection system below the liner. The detection system will consist of two textile layers (Geotextile) and a leak collection sump, connected to the surface by a 75 mm PVC pipe for observation and solution removal.

The function of the ponds is described below:

Pregnant solution pond

Solution from the heap that is under primary leach will flow into a pipe in the lined ditch located along the downslope edge of the leach pads and then into the pregnant pond. Solution will be pumped from here to the process plant.

Barren solution pond

Solution exiting the carbon adsorption columns will discharge into the barren pond. Cyanide strength will be adjusted when necessary by chemical additions to this pond, although it is expected that nearly all cyanide needed will be fed to the agglomerating drum. Solution will be pumped from this pond to the oldest heaps (in secondary or later leach cycles).

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Intermediate pond

Solutions from the heaps in the secondary leach cycle will flow into the intermediate pond. Wash solutions from old heaps will also flow into this pond. Solution will be pumped from this pond to the newest heaps (in the primary leach cycle).

Fresh water pond

This pond will receive water via a pipeline from the project water supply. Water will be pumped from this pond onto heaps in the wash cycle as needed to provide make-up water to the leaching system.

The installed cost for the three process solution ponds and the fresh water pond is estimated below:

	US-Dollar
excavation and compacting	15,000.00
equipment usage during installation	2,500.00
liner material	
2,050 sqm 0.9 mm Hypalon	11,500.00
2,050 sqm Geotextile	2,500.00
glue, leak detection system	18,500.00
miscellaneous supplies and equipment use	10,000.00
site preparation / materials sub-total	60,000.00
installation labor	5,000.00
shipping/insurance for liner material	4,000.00
total installed costs of ponds	69,000.00

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6.0 Flowrates and Water Requirements

The schematic water flow streams are shown in drawing no. 801-11-180 UA.

Each of the 198 by 45 meter heap modules (213 by 45 meters including two sideslopes) will contain 77,400 tonnes of ore, equivalent to 90 days of production. At any one time an area equal to 9600 square meters will be under leach (not including temporary wash cycles). In most operating conditions, 4800 square meters will be in primary leach and 4800 square meters in secondary leach, respectively. Process solution will be applied at the rate of 10 liters per hour per square meter or 48 cubic meters per hour per heap. The recovery plant is designed to process 48 cubic meters per hour. Evaporation of 20 percent of solution pumped will reduce the actual amount of solution available, so the plant effectively has 20 percent excess capacity.

Water make-up requirements include water absorbed and retained in the ore and losses due to evaporation.

Water absorption during agglomeration and subsequent saturation of the new heaps will be 200 liters per tonne of agglomerated ore or 5200 cubic meters per month.

Evaporation from heaps at constant humidity is a function of the amount of solution sprinkled. Average 24-hour loss due to evaporation is estimated at 20 percent of solution pumped onto the heaps or 13,800 cubic meters per month.

Wash cycle evaporation will be 15 percent of process water evaporation or 2,100 cubic meters per month.

Total process water requirement is therefore 21.100 cubic meters per month. Other water requirements for the project include camp drinkable supply and dust control needs for the haul roads and plant / office area. These are roughly estimated at 4,000 cubic meters per month.

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Current water sources should be reviewed to ensure water availability for 25,100 cubic meters per month or a continuous flow of 35 cubic meters per hour. According to information from SAMIN, the water supply will be ensured since the pipeline can deliver 58 cubic meters per hour.

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7.0 Recovery Plant and Heap Piping System

7.1 Recovery Plant Options

The recovery plant selected for Akjoujt is a modular carbon adsorption plant, incorporating a high-pressure hot strip followed by electrowinning of gold. The plant includes a smelting furnace and all associated equipment needed to recover dore bars on-site.

In the choice of recovery plants for cyanide leach operations, two basic options exist - recovery using zinc dust (Merrill-Crowe) and recovery using activated carbon. These two options are discussed below.

Merrill-Crowe vs. Carbon Adsorption for Gold Recovery

Zinc precipitation of gold and silver from pregnant solutions using the Merrill-Crowe process was developed several decades ago and is a common method of gold recovery. The process involves filtration and deaeration treatment steps followed by injection of zinc dust resulting in a gold-bearing filter cake. The filter cake is then dried and smelted in a furnace for production of a dore bar.

The carbon adsorption process is a more recent development and begins with the adsorption of gold and silver on activated carbon held in tanks or stages of a column. Because the carbon granules are large, pregnant solutions can be processed directly without prior filtration steps. The precious metals must then be stripped from the carbon and plated onto steel wool in an electrolytic cell. The cathodes are then smelted in a furnace and a bar is poured.

Zinc precipitation is best for treating clean process solutions containing high levels of dissolved gold and silver. When the metal content of the solution drops to low levels (such as those expected in the Akjoujt project), or when solutions become high in other metals or salts, zinc dust precipitation requires close technical supervision and continuous process adjustment.

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In comparison, a carbon adsorption plant can be operated by non-technical personnel regardless of the metal content of the solutions; it can process solutions high in suspended solids, dissolved salts or base metals and it allows for continued inexpensive recovery from low-grade dirty solutions.

Based on these and other criteria, a carbon adsorption recovery plant system is chosen for the study.

Carbon Stripping Alternatives

The two methods under consideration for removal of gold and silver from the loaded carbon are the alcohol/caustic (atmospheric pressure) stripping system and caustic pressure stripping system. Both methods are based on work conducted by J.B. Zadra at the United States Bureau of Mines in the early 1950's.

The alcohol/caustic system entails pumping a hot (85 degrees C) solution of 1 percent caustic soda, 1 percent sodium carbonate and 20 percent ethyl alcohol at atmospheric pressure through a batch of loaded carbon. The exiting solution is then passed through an electrolytic cell where gold and silver are plated out. The cell overflow solution is returned by gravity to a heated tank and recycled to the carbon. The entire stripping process, including electroplating, is completed in approximately 24 hours. The cathodes from the electrolytic cell contain the precious metals and these are transferred to a smelting furnace for production of dore bar.

The caustic pressure system is conducted essentially in the same way, except that it is conducted at a higher temperature and pressure (3 bars absolute, 130 degrees C). In order to achieve the high temperatures and pressures, the heating system is contained in a pressure vessel, and the system also contains heat exchangers and pressure control valves.

An alcohol strip procedure can be run in a system designed for caustic pressure stripping, but the reverse is not possible.

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Normally the alcohol strip system is applied because the capital cost of the plant is lower, there are fewer items of process equipment and control is easier.
However, for Akjoujt pressure stripping is recommended because of the difficulty and cost of procuring alcohol at this remote site.

7.2 Recovery Plant Design Parameters

Gold will be recovered in a carbon adsorption-desorption-recovery (ADR) plant.

The general design parameters of this plant are as follows:

Plant capacity at 100 % utilization *

ore process rate (26 days per month)	1,000 tonnes/day 310,000 tonnes/year
maximum plant solution flowrate	58 cu meters/h
operating plant solution flowrate	48 cu meters/h
gold recovery	
head grade (study 1983)	3.0 grams/t
plant design recovery	90.0 percent
expected field recovery	85.0 percent
total daily design recovery	2.7 kg Au
average gold content of pregnant solution	1.91 ppm Au
carbon loading levels	10.0 kg Au/t
carbon processed per day	255.0 kg

*
mode of operation at design capacity (100 % utilization)

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agglomerating, stacking (310,000.00 tpy)
26 days x 7 h/day x 12 months/year
leaching (310,000.00 tpy)
30 days x 24 h/day x 12 months/year

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mode of operation at 64 % availability (first year of production - basis of profitability calculation)

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agglomerating, stacking, leaching
310,000.00 tpy x 0.64 = 198,400.00 tpy
gold production
198,400 tpy x 3 g/t x 0.85 = 506 kg Au per year

mode of operation at 80 % availability (2nd and following years of production - basis of profitability calculation)

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agglomerating, stacking, leaching
310,000.00 tpy x 0,80 = 248,000.00 tpy
gold production
248,000 tpy x 3 g/t x 0.85 = 632 kg Au per year

7.3 Recovery Process Description

In the adsorption section of the recovery plant the pregnant leach solution will be contacted with 6 x 12 mesh granular activated carbon in an upflow, fluidized system. The adsorption equipment will consist of a single five-stage adsorption tower approximately 12.7 meters high and 1.13 meters diameter. Each stage will contain 540 kgs of carbon.

In the desorption section of the plant, the carbon will be stripped using a pressurized high-teperature caustic solution. The gold-bearing strip solution will flow to an electrolytic cell where the gold will be plated on steel wool cathodes. The cathodes will be processed in a diesel-fired pot furnace to produce impure metal bullion.

Following stripping, the carbon will be transferred to an acid wash tank where it will be washed with a dilute hydrochloric acid solution. Following acid washing, the carbon will be recycled to the adsorption tower.

Once every two to four months the carbon will be heat regenerated in a vertical tube or rotary regenerating furnace. The system will process 20 kg of carbon per hour.

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7.4 Recovery Plant and Equipment

The flowsheet of the recovery plant is shown in the drawings no. 801-31-180 UA. The process equipment for the recovery plant will consist of a vertical tower adsorption column (shipped separately); a strip-acid wash section installed in one 12-meter shipping container; a 6-meter shipping container containing storage and sump tanks and screens; a smelting furnace and miscellaneous equipment shipped in a separate 6-meter shipping container; and a carbon regeneration furnace shipped in a separate 6-meter shipping container.

The process equipment will consist of the following items:

- one 5-stage adsorption tower
- barren, intermediate, pregnant, wash pumps and controls (the pumps will be located at the ponds)
- instrumentation and sampling systems
- pressure strip solution system including two carbon strip vessels, electric in-line heaters, heat exchangers, back-pressure valves, strip solution storage tank, power supply and electrolytic cell
- acid wash system, carbon regenerating furnace and carbon transfer equipment
- fenced refinery area including flux storage facilities, flux mixing table, tilting furnace, crucibles, molds, slag process equipment, sink and water supply

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Investment costs of ADR plant

	US-Dollar
estimated price of 48 cu meters per hour recovery plant installed in two shipping containers with exterior five-stage adsorption tower, 4 process pumps and systems instrumentation	350,000.00
additional cost of pressure strip facilities and carbon regeneration	110,000.00
fenced refinery area and equipment, flux and slag process equipment, sink and water supply	35,000.00
equipment sub-total	495,000.00
five tonnes carbon; plus spare parts at 20 percent of equipment sub-total	135,000.00
field installation of ADR plant and associated process facilities	75,000.00
shipping: four 40-cu meter containers for ADR plant, refinery equipment and spare parts; plus 65 cu meters for adsorption tower, regenerating furnace and five tonnes carbon	75,000.00
total estimated cost of ADR plant assoc. facilities	780,000.00

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7.5 Heap Pipes and Sprinklers

At any given time during the leach cycle, solution or wash water will be sprinkled onto two heaps containing 77,400 tons of ore each at a flowrate of 10 liters per square meter per hour or 48 cubic meters per hour per heap.
The design also provides for sprinkling a third heap in a third-stage leach or a wash cycle; equipment and supplies for this third cycle are also included in costs.

The solution distribution system for two leach cycles and one wash cycle requires 720 meters of main solution headers and 1300 meters of sub-main solution headers. The main headers are of 150 mm diameter PVC and the sub-headers of 100 mm diameter PVC; these pipes are sized to accommodate a design flowrate of 800 liters per minute.

A total of 95 sprinklers per 77,400 tonne heap module will be spaced on a 6 x 9 meter pattern along the distribution lines. Each sprinkler will distribute approximately 9.0 liters of solution per minute on an area which will overlap the flow from adjacent sprinklers.

HDPE (high density polythylene) is a better material when exposed to hot sunny weather, but PVC (polyvinyl chloride) has been chosen because of easier installation. The installation of PVC requires simple tools and solvent welds, whereas HDPE requires specialized tools and heat welding techniques.

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Investment costs of heap piping system

	US-Dollar
solution main headers, 150 mm dia PVC, 720 m	18,000.00
solution sub-main headers 100 mm dia PVC, 1300 m	18,000.00
solution distribution lines 50 mm dia PVC, 2400 m	28,000.00
300 sprinklers	5,000.00
100 and 50 mm valves 70 pcs.	9,000.00
pipe fittings, various sizes, types 3000 pcs.	12,000.00
estimated freight / insurance	20,000.00
total first year pipe system	110,000.00

Heap piping for the second year of operation include 50 percent replacement of pipes and sprinklers. These requirements are listed as operating cost and are presented separately in section 11.7.

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8.0 Sampling Procedures and Laboratory Requirements

8.1 Concepts of Process Control

Heap leach process control will encompass several functions:

a. adequate sampling, weighing and assaying of solid (ore) samples to determine tonnages and ounces of gold placed on the heap

b. flow measurement and gold/silver/copper assays of process solutions to determine metallurgical recoveries

c. cyanide and pH measurements of process solutions

d. assays of activated carbon and strip solutions for correct control of recovery plant operations

The laboratory facilities required at Akjoujt will include preparation equipment to dry, mix, split and pulverize solid samples and a wet chemistry laboratory with atomic absorption spectrophotometer.

Fire assays of ore and carbon samples will be periodically required. However, results are not needed for immediate process control purposes and operation of a fire assay laboratory is not considered to be an on-site requirement. Samples for fire assay will be sent to commercial or government laboratories.

8.2 Sampling and Assaying Requirements

Ore samples

Grab samples consisting of 3 kg of ore feed to the agglomerating drum will be taken every 30 minutes by scooping material from the conveyor belt. The samples will be combined into 2-hour composites. Each of the composites will be weighed, dried, weighed again, split, pulverized and assayed for cyanide soluble gold content. A total of 2 to 6 solids samples will be processed per day. Additional grab samples may increase the total to ten per day.

A portion of each composite will be saved, and these will be combined into two-day master composites which will be sent for fire assay.

A weightometer at the agglomerating drum feed or discharge belts will record total throughput tonnage. If this weightometer is at the drum discharge, additional samples will be taken at this point for moisture determination.

Solution samples

Solution samples will be taken every four hours, 24 hours per day, at several points in the process area. These sample points are listed below:

- barren solution at the barren pump
- intermediate solution at the intermediate pump
- pregnant solution at the pregnant pump
- discharge from each carbon adsorption stage
- heap discharge at heap in primary cycle
- heap discharge at heap in secondary cycle
- heap discharge at heap in wash cycle
- strip solution entering electrolytic cell
- strip solution exiting electrolytic cell

A total of 54 solution samples will be processed per day. These will be analyzed by direct atomic absorption analysis for gold and copper (and occasionally other metals). They will also be analyzed for pH using a pH meter and titrated for cyanide content.

The flowrates from the heaps will be measured manually using open weirs. Adsorption tower flowrates and flowrates to each heap cycle (barren and intermediate) will be measured using continuous recording flowmeters. Electrolytic cell input and discharge flows will be sampled and measured using automatic proportional samplers (alternatively, the cell sampling and flowrate readings may be done manually).

Carbon samples

Carbon will be sampled each time it is transferred into or out of the strip vessels. Carbon will also be sampled from each adsorption stage at the end of each

month for monthly inventory control. Ten to fifteen carbon samples will be processed per month. Carbon samples will be sent for fire assays.

8.3 Sample Preparation and Assay Facilities

The laboratory will be mounted in one 12-meter shipping container.

The container for sample preparation and storage will include a dust collecting system, splitter, pulverizer and compressor. The wet assay lab will include an atomic absorption spectrophotometer, fume hood and fan, wrist action shaker, pH meter, centrifuge and general lab supplies. The container will be equipped with evaporative coolers, cabinets, benches, plumbing and electrics.

The container will be separated inside by a wall. One of the rooms will be used for sample preparation and the other for wet chemistry and analysis.

Investment costs of the field laboratory

	US-Doll
field lab equipment and supplies	77,000.
one shipping container / installation	23,000.00
freight and insurance	20,000.00
total field laboratory cost	120,000.00

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9.0 Infrastructure and Support Facilities

A summary of the estimated installed costs of the infrastructure and support facilities is presented below; a discussion follows for each category:

Investment costs of infrastructure and support facilities

f = foreign investment
l = local investment

	US-Dollar
power requirements * (f)	170,000.00
water requirements * (l)	330,000.00
trailer for personnel (f)	40,000.00
access/haul road construction or upgrade (l)	60,000.00
warehouse / changeroom	-
wind fences and site security (l)	25,000.00
service and support vehicles (f)	80,000.00
infrastructure sub-total	705,000.00
estimated freight / insurance	105,000.00
total infrastructure / support facilities	810,000.00

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* according to information from SAMIN US-Dollar 100,000 have to be spent for the repair of the water pipeline and US-Dollar 300,000 for the diesel engines. These amounts are included in the prices.

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Figure 21: Akjoujt 1000 tonnes/day Heap Leach

Motor List with Installed Power

	Equipment Description	Installed Power (kW)
A.	Primary transport conveyors (tailings area to plant area)	20
	Agglomerating drum	45
	Radial stacker	40
	Transfer conveyors (drum to heap)	100
	Winch	10
B.	Wetting agent metering pump	0.25
	Agglomerating solution pump	5.00
	NaCN agglomeration feed station with agitator	0,40
C.	Intermediate solution pump	12.00
	Barren solution pump	12.00
	Process water pump	12.00
	Pregnant solution pump	12.00
	Strip solution pump	0.75
D.	Strip solution heater, heat exchanger and controls	65.00
E.	Acid wash system	2.5
F.	Electrolytic cell, power supply exhaust hood with fan, proportional sampler and controls	7.5
G.	Smelting furnace and blower	3.0
H.	Regeneration kiln, gas fired	2.5
	Quench tank agitator	0.4
	Carbon transfer system with pump	4.0
	Carbon dewatering screen	0.5
	Carbon fines system	1.5
I.	Lights, general electrical service and evaporative coolers	7.0
J.	Laboratory complete	15.0
K.	Operator office	5.0
	T o t a l	383.3

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9.1 Power Requirements

Figure 21 is a list of motors and other power consuming equipment. Total installed power is 383 kW. The equipment in figure 21 is separated into groups lettered A through K. Consumed power, based on one shift of ore processing and 24 hours of heap operation, are estimated for each of the groups as follows:

Groups A and B

Group A equipment consists of the conveyors and agglomerating drum. These systems will operate 7 hours per day. The drum and stacker and incidental equipment (group B) will consume about 70 percent of their installed power. Also the conveyors will consume about 70 percent of their installed power. Total yearly power consumed for group A + B equipment is 309,650 kWhr (1.0 kWhr per tonne).

Groups C, I, J, K

These groups will operate 24 hours per day and will consume about 70 percent of their installed power. Total yearly power consumed for these groups will be 445,410 kWhr (1.44 kWhr per tonne).

Groups D through H

Equipment in these groups will operate intermittently with an estimated average power consumption (24 hours basis) of ten percent of their installed power. Total yearly power consumed for these groups will be 51,097 kWhr (0.16 kWhr per tonne).

Total power consumption will therefore be approximately 2.6 kWhr per tonne of ore processed.

Power for all project activities will be supplied by the existing power station. The cost of installed electrics for the various equipment items is included in the cost of the equipment. Additional power "infrastructure" requirements include about 100 meters of power line to the leach site and a main power distribution board. The installed cost of these facilities (including insurance and freight) is

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estimated to be US-Dollar 75,000.00. According to an information from SAMIN, the additional cost of diesel engine spare parts amounts to US-Dollar 300,000.00.

9.2 Water Requirements

As discussed in section 6.0, total water requirements are estimated to be 25,100 cubic meters per month. Water for all project activities will be supplied by the existing water supply system.

Additional water facilities will include 200 meters of 150 mm dia steel pipeline, a 20 cubic meter drinkable water tank and a domestic water pumping system. The installed cost of these extra water facilities (including insurance and freight) is estimated to be US Dollar 35,000.00.

The additional cost of repair of the pipeline amounts to US-Dollar 100.000.00 (information from SAMIN).

9.3 Trailer for Plant Personnel

This facility will consist of two 6-meter trailers, equipped with electrics, air-conditioner, furniture and communication. The installed cost of these facilities (including insurance and freight) is estimated to be US-Dollar 60,000.00.

9.4 Access / Haul Road Construction or Upgrade

Approximately two kilometers of existing road will have to be improved. The time and material for road improvement is estimated to require 4,000 cu meters of gravel and three weeks of an equipment fleet including a dozer, grader, water truck and a supervisor. The total cost of this work is estimated to be US-Dollar 60,000.00.

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9.5 Warehouse / Changeroom

It is assumed that the facilities for the warehouse and changeroom are currently available at the project site. If not, these items will be housed in three of four 6-meter trailers. The trailers will be equipped with simple electrics, ventilation and storage facilities. The installed cost of these facilities are not included in the cost estimates.

9.6 Wind Fences and Site Security

Approximately 1000 meters of 4-strand barbed wire fence will be installed around the first year's project site layout. In addition, about 500 meters of thatch fencing for wind breaks and sand diversion will be placed in the windward side of the project. For the process plant and solution pond areas, approximately 200 meters of two-meter high chain link fence will be installed. The total installed cost of site fencing (including insurance and freight) is estimated to be US-Dollar 30,000.00.

9.7 Service and Support Vehicles

Two pick-up trucks and an all-purpose fork-lift will be required for general project support. Delivery cost (including insurance and freight) of these vehicles is estimated to be US-Dollar 90,000.00.

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10.0 Personnel

10.1 Professional and Clerical Staff

The projected professional and clerical staffing suggested for the Akjoujt Heap Leach Project is listed below.

- 1 General Operations Manager
  Experienced senior engineer who is familiar with the business and technical aspects of production operations. Ultimate responsibility for all phases of mine-plant control, gold production and safety.

- 1 Chief Metallurgist / Project Engineer
  Senior engineer with a basic understanding of the heap leaching and carbon processing phases of the operation. Responsible for daily plant operations, process improvement, operator supervision and training, leach and plant equipment maintenance, metallurgical accounting and smelting operation.

- 1 Chemist / Assayer
  Degreed chemist responsible for all functions of the laboratory and sample preparation, including equipment / instrument upkeep, requisitioning of supplies, maintaining records and calculating metallurgical summaries and supervision of lab personnel.

- 1 Bookkeeper
  Bilingual bookkeeper who is familiar with general accounting and bookkeeping procedures, payroll calculations and purchasing functions.

- 1 Bilingual Secretary

10.2 Skilled Operating Personnel

- 4 ADR Plant Operators
  Persons who are familiar with general industrial processes. These individuals will be trained to operate the ADR plant. Specific tasks will include solution sampling, carbon transfer, stripping, acid washing and plant record keeping.

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- 2 Laboratory Assistants
  Persons who are familiar with general industrial processes. These individuals will be trained to assist the chemist. Specific tasks will include solid and solution sample preparation, sample and assay data record keeping.

- 3 Agglomerating / Stacking Operators
  Persons who are familiar with general industrial processes. These individuals will be trained to operate the agglomerating and stacking equipment. Specific tasks will include daily equipment maintenance, start-up and shut-down procedures, reagent additions and feed material sampling.

- 6 Equipment Operators
  Experienced equipment operators who are familiar with daily equipment maintenance. These individuals will be responsible for the daily service and operation of the heavy equipment fleet (trucks, dozer and endloader).

10.3 Operating Personnel

- 5 Heap Operators
  These persons will be trained to monitor and maintain the heap systems. Specific tasks will include heap pipe and sprinkler installation, heap solution sampling and miscellaneous support work.

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10.4 Heap Leach Technical Training Program

KHD strongly recommends the performance of a four-week heap leach technical training program for 4 people from the skilled operating personnel.

Such a program is designed to train a four-member team to manage and operate a typical 1,000 tonne per day heap leach operation. The key elements of the program and associated costs are as follows:

- four-day eduction in heap leach technology covering typical unit operations
- several two or three-day site visits to various operating mine / heap leach operations
- field exposure to material handling, leach pad and heap maintenance, recovery plant operations, laboratory and plant control and refinery systems.

	US-Dollar
daily room and board expenses	12,000.00
transportation (4 people)	21,000.00
engineering instruction by a senior engineer assigned full time for a four day seminar	13,000.00
field expenses for site visits	4,000.00
total technical training program	50,000.00

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11.0 Operating Costs

The operating costs developed below are based on an annual production rate of 310,000 tonnes per year.

11.1 Professional Staff, Operating Labor, Administration, Overheads

f - foreing
l - local
a - administration
d - direct labor

	US-Dollar/month
project manager (f, a)	7,500
project engineer (f, d)	6,500
maintenance mechanic (l, d)	6,500
chemist (l, a)	2,000
bookkeeper (l, a)	1,000
secretary	1,000
operating labor (l, d) US D 16.00 / manshift	8,000
total professional and labor	32,500
	= 1,26 per tonne
administration overheads (10 %)	3,250

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11.2 Discing and Hauling Tailings to Leach Site

The cost of equipment operators is included in section 11.1. The operating costs listed below are for company-owned vehicles and include costs of maintenance, tires, fuels and repairs.

	US-Dollar per month
haul truck fleet (3 trucks) each truck 15.25 US-D per hr 130 hrs/month	5,950.00
endloader, 20.35 US-D per hour 130 hrs/month	2,645.00
dozer, 20.15 US-D per hour 180 hrs/month	3,625.00
disc plow (1 agriculture type) 7.40 US-D per hourhr 50 hrs/month	370.00
total disc / hauling operation	12,590.00
	= 0.49 per tonne

11.3 Agglomerating and Stacking

The labor and power costs to operate the agglomerating drum and stacking equipment are included in sections 11.1 and 11.5.

The costs listed below are for maintenance of the equipment and operation of the endloader. The maintenance cost is based on 8 percent of capital costs.

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	US-Dollar
belt feeder	32,000.00
agglomerating drum	178,000.00
conveyors	373,000.00
radial stacker	55,000.00
total capital cost	638,000.00

	US-Dollar per year
operating cost 8 percent	51,000.00
plus endloader 13.50 hr = 2460 hrs/month	33,200.00
total agglomerating and stacking	84,200.00
	= 0.27 per tonne

11.4 Leach Solution Reagents

The labor and power costs to operate the reagent addition systems are included in sections 11.1 and 11.5. The costs listed below include the reagent consumption rate based on the laboratory test multiplied by the estimated delivery cost of each consumable.

	US-Dollar per tonne
sodium cyanide 2.0 kg/tonne US-D 1.50/kg	3.00
cement (Portland) 10.0 kg/tonne US-D 0.13/kg	1.30
Nalco wetting agent 0.04 kg/tonne US-D 5.00/kg	0.20
total leach solution reagents	4.50

1,395,000.00 per year

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11.5 Leach Utilities: Power and Water

Project power and water requirements are discussed in sections 9.1 and 9.2. The costs listed below assume an electrical power cost of US-Dollar 0.10 per kWhr and a water cost of US-Dollar 0.07 per cubic meter.

	US-Dollar per tonne
electric power 2.60 kWhr per tonne US-D 0.10/kWhr	0.26
drinkable water one cu meter per tonne US-D 0.07 / cu meter	0.07
total leach utilities costs	0.33

102,300.00 per year

11.6 Leach Pads and Ponds

The capital cost of first year's leach pad, drainage base and solution ditch is US-Dollar 375,000.00. This cost is outlined in section 5.6. An additional 45,000 square meters of pad materials will be required for subsequent years at an estimated capital cost of US-Dollar 265,000.00 per year (or US-D 5.89 per square meter). No additional ponds will be required.

	US-Dollar
45,000 sq meters US-D 5.88/sq meter	265,000.00 per year 0.85 per tonne

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11.7 Heap Pipe System

Capital costs of the first year's heap piping requirements and sprinklers are US-Dollar 110,000.00. These costs are outlined in section 7.5. Heap piping costs of the second year's operation include replacement of 60 percent of all pipes, valves and sprinklers.

	US-Dollar
60 percent of US-D 110,000.00	66,000.00 per year
	0.18 per tonne

11.8 Laboratory and Assay Systems (allocated to Factory Overheads)

Operating costs of the laboratory and assay system to control the feed material and plant functions are presented below. Laboratory labor and utilities costs are included in sections 11.1 and 11.5.

	US-Dollar per year
solid sample preparation / assay 20 per day US-D 2.50 per sample	15,600.00
soln sample preparation / assay 40 per day US-D 2.00 per sample	25,000.00
fire assay (outside check) 5 per day US-D 10.00 per sample	15,600.00
total laboratory/assay system	56,200.00
	= 0.18 per tonne

11.9 ADR Recovery Systems Operation

During one year of operation, approximately 800 kg of gold would be recovered from 310,000 tonnes of ore (design capacity). At an average carbon loading level of 10.0 kg metal per tonne of carbon, 80 tonnes of carbon will be stripped during one operating year. Approximately one tonne of carbon will be processed in each strip cycle.

The composition of the produced dore metal is still unknown. Depending on the gold loading level of the carbon, the gold content of the bullion from the electrolysis is expected to be between 10 and 50 %. In order to guarantee the copper content of the bullion, a semi-production facility will have to be run on-site for a period of at least three months at a rate of 100 tonnes of tailings processed per day. However, the cost to run these tests would greatly exceed the potential costs due to having a low or variable gold content in the bullion during production operation.

KHD have correspondence from a major refinery in Germany stating that the refinery charge for one kg of bullion with 50 % gold would be in the range of DM 60.00 per kg of bullion and for a bullion with only 10 % gold, DM 30.00 per kg bullion. The effective costs per kg of gold are therefore DM 120.00 (approx. US-Dollar 65) and DM 300.00 (approx. US-Dollar 162) per kg of gold, a very small amount in relation to the gold value.

Typical US refiners do not charge any penalty for copper in the bullion, since copper is often added to the bullion in order to refine it.

The costs of the ADR plant operation are listed below and include the consumable supplies and general maintenance (costs of labor and operating power are included in sections 11.1 and 11.5). The purchase cost of the carbon, including several years of make-up, is included in the ADR plant capital cost, section 7.4.

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Plant Maintenance:

10 % of plant capital cost	US D 43,000.00 per year
	0.14 per tonne

Stripping Chemicals / Supplies (80 strips per year):

	US-Dollar per year
sodium hydroxide 25 kg/strip US-D 1.5/ kg	3,000.00
sodium carbonate 25 kg/strip US-D 1.00/kg	2,000.00
muriatic acid 200 l/strip US-D 0.75/l	12,000.00
cathodes US-D 40.00 per strip	3,200.00
diesel (carbon regeneration) 60,000 liters US-D 0.40/liter	24,000.00
total stripping chemicals	44,200.00
	= 0.14 per tonne

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Smelting Supplies:

	US-Dollar per year
fluxes **1000 kg flux** **US-D 1.00/kg**	**1,000.00**
crucibles **12 crucibles** **US-D 500.00/crucible**	**6,000.00**
diesel (furnace) **12,000 liters** **US-D 0.40/liter**	**4,800.00**
total smelting supplies	**11,800.00**
	= 0.04 per tonne

Total ADR Maintenance and Consumables (section 11.9):

	US-Dollar per year
plant maintenance	**43,000.00**
stripping chemicals and supplies	**44,200.00**
smelting supplies	**11,800.00**
total ADR maintenance and consumables	**99,000.00**
	= 0.32 per tonne

11.10 Gold Refinery Charges and Insurance

The expenses for annual gold sales include refinery charges for secondary refinement and insurance charges for shipment of bullion to the refinery. This cost will amount to approximately US-D 180,000.00 per year.

11.11 General and Administrative

General and administrative costs include items such as property and equipment taxes, vehicle operation, local goodwill expenses, office and communication expenses, legal and accounting fees, outside technical consulting and insurance.

	US-Dollar per month
office supplies	1,000.00
communication	5,000.00
liability insurance and property taxes	9,000.00
company vehicles	2,000.00
legal and accounting services	5,000.00
outside technical consulting	4,000.00
total estimated general and administrative	26,000.00
	= 1.0 per tonne

12.0 Financial and Economic Evaluation

The financial evaluation of the project has been performed with the help of the UNIDO IPS Investment Promotion Service, Cologne. The total calculation of the "basis case" and the sensitivity calculations are presented in chapter 13.

For the basic calculation the following assumptions have been made:

- 1 year of construction
- 10 years of production
- start of construction in 1988
- all costs and prices expressed in 1,000 US-Dollar
- 1 product: gold bullion
- discount rate for Net Present Value: 15 %
- local equity of US-D 1,733,100.00 disbursed in 1988
- no foreign loan
- local loan US-D 4,043,900.00 disbursed in 1988, interest rate 12 %, repayment beginning with first year of production with constant instalments
- gold price US-D 420 per ounce corresponding to approx US-D 13,500 per kg (price of January 20th, 1987, day of calculation).

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12.1 Investment Costs

All costs of investment are listed in the previous chapters. However, for the calculation of the profitability, it is necessary to split investment costs in foreign and local currency.

All prices mentioned below are related to installed equipment, including freight and insurance.

INVESTMENT COSTS IN FOREIGN CURRENCY

SUMMARY SHEET

No.	Project component Description	line COMFAR	Investment Cost US-D
1	structures and civils power requirements	3	194,000.00
2	incorp. fix. ass. transport disk / haul tailings	5	1,240,000.00
3	incorp. fix. ass. technology agglomeration/stacking leach pads solution storage ponds ADR plant system heap piping system field laboratory	6	3,222,000.00
4	incorp. fix. ass., other engineering, procurement, construction management	7	350,000.00
5	plant mach. and equipm., a service and support vehicles	8	97,000.00
6	plant mach. and equipm., b initial investm. in spare parts	9	105,000.00
7	preproduction expenditures technical training program	11	50,000.00
	T O T A L		5,258,000.00

For the estimate of the investment costs in local currency it was assumed that no purchase of land would be necessary.

INVESTMENT COSTS IN LOCAL CURRENCY SUMMARY SHEET			
No.	Project component Description	line COMFAR	Investment cost US-D
1	site preparation and development acess/haul road construction or upgrade	14	65,000.00
2	structures and civil works water requirements trailer for personnel wind fences and site security	15	454,000.00
	T O T A L		519,000.00

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12.2 Reinvestments

Due to the production period of 10 years, after which the available TORCO tailings are most likely exhausted, depreciation is generally assumed with 10 years.

Only the service and support vehicles as well as the investment in disk/haul tailings (all mobile equipment) are depreciated within 5 years. Therefore, only these items have to be reinvested.

REINVESTMENT AFTER 5 YEARS OF PRODUCTION in 1993
SUMMARY SHEET

No.	Project component Description	line COMFAR	investment cost US-D
1	incorp. fix assets		
	transport	29	1,240,000.00
	disk/haul tailings		
2	plant, mach. and equip-ment	32	97,000.00
	service and support vehicles		
	T O T A L		1,337,000.00

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12.3 Production Costs

The production costs are based on the following assumptions agreed upon in the economic tripartite meeting.

The plant will be designed for a capacity of 310,000 tpy of tailings. Because of the start-up difficulties and the logistic difficulties which must be expected due to the remote location of the plant, it will be unlikely to reach the planned capacity. Therefore, it is assumed that within the first year only 198,400 tpy of tailings can be treated (64 % of designed capacity) and 506 kg gold will be produced. This production results from the assumption of an ore grade of 3 gram per tonne and a recovery of 85 %.

As of the second year 248,000 tpy will be treated and 632 kg gold will be produced every year (80 % of designed capacity).

In the following, the production costs are split into foreign and local currency.

PRODUCTION COSTS IN FOREIGN CURRENCY

SUMMARY SHEET

No.	Project component Description	line COMFAR	production cost US-D per year
1	raw material, b leach solution reagents - sodium cyanide - cement - Nalco wetting agent leach pads and ponds stripping chemicals and supplies smelting supplies 80 % variable	66	1,716,000.00
2	direct labor project engineer 0 % variable	70	78,000.00
3	maintenance costs heap pipe system 0 % variable	71	66,000.00
4	factory overheads fire assay (outside check) 0 % variable	73	15,600.00
5	administration labor project manager 0 % variable	74	90,000.00
6	administration, non-labor outside technical consultant 0 % variable	75	48,000.00
7	marketing, non-labor gold refinery charges 100 % variable	77	90,000.00
	T O T A L		2,103,600.00

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PRODUCTION COSTS IN LOCAL CURRENCY

SUMMARY SHEET

No.	Project component Description	line COMFAR	production cost US-D per year
1	Utilities power and water 20 % variable	98	102,300.00
2	energy fuel is included in maintenance costs for vehicles	99	
3	direct labor maintenance mechanic operating labor 80 % variable	100	174,000.00
4	maintenance discing and hauling tailings agglomerating and stacking ADR 20 % variable	101	278,280.00
5	factory overheads solid sample preparation, assay solution sample assay administr. overheads for total personnel 80 % variable	103	79,600.00
6	administration labor chemist secretary bookkeeper 0 % variable	104	48,000.00
7	administration, non-labor communication, liability insurance and property tax, company vehicles, leagal and accounting service office supplies 0 % variable	105	264,000.00
8	marketing, non-labor insurance charges for shipm. of bullion to foreign refinery 100 % variable	107	90,000.00
	T o t a l		1,036,180.00

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12.4 Working Capital

The net working capital amounts to US-Dollar 1,254,310 and is based on the following main assumptions:

- accounts receivable
  30 days at production costs minus depreciation and interests

- inventory
  all required raw materials (other than TORCO tailings) will be kept in stock for 90 days

- work in progress
  the leaching time of the heaps amounts to 90 days.

- finished product (gold bullion)
  the bullion remains only for 3 days in the plant; afterwards it is sold.

- cash in hand
  30 days

- accounts payable
  30 days for raw materials and utilities

12.5 Source of Finance

It was agreed in the economic tripartite meeting that the project should be financed by local loan only. This loan with an interest rate of 12 % has to be repaid within the 10 years period of production. The local equity amounts to 30 %.

12.6 Income Tax

Taxation was calculated according to an existing agreement between the Mauritanian Government and the company SAMIN.

The taxes to be paid from the taxable profit amount to

- 10 % within the first 5 years of production
- 30 % as of the 6th year and all following years of production

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12.7 Financial Evaluation

The total initial investment during the construction phase amounts to US-D 6,262,270.00.
This amount includes US-D 685,270.00 as 12 months interest for a local loan of US-D 4,043,900.00 and US-D 50,000.00 for a training program.

Replacements are due in 1993 for all the mobile equipment and amount to US-D 1,327,000.00.
In 1999, at the end of exploitation, the working capital of US-D 1,254,310.00 will be recovered.

Total production costs amount to approximately US-D 4,000.000.00 in the first year of production and remain almost constant in the following years.

As of the second year of production the specific production costs for gold bullion amount to 6,760 US-D per kg, or 50 % of the assumed sales value.

The most important production costs refer to the other raw materials required for the leaching process, for example

- leach solution reagents
- leach pads and ponds
- stripping chemicals and supplies
- smelting supplies.

About 65 % of total production costs accrue in foreign currency and 42 % of them are variable.

Depreciation amounts to about 16 % of total production costs.

Nearly 50 % of the net working capital is necessary to prefinance the production process (work in progress) which lasts for about 90 days. About 36 % serves to finance the necessary stocks of inventory and materials.

It is assumed that US-D 1,733,100.00 of local equity and a local loan of US-D 4,043,900.00 will be available in 1988, the year of construction. Thus, 30 % of total funds will be financed by equity.

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The pay back period of the project is less than 2 years and the Internal Rate of Return on Total Investment amounts to 66,52 % at a discounting rate of 15 %.

The Net Income Statement shows a yearly turn-over of US-D 8,532,000.00 and as of the second year of production a net profit of about US-D 3,900,000.00.

As of the 6th year of production the net profit amounts to about US-D 3,200,000.00 due to higher taxes to be paid.

Since no distribution of dividends is assumed, the cumulated undistributed net profit at the end of the project amounts to about US-D 34,100,000.00.

The break even point of the project is at 30 % which indicates a low economic risk.

12.8 Sensitivity Analysis

The main parameters influencing the profitability of the project are

- gold recovery
- gold price
- consumption of chemicals.

In the sensitivity analyses the three parameters were scrutinized and the results are shown below.

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A. Effect of decrease of gold recovery on the IRR

calculation	recovery %	gold price US-D/kg	IRR %
basis model	85.0	13,500	66.52
sensitivity 1	59.5	13,500	40.56

As it can be seen from analysis A and B, a slump of the gold price from 13,500 to 9,450 US-D/kg has the same effect as decreasing the recovery from 85.0 to 59.5 %.

B. Effect of decrease of gold price on the IRR

calculation	recovery %	gold price US-D/kg	IRR %
basis model	85.0	13,500	66.62
sensitivity 1	85.0	9,450	40.56

The sensitivity analysis C combines very pessimistic assumptions as

- decrease of gold price
- low recovery

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C. Effect of decrease of gold price on the IRR at low recovery

calculation	recovery %	gold price US-D/kg	IRR %
sensitivity 1	59.5	13,500	40.56
sensitivity 2	59.5	10.800	23.48
sensitivity 3	59.5	9.450	14.38

Since the consumption of chemicals is an important factor in gold production, this parameter was checked in a wide range.

D. Effect of increase in consumption of leach solution reagents and other supplies on the IRR

calculation	recovery %	gold price US-D/kg	chemical consumption projected = 100%	IRR %
basis model	85.0	13,500	100	66.52
sensitiv. 4	85.0	13,500	110	63.71
sensitiv. 5	85.0	13,500	130	58.15
sensitiv. 6	85.0	13,500	150	52.66
sensitiv. 7	85.0	13,500	200	39,25

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The sensitivity analysis A shows that the risk of the project is very low. Even a decrease of 30 % of the present gold price reduces the IRR only from 66 to 40 %. This percentage is however still an extremely good return on investment.

From the sensitivity analysis B results that the project remains still economical with a very bad recovery rate of about 60 %.

The combination of the worst events, i.e. low recovery and low gold price, is shown in analysis C. As it can be seen, the very unlikely combination of a gold price at 10,800 US-D/kg or 335 US-D per ounce and a bad recovery of 60 % still leads to an acceptable IRR of 23 %. Only the combination of completely unrealistic conditions results in an IRR of 14 %.

The sensitivity analysis D shows that the IRR remains on the very high level of 39 % even if the consumption of chemicals would amount to 200 % of the projected consumption.

Because of the low risk and the promising economic results, the project should be realized immediately.

13 Profitability Calculation COMFAR

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TORCO TAILINGS - GOLD EXTRACTION
26.01.1987
basic version

1 year(s) of construction, 10 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	2784.10	3139.78	3139.78
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	3965.27	4272.42	4223.89
thereof foreign	61.94 %	64.31 %	65.05 %
total sales :	6831.00	8532.00	8532.00
gross income :	2865.73	4259.58	4308.11
net income :	2579.16	3833.62	3877.29
cash balance :	1774.91	3966.58	4168.80
net cashflow :	2664.56	4807.71	4961.41

Net Present Value at: 15.00 % = 15072.96
Internal Rate of Return: 66.52 %
Return on equity1: 175.30 %
Return on equity2: 152.85 %

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Total Initial Investment in US $ 1000

Year	88
Fixed investment costs	
Land, site preparation, development	65.00
Buildings and civil works	648.00
Auxiliary and service facilities .	0.00
Incorporated fixed assets	4812.00
Plant machinery and equipment . . .	202.00
Total fixed investment costs	5727.00
Pre-production capital expenditures.	535.27
Net working capital	0.00
Total initial investment costs . . .	6262.27
Of it foreign, in %	83.96

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COMFAR 2.0

Total Current Investment in US $ 1000

Year	89	90	91-92	93	94-98	99
Fixed investment costs						
Land, site preparation, development	0.00	0.00	0.00	0.00	0.00	0.00
Buildings and civil works	0.00	0.00	0.00	0.00	0.00	0.00
Auxiliary and service facilities	0.00	0.00	0.00	0.00	0.00	0.00
Incorporated fixed assets	0.00	0.00	0.00	1240.00	0.00	0.00
Plant, machinery and equipment	0.00	0.00	0.00	97.00	0.00	0.00
Total fixed investment costs	0.00	0.00	0.00	1337.00	0.00	0.00
Preproduction capitals expenditures.	0.00	0.00	0.00	0.00	0.00	0.00
Working capital	1095.76	158.55	0.00	0.00	0.00	-1254.31
Total current investment costs	1095.76	158.55	0.00	1337.00	0.00	-1254.31
Of it foreign, %	74.64	88.69	0.00	100.00	0.00	0.00

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Total Production Costs in US $ 1000

Year	89	90	91	92	93	94
% of nom. capacity (single product).	80.06	100.00	100.00	100.00	100.00	100.00
Raw material 1	0.00	0.00	0.00	0.00	0.00	0.00
Other raw materials	1442.31	1716.00	1716.00	1716.00	1716.00	1716.00
Utilities	98.22	102.30	102.30	102.30	102.30	102.30
Energy	0.00	0.00	0.00	0.00	0.00	0.00
Labour, direct	224.25	252.00	252.00	252.00	252.00	252.00
Repair, maintenance	333.18	344.28	344.28	344.28	344.28	344.28
Spares	0.00	0.00	0.00	0.00	0.00	0.00
Factory overheads	92.03	95.20	95.20	95.20	95.20	95.20
Factory costs	2189.99	2509.78	2509.78	2509.78	2509.78	2509.78
Administrative overheads	450.00	450.00	450.00	450.00	450.00	450.00
Indir. costs, sales and distribution	144.11	180.00	180.00	180.00	180.00	180.00
Direct costs, sales and distribution	0.00	0.00	0.00	0.00	0.00	0.00
Depreciation	695.90	695.90	695.90	695.90	695.90	695.90
Financial costs	485.27	436.74	388.21	339.69	291.16	242.63
Total production costs	3965.27	4272.42	4223.89	4175.37	4126.84	4078.31
Costs per unit (single product)	7.84	6.76	6.68	6.61	6.53	6.45
Of it foreign, %	61.94	64.31	65.05	65.80	66.58	67.37
Of it variable,%	36.02	41.76	42.24	42.73	43.23	43.74
Total labour	362.25	390.00	390.00	390.00	390.00	390.00

Total Production Costs in US $ 1000

Year	95	96	97	98	99- 103
% of nom. capacity (single product).	100.00	100.00	100.00	100.00	0.00
Raw material 1	0.00	0.00	0.00	0.00	0.00
Other raw materials	1716.00	1716.00	1716.00	1716.00	-0.00
Utilities	102.30	102.30	102.30	102.30	0.00
Energy	0.00	0.00	0.00	0.00	0.00
Labour, direct	252.00	252.00	252.00	252.00	0.00
Repair, maintenance	344.28	344.28	344.28	344.28	0.00
Spares	0.00	0.00	0.00	0.00	0.00
Factory overheads	95.20	95.20	95.20	95.20	0.00
Factory costs	2509.78	2509.78	2509.78	2509.78	0.00
Administrative overheads	450.00	450.00	450.00	450.00	0.00
Indir. costs, sales and distribution	180.00	180.00	180.00	180.00	0.00
Direct costs, sales and distribution	0.00	0.00	0.00	0.00	0.00
Depreciation	695.90	695.90	695.90	695.90	0.00
Financial costs	194.11	145.58	97.05	48.53	0.00
Total production costs	4029.79	3981.26	3932.73	3884.21	0.00
Costs per unit (single product)	6.38	6.30	6.22	6.15	0.00
Of it foreign, %	68.18	69.01	69.86	70.74	-18020890.00
Of it variable,%	44.27	44.81	45.36	45.93	0.00
Total labour	390.00	390.00	390.00	390.00	-312.00

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Net Working Capital in US $ 1000

Year			89	90	91-98	99	100- 3
Coverage	adc	coto					
Current assets &							
Accounts receivable	30	12.0	232.01	261.65	261.65	0.00	0.00
Inventory and materials	90	4.0	385.13	454.58	454.58	-0.00	-0.00
Energy	0	---	0.00	0.00	0.00	0.00	0.00
Spares	0	---	0.00	0.00	0.00	0.00	0.00
Work in progress	90	4.0	547.50	627.44	627.44	0.00	0.00
Finished products	3	120.0	22.00	24.66	24.66	0.00	0.00
Cash in hand	30	12.0	91.62	95.12	95.12	0.00	0.00
Total current assets			1278.26	1463.46	1463.46	0.00	0.00
Current liabilities and Accounts payable	30	12.0	182.50	209.15	209.15	0.00	0.00
Net working capital			1095.76	1254.31	1254.31	0.00	0.00
Increase in working capital			1095.76	158.55	0.00	-1254.31	0.00
Net working capital, local			277.90	295.83	295.83	205.91	205.91
Net working capital, foreign			817.86	958.48	958.48	-205.91	-205.91

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

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Source of Finance, construction in US $ 1000

Year	89
Equity, ordinary ..	1733.10
Equity, preference.	0.00
Subsidies, grants .	0.00
Loan A, foreign .	0.00
Loan B, foreign..	0.00
Loan C, foreign .	0.00
Loan A, local....	4043.90
Loan B, local....	0.00
Loan C, local....	0.00
Total loan	4043.90
Current liabilities	0.00
Bank overdraft	485.27
Total funds	6262.27

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Source of Finance, production in US $ 1000

Year	89	90	91-98	99
Equity, ordinary ..	0.00	0.00	0.00	0.00
Equity, preference.	0.00	0.00	0.00	0.00
Subsidies, grants .	0.00	0.00	0.00	0.00
Loan A, foreign .	0.00	0.00	0.00	0.00
Loan B, foreign..	0.00	0.00	0.00	0.00
Loan C, foreign .	0.00	0.00	0.00	0.00
Loan A, local....	-404.39	-404.39	-404.39	0.00
Loan B, local....	0.00	0.00	0.00	0.00
Loan C, local....	0.00	0.00	0.00	0.00
Total loan	-404.39	-404.39	-404.39	0.00
Current liabilities	182.50	26.65	0.00	-209.15
Bank overdraft	-485.27	0.00	0.00	0.00
Total funds	-707.16	-377.74	-404.39	-209.15

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Cashflow Tables, construction in US $ 1000

Year	86
Total cash inflow . .	5777.00
Financial resources .	5777.00
Sales, net of tax . .	0.00
Total cash outflow . .	6262.27
Total assets	5777.00
Operating costs . . .	0.00
Cost of finance . . .	485.27
Repayment	0.00
Corporate tax . . .	0.00
Dividends paid . . .	0.00
Surplus (deficit) .	-485.27
Cumulated cash balance	-485.27
Inflow, local	5777.00
Outflow, local	1004.27
Surplus (deficit) .	4772.73
Inflow, foreign . . .	0.00
Outflow, foreign . . .	5258.00
Surplus (deficit) .	-5258.00
Net cashflow	-5777.00
Cumulated net cashflow	-5777.00

Cashflow tables, production in US $ 1000

Year	89	90	91	92	93	94
Total cash inflow	7013.50	8558.65	8532.00	8532.00	8532.00	8532.00
Financial resources	182.50	26.65	0.00	0.00	0.00	0.00
Sales, net of tax	6831.00	8532.00	8532.00	8532.00	8532.00	8532.00
Total cash outflow	5238.59	4972.07	4363.19	4319.52	5612.85	5122.91
Total assets	1278.26	185.20	0.00	0.00	1337.00	0.00
Operating costs	2704.10	3139.78	3139.78	3139.78	3139.78	3139.78
Cost of finance	485.27	436.74	388.21	339.69	291.16	242.63
Repayment	404.39	404.39	404.39	404.39	404.39	404.39
Corporate tax	286.57	425.96	430.81	435.66	440.52	1336.11
Dividends paid	0.00	0.00	0.00	0.00	0.00	0.00
Surplus (deficit)	1774.91	3966.58	4168.81	4212.48	2919.15	3409.09
Cumulated cash balance	1289.64	5256.22	9425.03	13637.51	16556.66	19965.75
Inflow, local	49.01	3.84	0.00	0.00	0.00	0.00
Outflow, local	2475.28	2325.04	2259.59	2215.92	2172.25	3019.31
Surplus (deficit)	-2426.27	-2321.20	-2259.59	-2215.92	-2172.25	-3019.31
Inflow, foreign	6964.49	8554.81	8532.00	8532.00	8532.00	8532.00
Outflow, foreign	2763.32	2267.03	2103.60	2103.60	3440.60	2103.60
Surplus (deficit)	4201.18	6287.78	6428.40	6428.40	5091.40	6428.40
Net cashflow	2664.56	4807.71	4961.41	4956.56	3614.70	4056.11
Cumulated net cashflow	-3112.44	1695.28	6656.69	11613.25	15227.95	19284.07

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Cashflow tables, production in US $ 1000

Year	95	96	97	98	99	100- 1
Total cash inflow . .	8532.00	8532.00	8532.00	8532.00	0.00	0.00
Financial resources .	0.00	0.00	0.00	0.00	0.00	0.00
Sales, net of tax . .	8532.00	8532.00	8532.00	8532.00	0.00	0.00
Total cash outflow . .	5088.94	5054.97	5021.00	4987.03	-1254.30	0.00
Total assets	0.00	0.00	0.00	0.00	-1463.45	0.00
Operating costs . . .	3139.78	3139.78	3139.78	3139.78	0.00	0.00
Cost of finance . . .	194.11	145.58	97.05	48.53	0.00	0.00
Repayment	404.39	404.39	404.39	404.39	209.15	0.00
Corporate tax . . .	1350.66	1365.22	1379.78	1394.34	0.00	0.00
Dividends paid . . .	0.00	0.00	0.00	0.00	0.00	0.00
Surplus (deficit) .	3443.06	3477.03	3511.00	3544.97	1254.30	-0.00
Cumulated cash balance	23408.81	26885.84	30396.83	33941.80	35196.10	35196.10
Inflow, local	0.00	0.00	0.00	0.00	0.00	0.00
Outflow, local	2985.34	2951.37	2917.40	2883.44	625.83	714.94
Surplus (deficit) .	-2985.34	-2951.37	-2917.40	-2883.44	-625.83	-714.94
Inflow, foreign . . .	8532.00	8532.00	8532.00	8532.00	0.00	0.00
Outflow, foreign . . .	2103.60	2103.60	2103.60	2103.60	-1879.33	-714.94
Surplus (deficit) .	6428.40	6428.40	6428.40	6428.40	1879.33	714.94
Net cashflow	4041.56	4027.00	4012.44	3997.88	1254.30	-0.00
Cumulated net cashflow	23325.62	27352.62	31365.06	35362.95	36617.25	36617.25

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Cashflow tables, production in US $ 1000

Year	102- 3
Total cash inflow . .	0.00
Financial resources .	0.00
Sales, net of tax . .	0.00
Total cash outflow . .	0.00
Total assets	0.00
Operating costs . . .	0.00
Cost of finance . . .	0.00
Repayment	0.00
Corporate tax . . .	0.00
Dividends paid . . .	0.00
Surplus (deficit) .	-0.00
Cumulated cash balance	35196.09
Inflow, local	0.00
Outflow, local	714.94
Surplus (deficit) .	-714.94
Inflow, foreign . . .	0.00
Outflow, foreign . . .	-714.94
Surplus (deficit) .	714.94
Net cashflow	-0.00
Cumulated net cashflow	36617.24

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Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	15464.09	at	15.00 %
Internal Rate of Return (IRRE1) ..	175.30 %		

b) Net Worth versus Net cash return:

Net present value	15475.83	at	15.00 %
Internal Rate of Return (IRRE2) ..	152.85 %		

c) Internal Rate of Return on total investment:

Net present value	15072.96	at	15.00 %
Internal Rate of Return (IRR) ..	66.52 %		

Net Worth = Equity paid plus reserves

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COMFAR 2.0 UNIDO

COMFAR 2.0 - UNIDO IPS Investment Promotion, Cologne

Net Income Statement in US $ 1000

Year	89	90	91	92	93
Total sales, incl. sales tax	6831.00	8532.00	8532.00	8532.00	8532.00
Less: variable costs, incl. sales tax.	1428.36	1784.04	1784.04	1784.04	1784.04
Variable margin	5402.64	6747.96	6747.96	6747.96	6747.96
As % of total sales	79.09	79.09	79.09	79.09	79.09
Non-variable costs, incl. depreciation	2051.64	2051.64	2051.64	2051.64	2051.64
Operational margin	3351.00	4696.32	4696.32	4696.32	4696.32
As % of total sales	49.06	55.04	55.04	55.04	55.04
Cost of finance	485.27	436.74	388.21	339.69	291.16
Gross profit	2865.73	4259.58	4308.11	4356.63	4405.16
Allowances	0.00	0.00	0.00	0.00	0.00
Taxable profit	2865.73	4259.58	4308.11	4356.63	4405.16
Tax	286.57	425.96	430.81	435.66	440.52
Net profit	2579.16	3833.62	3877.29	3920.97	3964.64
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	2579.16	3833.62	3877.29	3920.97	3964.64
Accumulated undistributed profit	2579.16	6412.78	10290.07	14211.04	18175.68
Gross profit, % of total sales	41.95	49.92	50.49	51.06	51.63
Net profit, % of total sales	37.76	44.93	45.44	45.96	46.47
ROE, Net profit, % of equity	148.82	221.20	223.72	226.24	228.76
ROI, Net profit+interest, % of invest.	44.59	60.73	60.66	60.60	50.86

TN 0103 0431 04
(HW 3002/4)
40000 12 88 O

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COMFAR 2.0 UNIDO

Net Income Statement in US $ 1000

Year	94	95	96	97	98
Total sales, incl. sales tax	8532.00	8532.00	8532.00	8532.00	8532.00
Less: variable costs, incl. sales tax.	1784.04	1784.04	1784.04	1784.04	1784.04
Variable margin	6747.96	6747.96	6747.96	6747.96	6747.96
As % of total sales	79.09	79.09	79.09	79.09	79.09
Non-variable costs, incl. depreciation	2051.64	2051.64	2051.64	2051.64	2051.64
Operational margin	4696.32	4696.32	4696.32	4696.32	4696.32
As % of total sales	55.04	55.04	55.04	55.04	55.04
Cost of finance	242.63	194.11	145.58	97.05	48.53
Gross profit	4453.69	4502.21	4550.74	4599.27	4647.79
Allowances	0.00	0.00	0.00	0.00	0.00
Taxable profit	4453.69	4502.21	4550.74	4599.27	4647.79
Tax	1336.11	1350.66	1365.22	1379.78	1394.34
Net profit	3117.58	3151.55	3185.52	3219.49	3253.46
Dividends paid	0.00	0.00	0.00	0.00	0.00
Undistributed profit	3117.58	3151.55	3185.52	3219.49	3253.46
Accumulated undistributed profit	21293.26	24444.81	27630.33	30849.82	34103.27
Gross profit, % of total sales	52.20	52.77	53.34	53.91	54.47
Net profit, % of total sales	36.54	36.94	37.34	37.73	38.13
ROE, Net profit, % of equity	179.08	181.04	183.00	185.76	187.72
ROI, Net profit+interest, % of invest.	40.15	39.98	39.81	39.63	39.46

TN 0103 0431 04
(HW 3002.4)
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Net Income Statement in US $ 1000

Year	99- 100	101- 2	103
Total sales, incl. sales tax	0.00	0.00	0.00
Less: variable costs, incl. sales tax.	0.00	0.00	0.00
Variable margin	0.00	0.00	0.00
As % of total sales	0.00	0.00	0.00
Non-variable costs, incl. depreciation	0.00	0.00	0.00
Operational margin	-0.00	-0.00	-0.00
As % of total sales	0.00	0.00	0.00
Cost of finance	0.00	0.00	0.00
Gross profit	-0.00	-0.00	-0.00
Allowances	0.00	0.00	0.00
Taxable profit	-0.00	-0.00	-0.00
Tax	0.00	0.00	0.00
Net profit	-0.00	-0.00	-0.00
Dividends paid	0.00	0.00	0.00
Undistributed profit	-0.00	-0.00	-0.00
Accumulated undistributed profit	34103.27	34103.26	34103.25
Gross profit, % of total sales	0.00	0.00	0.00
Net profit, % of total sales	0.00	0.00	0.00
RCE, Net profit, % of equity	-0.00	-0.00	-0.00
ROI, Net profit+interest, % of invest.	-0.00	-0.00	-0.00

TN 0103 0431 04
(HW 3002/4)
40 000 12 86 O

Projected Balance Sheets, construction in US $ 1000

Year	88
Total assets	6262.27
Fixed assets, net of depreciation	0.00
Construction in progress	6262.27
Current assets	0.00
Cash, bank	0.00
Cash surplus, finance available	0.00
Loss carried forward	0.00
Loss	0.00
Total liabilities	6262.27
Equity capital	1733.10
Reserves, retained profit	0.00
Profit	0.00
Long and medium term debt	4043.90
Current liabilities	0.00
Bank overdraft, finance required.	485.27
Total debt	4529.17
Equity, % of liabilities	27.68

TN 0103 0431 04
(HW 3002/4)
40000 12 88 O

KHD HUMBOLDT WEDAG AG

COMFAR 2.0 UNIDO

---------- COMFAR 2.0 - UNIDO IPS Investment Promotion, Cologne -----

Projected Balance Sheets, Production in US $ 1000

Year	89	90	91	92	93	94
Total assets	8134.27	11590.15	15063.05	18579.63	22139.88	24853.07
Fixed assets, net of depreciation	5566.37	4870.47	4174.57	3478.67	2782.77	3423.87
Construction in progress	0.00	0.00	0.00	0.00	1337.00	0.00
Current assets	1186.64	1368.33	1368.33	1368.33	1368.33	1368.33
Cash, bank	91.62	95.12	95.12	95.12	95.12	95.12
Cash surplus, finance available	1289.64	5256.22	9425.03	13637.50	16556.66	19965.75
Loss carried forward	0.00	0.00	0.00	0.00	0.00	0.00
Loss	0.00	0.00	0.00	0.00	0.00	0.00
Total liabilities	8134.27	11590.15	15063.05	18579.63	22139.88	24853.07
Equity capital	1733.10	1733.10	1733.10	1733.10	1733.10	1733.10
Reserves, retained profit	0.00	2579.16	6412.78	10290.07	14211.04	18175.68
Profit	2579.16	3833.62	3877.29	3920.97	3964.64	3117.58
Long and medium term debt	3639.51	3235.12	2830.73	2426.34	2021.95	1617.56
Current liabilities	182.50	209.15	209.15	209.15	209.15	209.15
Bank overdraft, finance required	0.00	0.00	0.00	0.00	0.00	0.00
Total debt	3822.01	3444.27	3039.88	2635.49	2231.10	1826.71
Equity, % of liabilities	21.31	14.95	11.51	9.33	7.83	6.97

TORCO TAILINGS - GOLD EXTRACTION --- 26.01.1987

---------- COMFAR 2.0 - UNIDO IPS Investment Promotion, Cologne -----

Projected Balance Sheets, Production in US $ 1000

Year	95	96	97	98	99- 100	101- 1
Total assets	27600.23	30381.36	33196.45	36045.52	35836.38	35836.37
Fixed assets, net of depreciation	2727.97	2032.07	1336.17	640.27	640.27	640.27
Construction in progress	0.00	0.00	0.00	0.00	0.00	0.00
Current assets	1368.33	1368.33	1368.33	1368.33	0.00	0.00
Cash, bank	95.12	95.12	95.12	95.12	0.00	0.00
Cash surplus, finance available	23408.80	26885.83	30396.83	33941.79	35196.10	35196.09
Loss carried forward	0.00	0.00	0.00	0.00	0.00	0.00
Loss	0.00	0.00	0.00	0.00	0.00	0.00
Total liabilities	27600.23	30381.36	33196.45	36045.52	35836.38	35836.37
Equity capital	1733.10	1733.10	1733.10	1733.10	1733.10	1733.10
Reserves, retained profit	21293.26	24444.81	27630.33	30849.82	34103.27	34103.27
Profit	3151.55	3185.52	3219.49	3253.46	0.00	0.00
Long and medium term debt	1213.17	808.78	404.39	-0.00	-0.00	-0.00
Current liabilities	209.15	209.15	209.15	209.15	0.00	0.00
Bank overdraft, finance required	0.00	0.00	0.00	0.00	0.00	0.00
Total debt	1422.32	1017.93	613.54	209.15	0.00	0.00
Equity, % of liabilities	6.28	5.70	5.22	4.81	4.84	4.84

Projected Balance Sheets, Production in US $ 1000

Year	103
Total assets	35836.36
Fixed assets, net of depreciation	640.27
Construction in progress	0.00
Current assets	0.00
Cash, bank	0.00
Cash surplus, finance available .	35196.09
Loss carried forward	0.00
Loss	0.00
Total liabilities	35836.36
Equity capital	1733.10
Reserves, retained profit	34103.26
Profit	0.00
Long and medium term debt	-0.00
Current liabilities	0.00
Bank overdraft, finance required.	0.00
Total debt	0.00
Equity, % of liabilities	4.84

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(HW 3002/4)
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COMFAR 2.0 UNIDO

TORCO TAILINGS - GOLD EXTRACTION
26.01 1987
test run with 70% production of basis , sensitivity 1

1 year(s) of construction, 10 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	2355.59	2604.57	2604.57
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	3536.76	3737.21	3688.68
thereof foreign	59.51 %	61.78 %	62.59 %
total sales :	4781.70	5972.40	5972.40
gross income :	1244.94	2235.19	2287.72
net income :	1120.44	2011.67	2055.34
cash balance :	507.21	2192.20	2346.86
net cashflow :	1396.66	3033.33	3139.46

Net Present Value at: 15.00 % = 7070.43
Internal Rate of Return: 40.56 %
Return on equity1: 91.65 %
Return on equity2: 81.56 %

Index of Schedules produced by COMFAR

Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance

TN 0103 0431 04
(HW 3002.4)
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KHD HUMBOLDT WEDAG AG

COMFAR

---------- COMFAR 2.0 - UNIDO IPS Investment Promotion, Cologne -----

TORCO TAILINGS - GOLD EXTRACTION
26.01.1987
70% prod. and only 80% of basis Au-price, sensitivity 2

1 year(s) of construction, 10 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	2355.59	2604.57	2604.57
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	3536.76	3737.21	3688.68
thereof foreign	59.51 %	61.78 %	62.59 %
total sales :	3825.36	4777.92	4777.92
gross income :	288.60	1040.71	1089.24
net income :	259.74	936.64	980.31
cash balance :	-353.50	1117.17	1271.82
net cashflow :	536.16	1958.30	2064.43

Net Present Value at: 15.00 % = 2259.61
Internal Rate of Return: 23.48 %
Return on equity1: 42.08 %
Return on equity2: 37.74 %

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Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance

TN 0103 0431 04
(HW 3002/4)
40 000 12 86 O.

TORCO TAILINGS - GOLD EXTRACTION
26.01.1987
70% prod. and only 70% of basis Au-price, **sensitivity 3**

1 year(s) of construction, 10 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	2355.59	2604.57	2604.57
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	3536.76	3737.21	3688.68
thereof foreign	59.51 %	61.78 %	62.59 %
total sales :	3347.19	4180.68	4180.68
gross income :	-189.57	443.47	492.00
net income :	-189.57	399.12	442.80
cash balance :	-602.61	579.65	734.31
net cashflow :	86.65	1420.78	1526.91

Net Present Value at: 15.00 % = -162.29
Internal Rate of Return: 14.36 %
Return on equity1: 15.89 %
Return on equity2: 16.97 %

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(HW 3002/4)
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TORCO TAILINGS - GOLD EXTRACTION
26.01.1987
basic version + 10 % raw mat., sensitivity 4

1 year(s) of construction, 10 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	2928.33	3311.38	3311.38
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	4109.50	4444.02	4395.49
thereof foreign	63.27 %	65.69 %	66.41 %
total sales :	6831.00	8532.00	8532.00
gross income :	2721.50	4087.98	4136.51
net income :	2449.35	3679.18	3722.85
cash balance :	1571.78	3798.23	4014.37
net cashflow :	2461.44	4639.36	4806.97

Net Present Value at: 15.00 % = 14290.63
Internal Rate of Return: 63.71 %
Return on equity1: 168.00 %
Return on equity2: 143.88 %

Index of Schedules produced by COMFAR

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TORCO TAILINGS - GOLD EXTRACTION
26.01.1987
basic version - raw material 30% ore, sensitivity 5

1 year(s) of construction, 10 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	3216.79	3654.58	3654.58
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	4397.96	4787.22	4738.69
thereof foreign	65.68 %	68.15 %	68.85 %
total sales :	6831.00	8532.00	8532.00
gross income :	2433.04	3744.78	3793.31
net income :	2169.73	3370.30	3413.98
cash balance :	1165.53	3461.52	3705.48
net cashflow :	2055.19	4302.66	4498.09

Net Present Value at: 15.00 % = 12725.97
Internal Rate of Return: 58.15 %
Return on equity1: 153.42 %
Return on equity2: 126.44 %

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Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

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COMFAR 2.0 UNIDO

---------- COMFAR 2.0 - UNIDO IPS Investment Promotion, Cologne ----

TORCO TAILINGS - GOLD EXTRACTION
26.01.1987
basic version - raw material 50% more

1 year(s) of construction, 10 years of production , sensitivity 6
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	3505.26	3997.78	3997.78
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	4686.42	5130.42	5081.89
thereof foreign	67.79 %	70.28 %	70.95 %
total sales :	6631.00	8532.00	8532.00
gross income :	2144.58	3401.58	3450.11
net income :	1930.12	3061.42	3105.09
cash balance :	759.28	3124.82	3396.60
net cashflow :	1648.94	3965.95	4189.21

Net Present Value at: 15.00 % = 11161.31
Internal Rate of Return: 52.66 %
Return on equity1: 138.89 %
Return on equity2: 109.76 %

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(HW 3002/4)
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COMFAR 2.0 UNIDO

TGRCO TAILINGS - GOLD EXTRACTION
26.01.1987
basic version - with 100% ore raw mate. sensitivity 7

1 year(s) of construction, 10 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: US $ 1000

Total initial investment during construction phase

fixed assets:	6262.27	83.963 % foreign
current assets:	0.00	0.000 % foreign
total assets:	6262.27	83.963 % foreign

Source of funds during construction phase

equity & grants:	1733.10	0.000 % foreign
foreign loans :	0.00	
local loans :	4043.90	
total funds :	5777.00	0.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	4226.41	4855.76	4855.76
depreciation :	695.90	695.90	695.90
interest :	485.27	436.74	388.21
production costs	5407.58	5988.42	5939.89
thereof foreign	72.09 %	74.54 %	75.15 %
total sales :	6831.00	8532.00	8532.00
gross income :	1423.42	2543.58	2592.11
net income :	1281.08	2289.22	2332.90
cash balance :	-256.34	2283.06	2624.40
net cashflow :	633.31	3124.19	3417.01

Net Present Value at: 15.00 % = 7249.67
Internal Rate of Return: 36.23 %
Return on equity1: 102.76 %
Return on equity2: 71.94 %

Index of Schedules produced by COMFAR

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(HW 3002/4)
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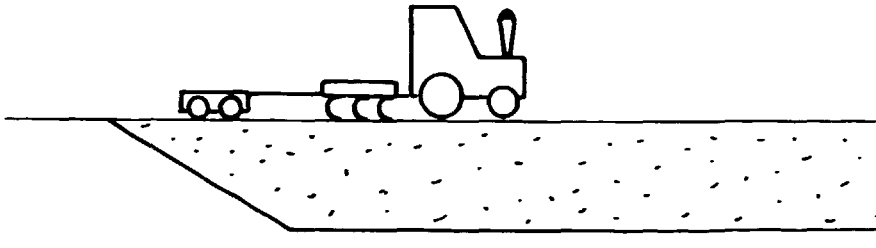
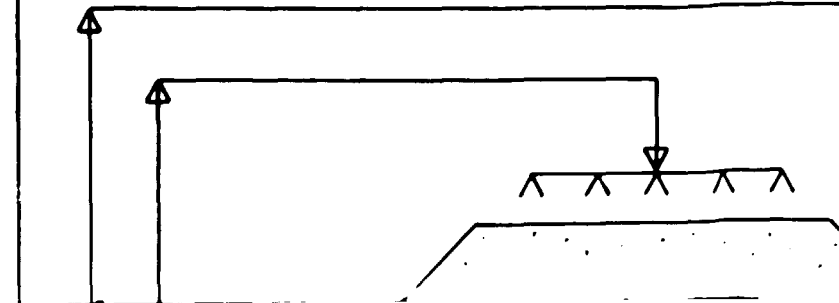
1.01 1.02



tailings

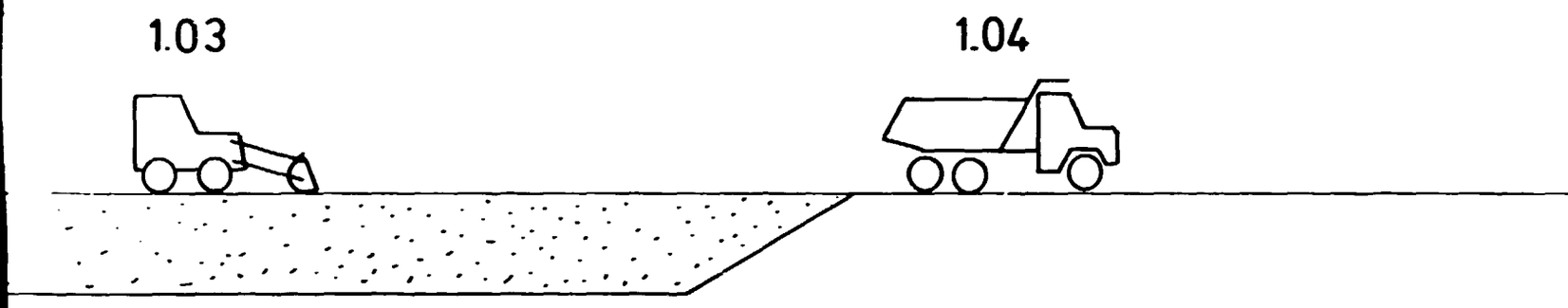
SECTION 1

estimation of



1. Mining

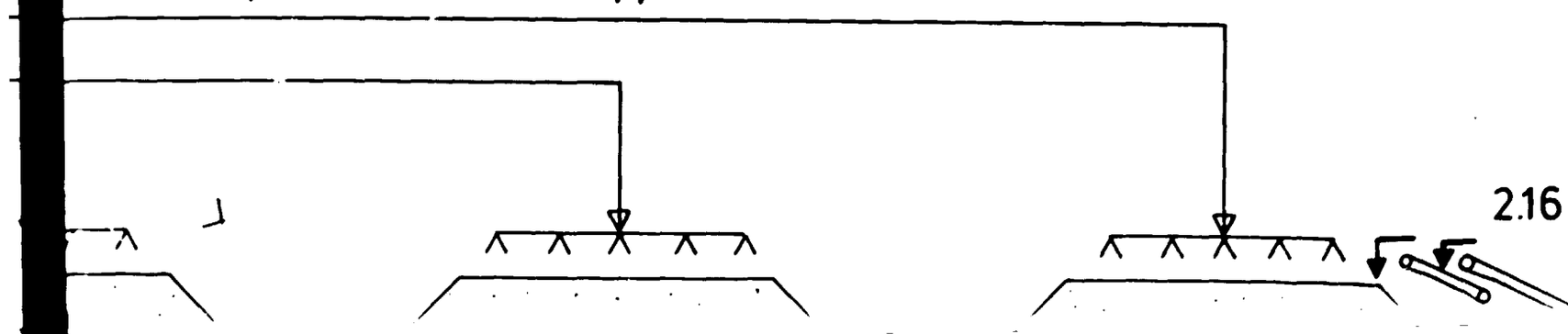
(1 shift/d with 7h)

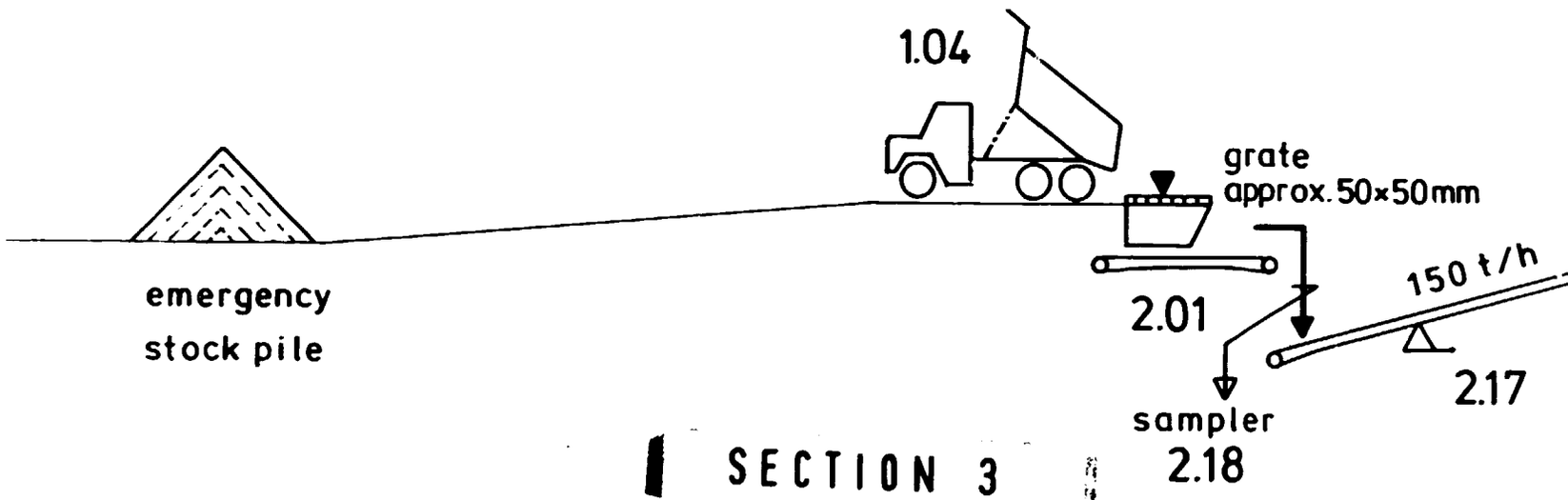


ngs deposit

SECTION 2

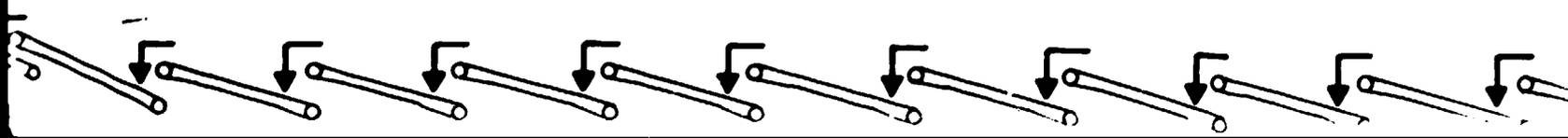
n of evaporation total approx. 22 m³/h

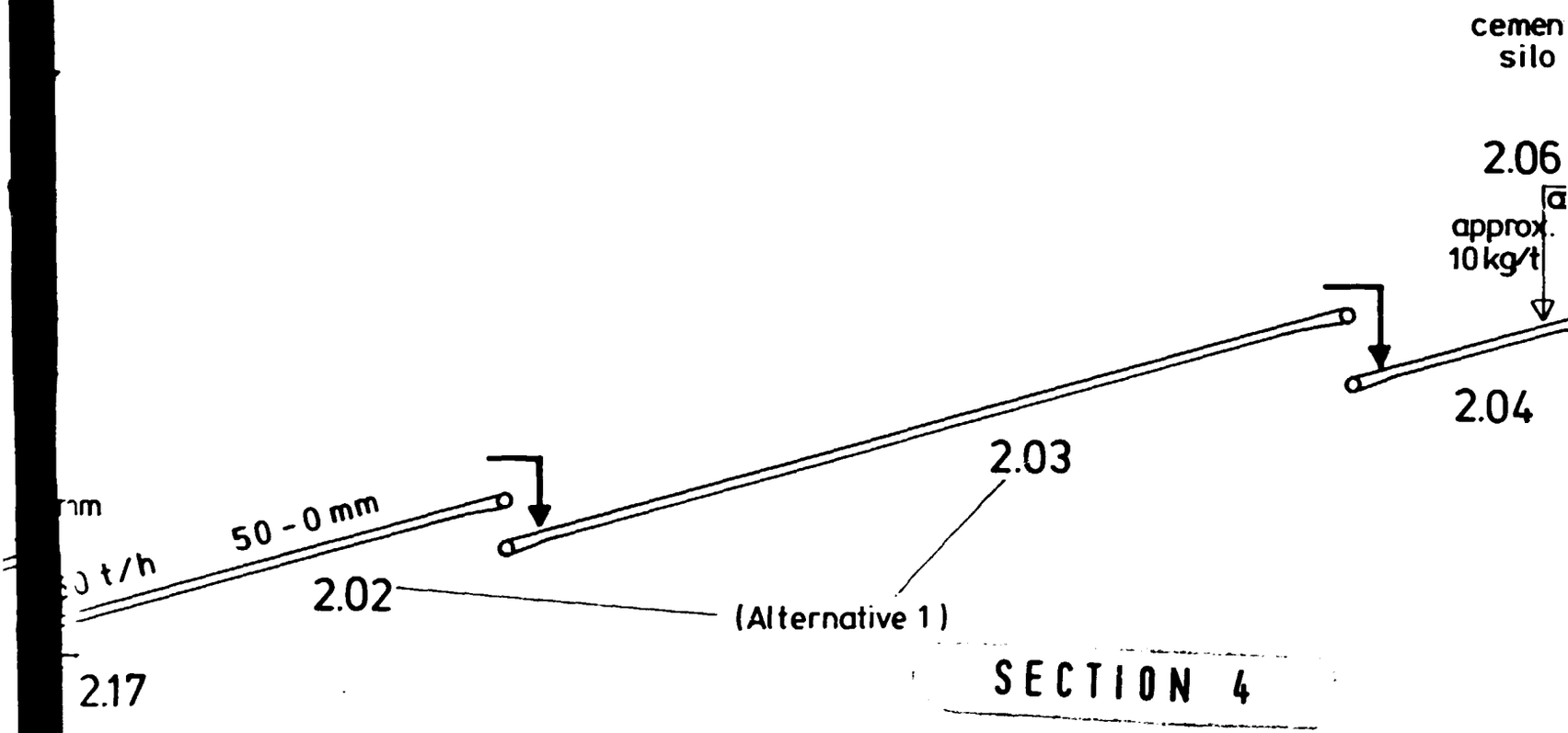




SECTION 3

2.16 2.14 2.15 2.14 2.13

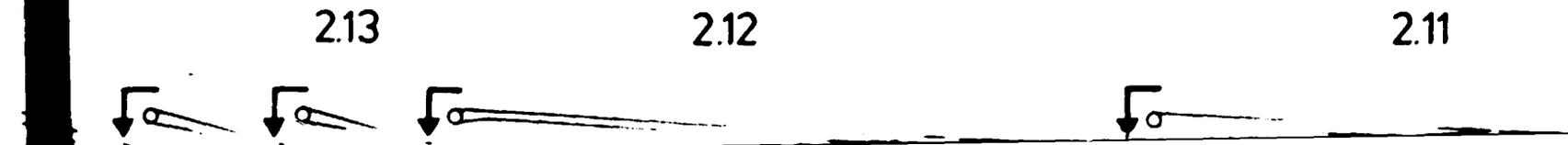


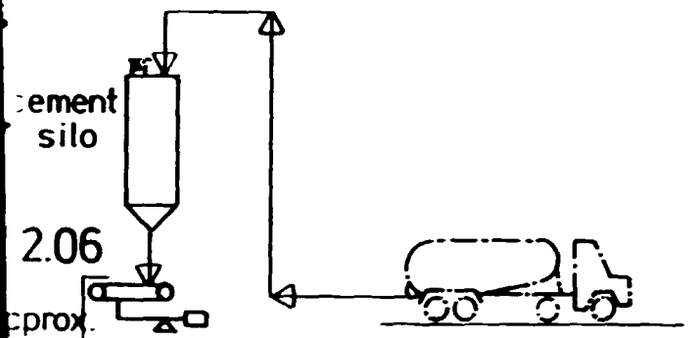


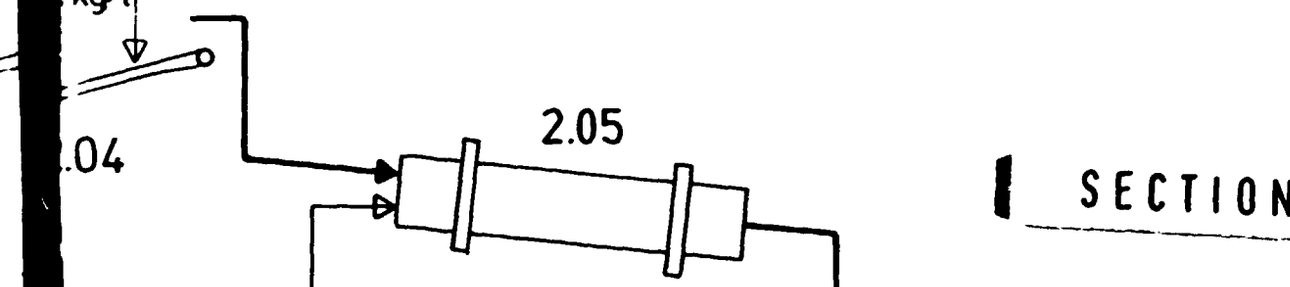
SECTION 4

2. Preparation

(1 shift/d with 7h)



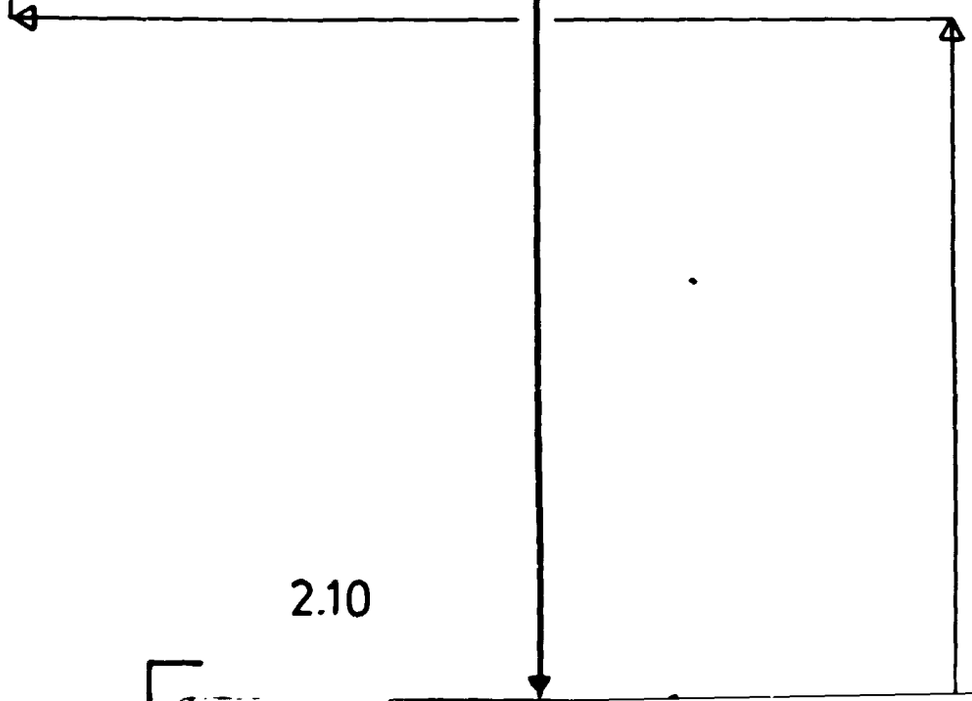




SECTION 5

granulation

150 t/h

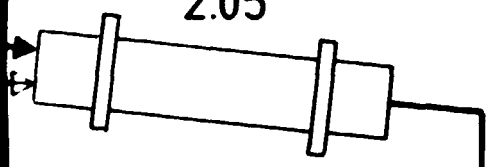


14 15 16

A

B

2.05



granulation

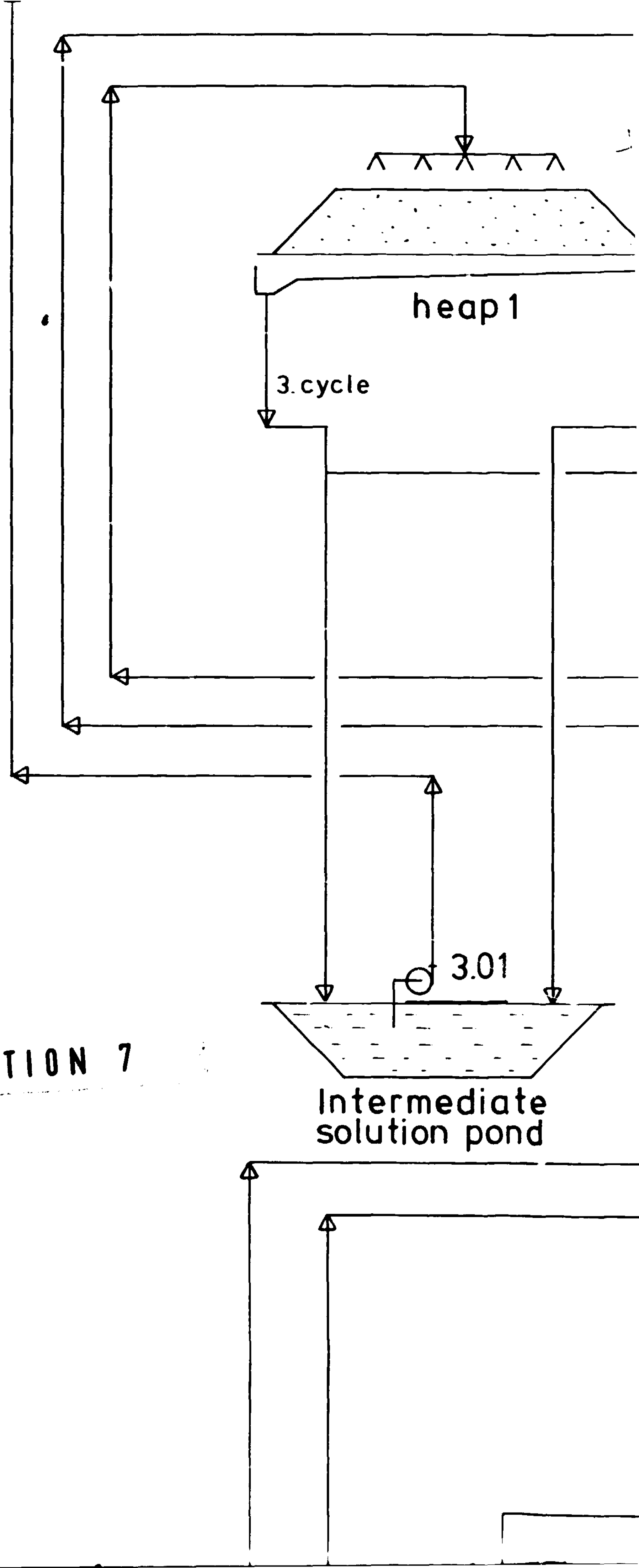
150 t/h

C

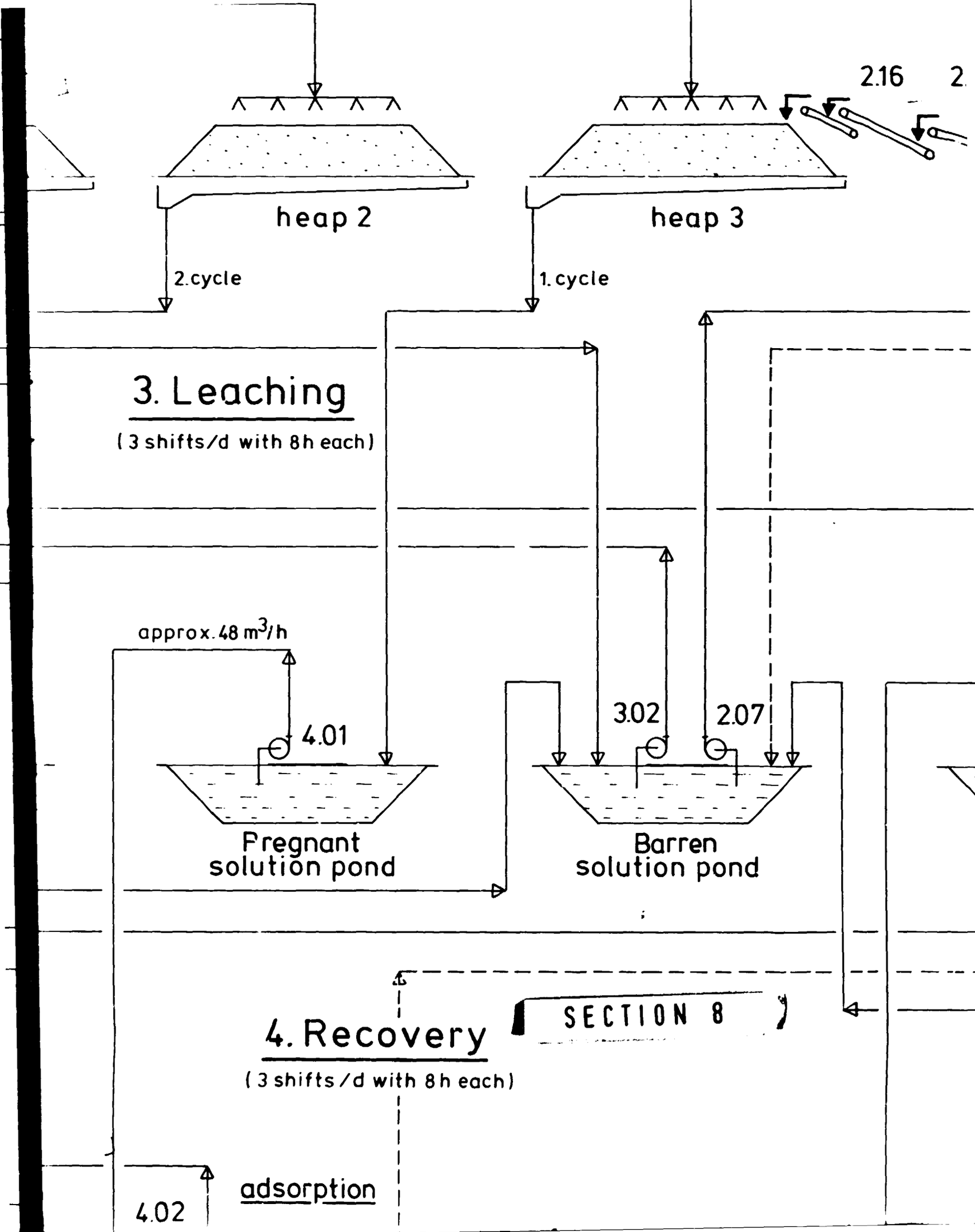
SECTION 6

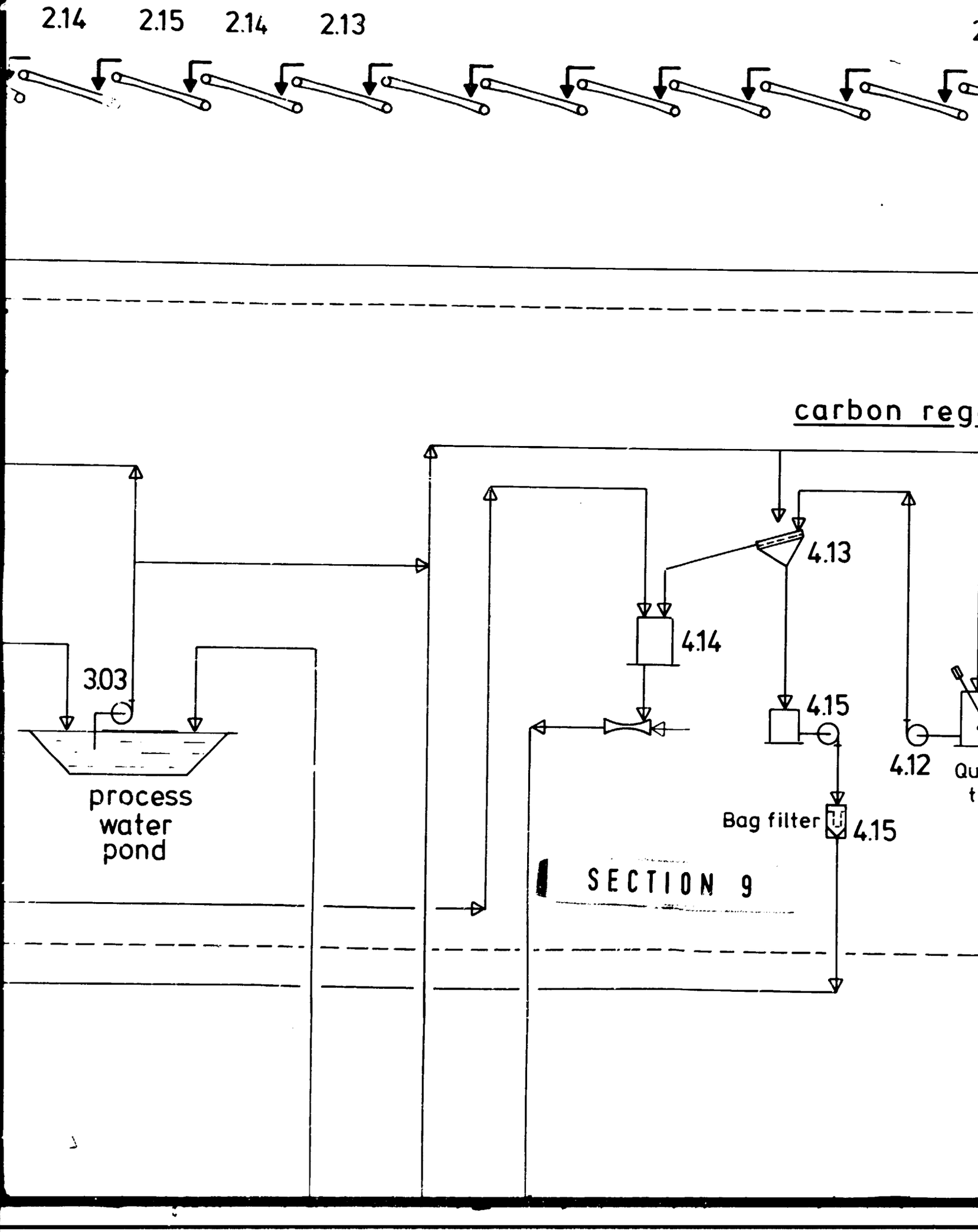
D

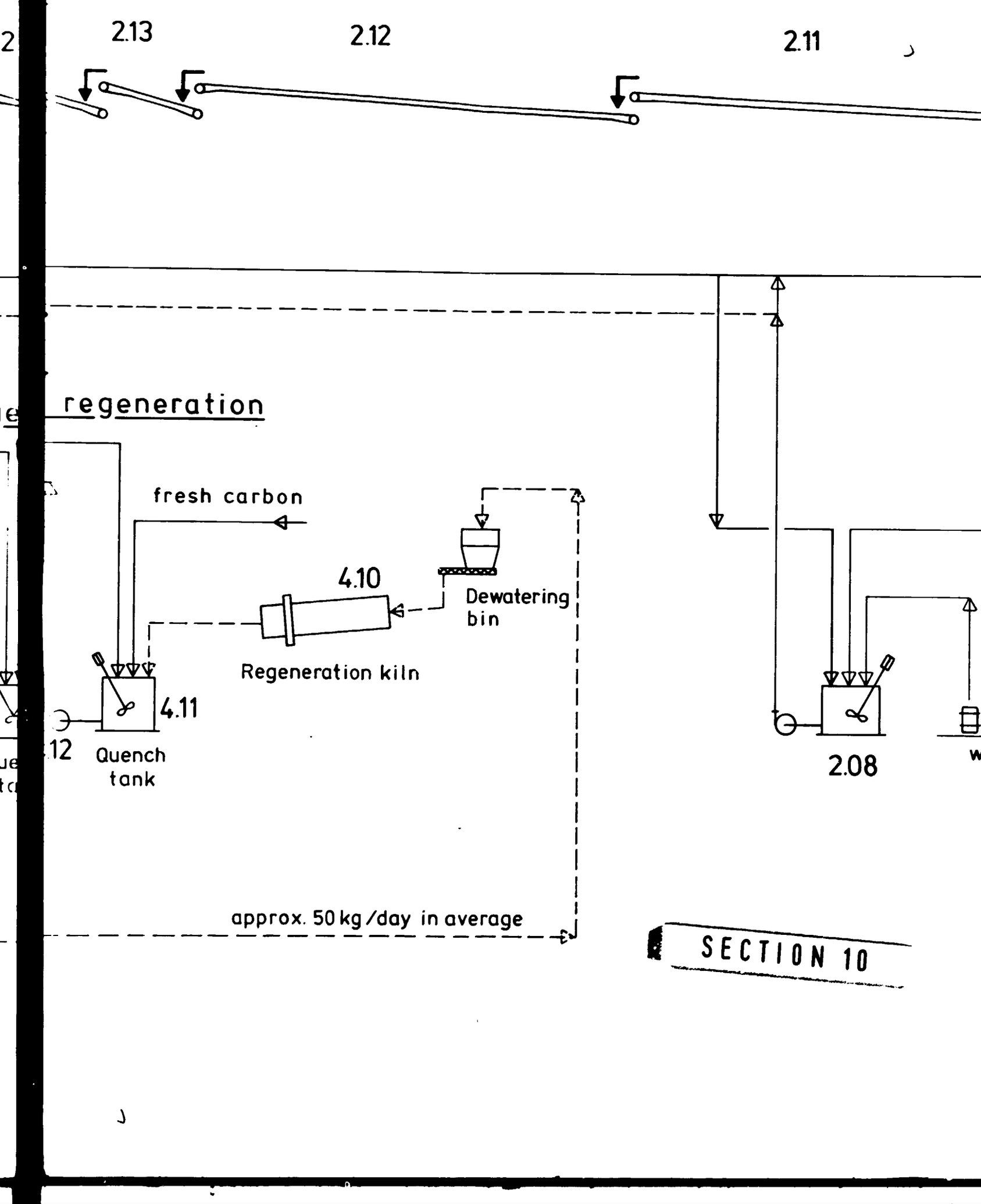
2.10



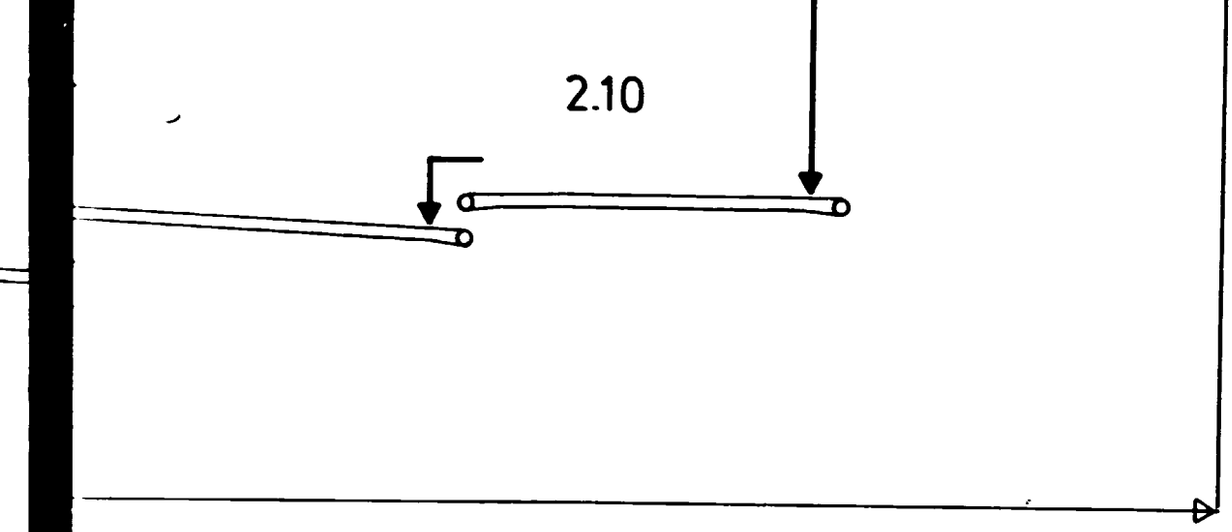
SECTION 7

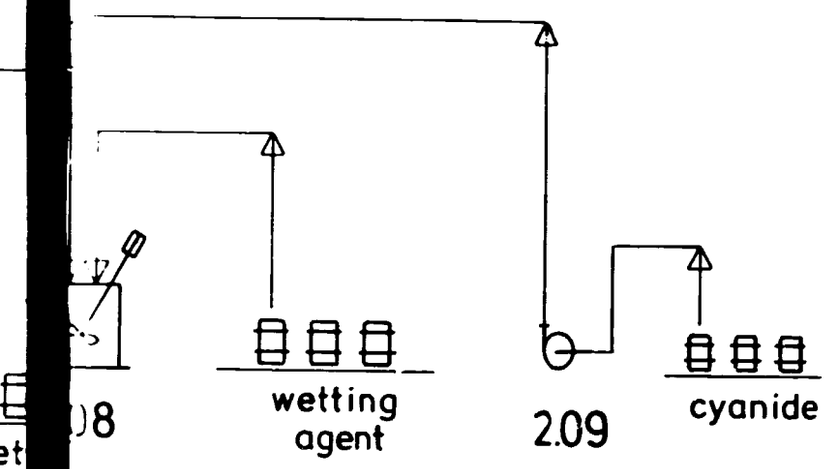

2.16
heap 2
heap 3
2.cycle
1.cycle
3. Leaching
(3 shifts/d with 8h each)
approx. 48 m³/h
4.01
3.02
2.07
Pregnant
solution pond
Barren
solution pond
SECTION 8
4. Recovery
(3 shifts /d with 8h each)
adsorption
4.02


2.14
2.15
2.14
2.13
carbon reg
4.13
4.14
3.03
4.15
4.12
process
water
pond
Bag filter
4.15
SECTION 9

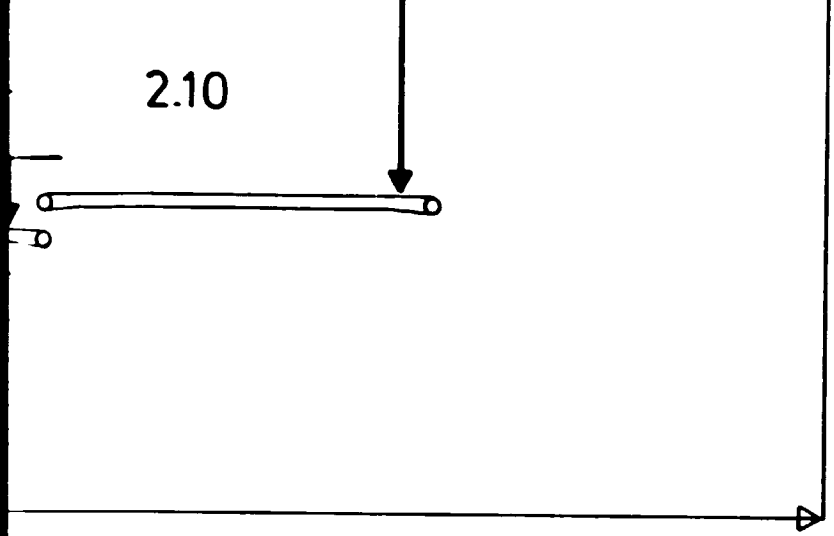

2.13
2.12
2.11
regeneration
fresh carbon
4.10
Dewatering bin
Regeneration kiln
4.11
Quench tank
2.08
approx. 50 kg/day in average

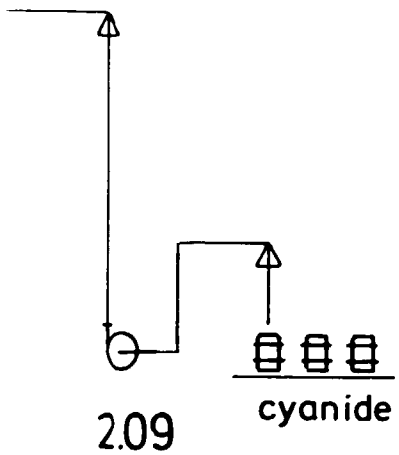
SECTION 10



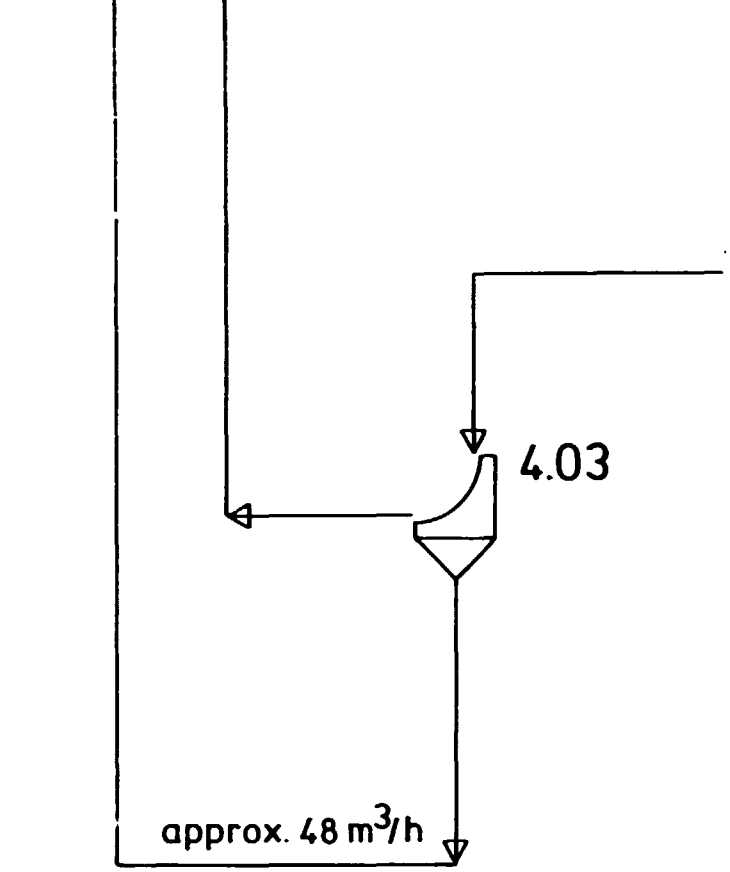


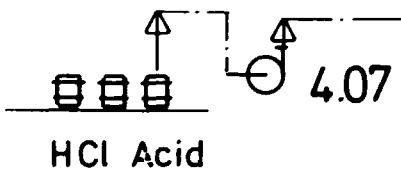
SECTION 11





SECTION 12





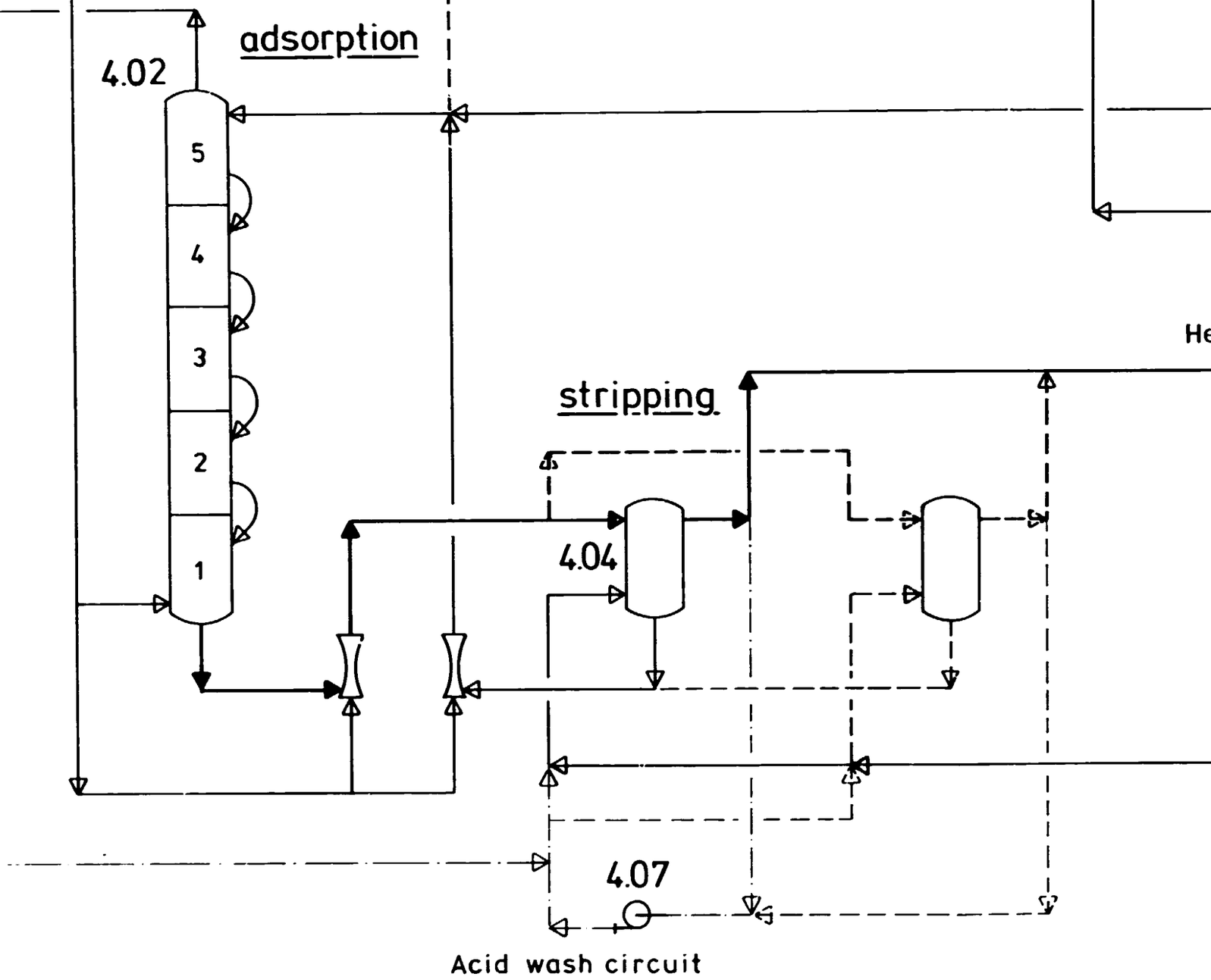
SECTION 13

J K L M

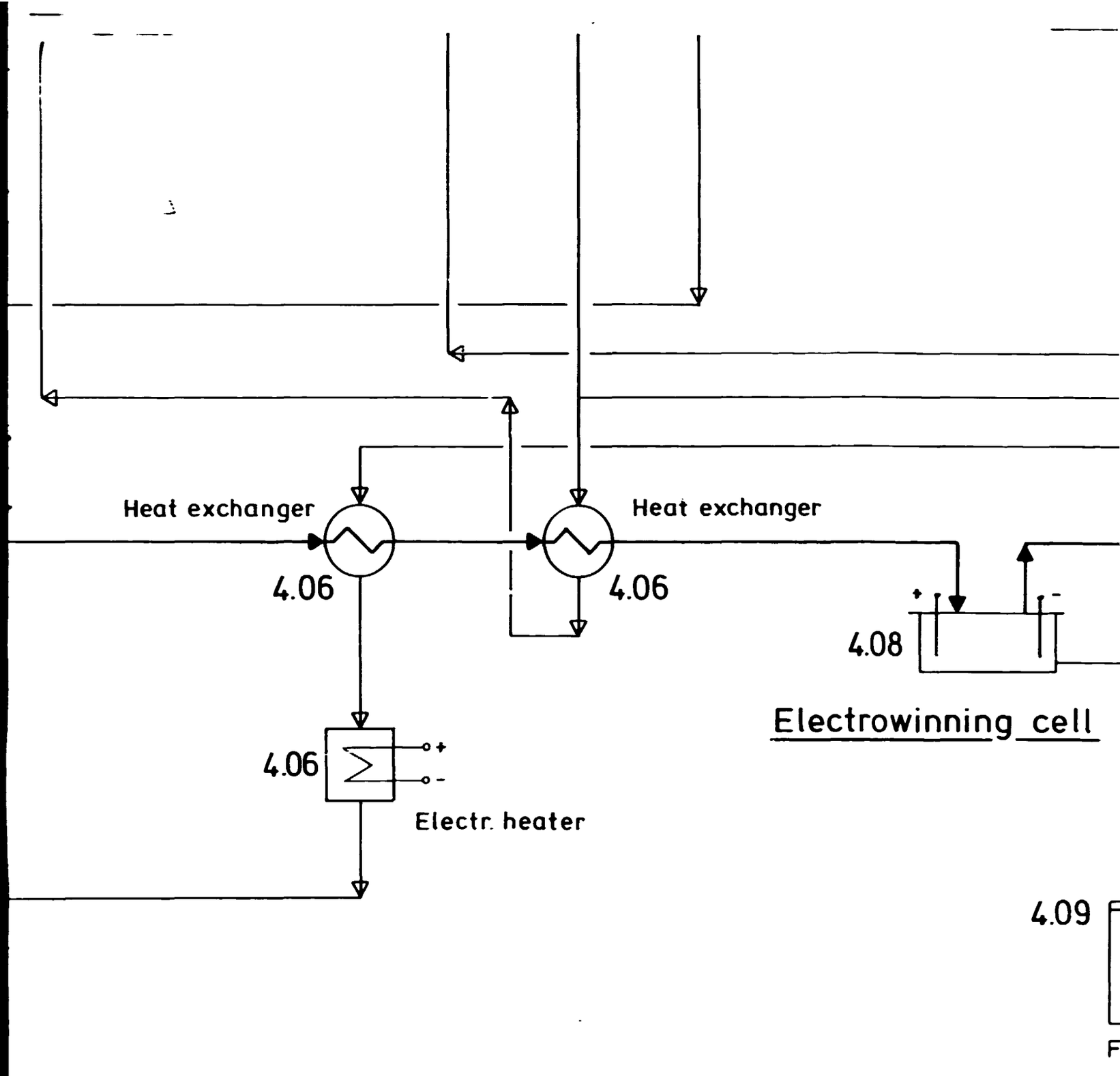
1 2 3

4. Recovery

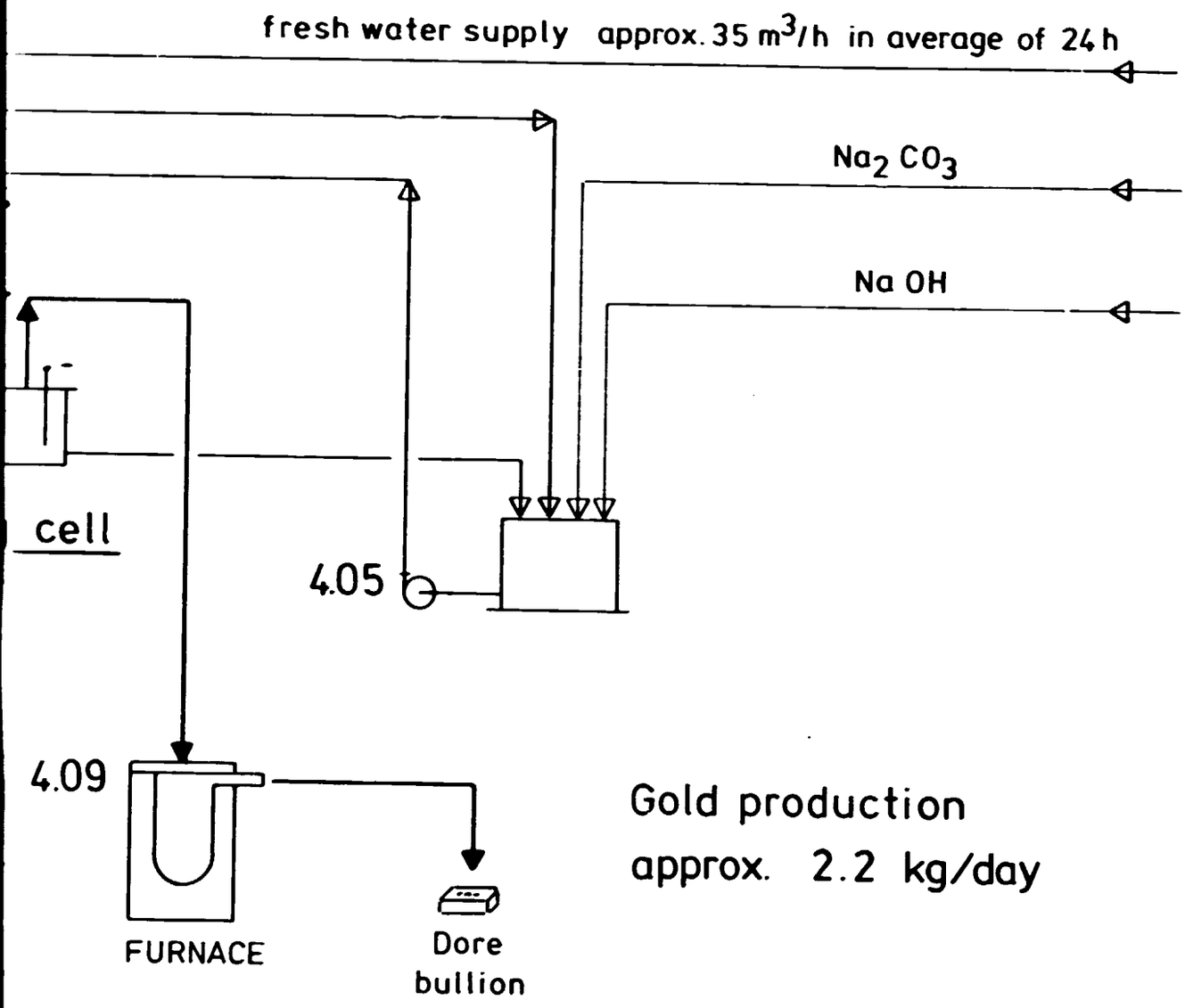
(3 shifts / d with 8 h each)



SECTION 14


Heat exchanger
4.06
Heat exchanger
4.06
4.08
Electrowinning cell
4.06
Electr. heater
4.09

SECTION 15



Gold production
approx. 2.2 kg/day

SECTION 16

AKJOUJT / MAURI

SECTION 17

2	Alternative 1	20.1.87		
1	modification of item 2.06	4.12.86		
Mstr	Zust	Änderung/revision	Dat./No.	gen. appr.

Anlage / plant: Gold Heap Leach
for Torco Taili

Bezeichnung / designation: Preliminary
FLOWSHE

Maßstab / scale: /.

Angebots-Nr / quot-No
Auftrags-Nr / comm-No: 9-2121-5

Gezeichnet / drawn: November 86 Lu.

Zeichnungs-Nr / drawing-No: 801-31-

Geprüft / checked: Fgl

Bemerkung / note:

KHD Humboldt Wedag AG

KHD HUMBOLDT

Kappes, Cassiday & Associates

DRAWING N

13 14 15

SECTION 18

AKJOUJT / MAURITANIA

2	Alternative 1	20.1.87	VA
1	modification of item 2.06	4.12.86	Hz

Mdf. | Zust. | Änderung/revision | Dat./No. | gen. appr.

Anlage / plant: Gold Heap Leach Plant for Torco Tailings

Bezeichnung / designation: Preliminary FLOWSHEET

Maßstab / scale: /.

Angebots-Nr / quot.-No. Aufträge-Nr / comm.-No. 9-2121-5-0154

Gezeichnet / drawn: November 86 Lu.

Zeichnungs-Nr / drawing-No: 801-31-180 UA

Geprüft / checked: Fgl

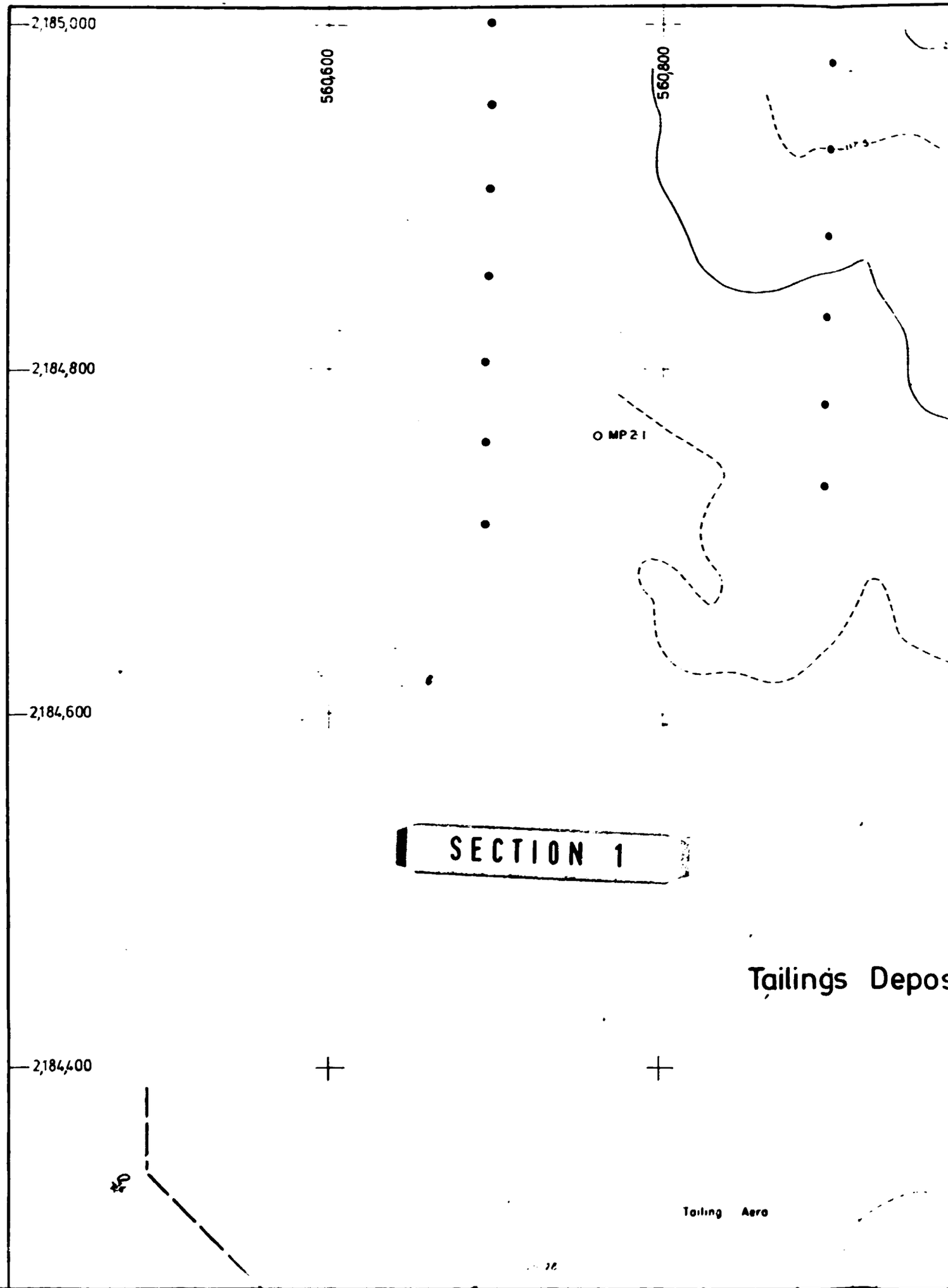
Bemerkung / note:

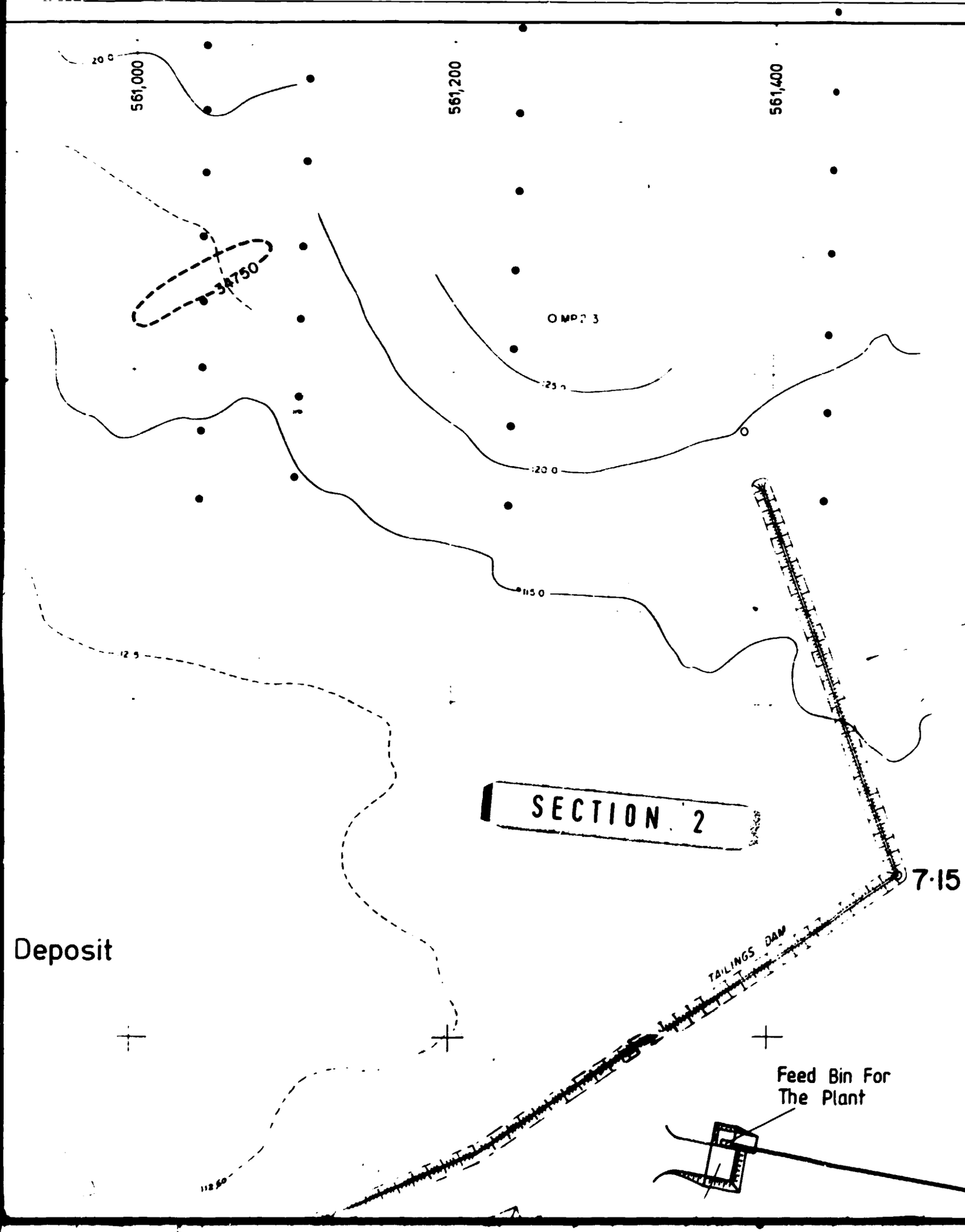
KHD Humboldt Wedag AG

KHD HUMBOLDT WEDAG AG

Kappes, Cassiday & Associates

DRAWING No.


2,185,000
560,600
560,800
2,184,800
OMP21
2,184,600
SECTION 1
Tailings Depos
2,184,400
Tailing Aera
Heap


561,000
561,200
561,400
SECTION 2
7·15
Deposit
TAILINGS DAM
Feed Bin For
The Plant

561,600

561,800

562,000

SECTION 3

15

12

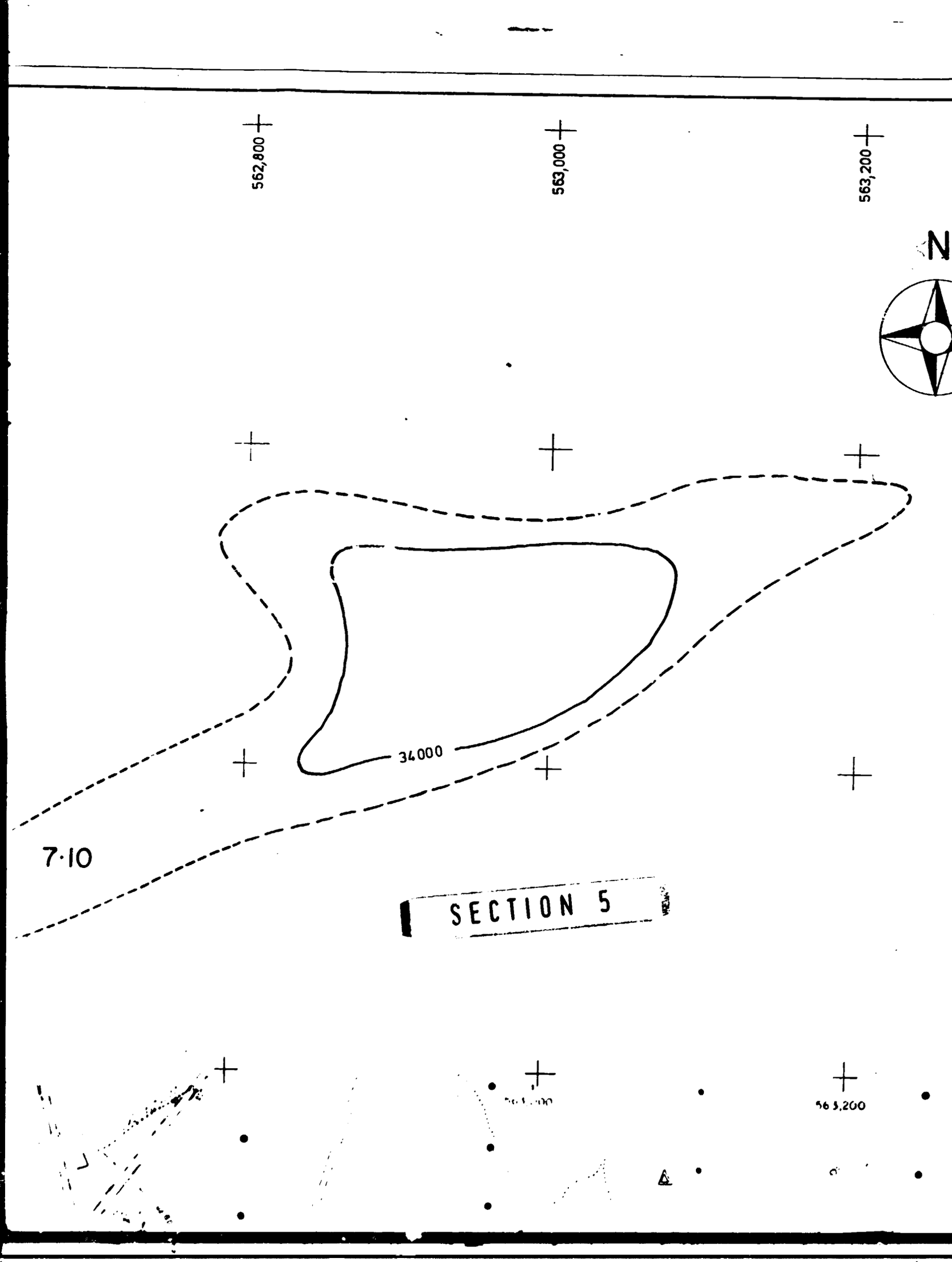
562,200

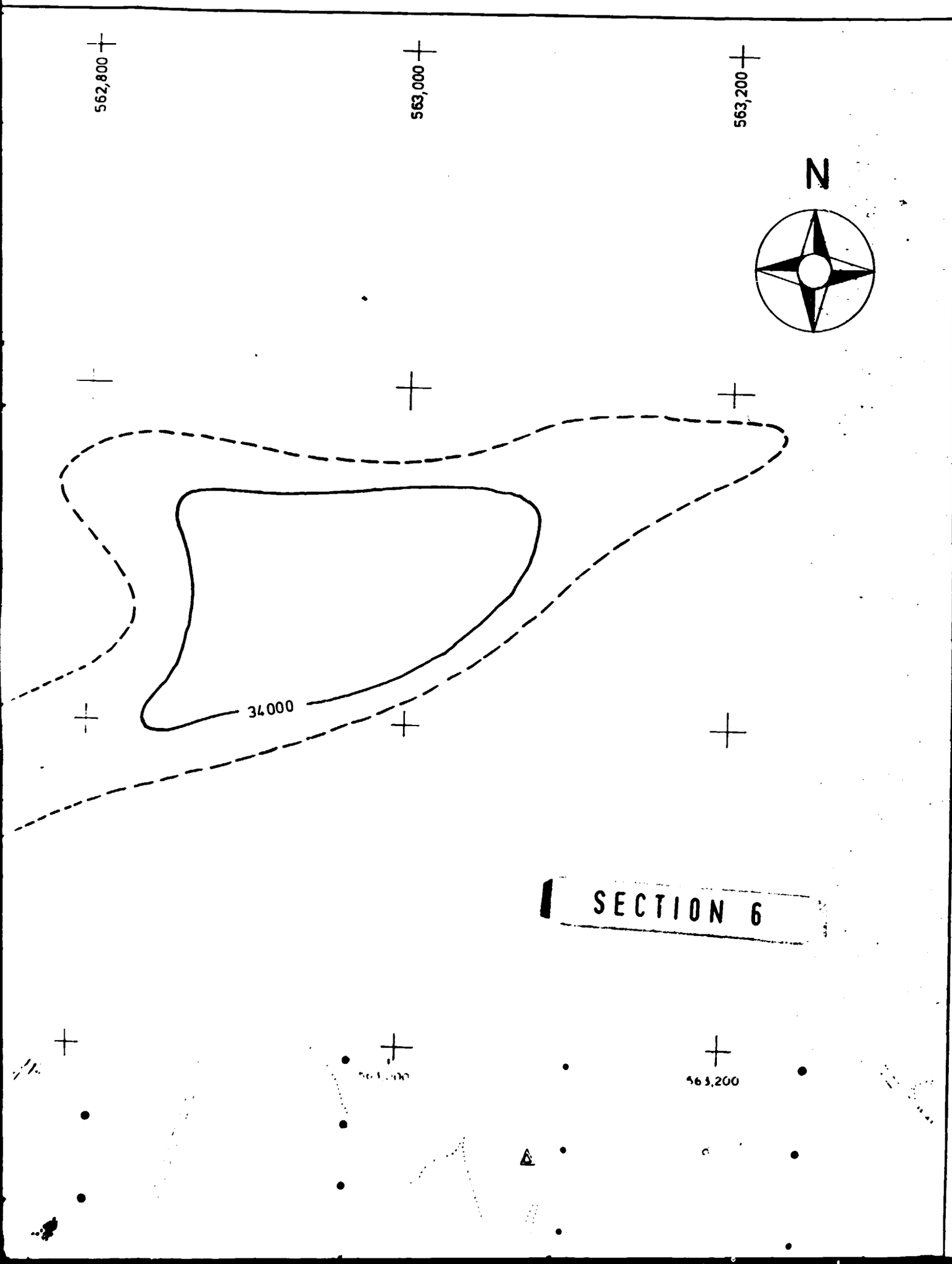
562,400

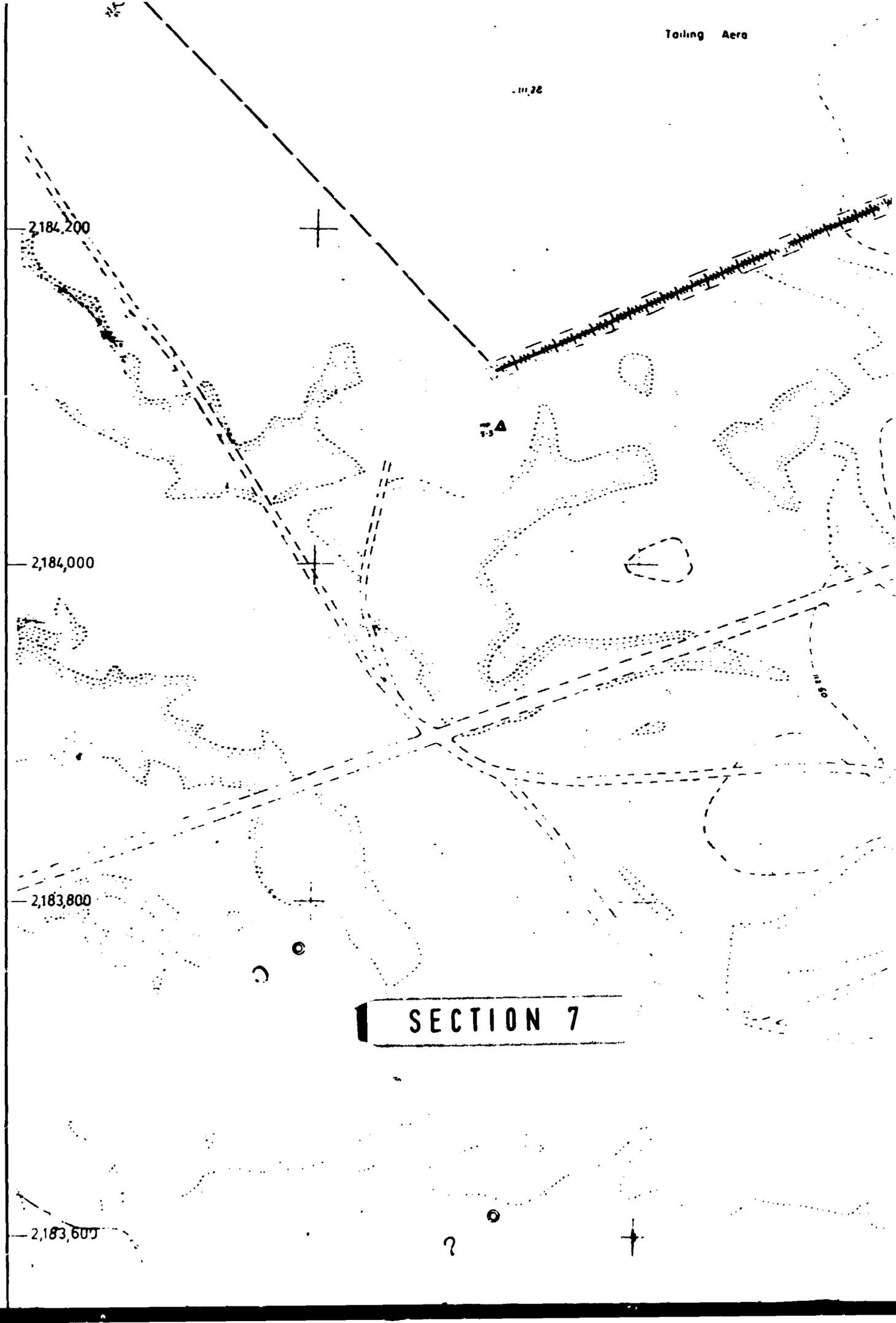
562,600

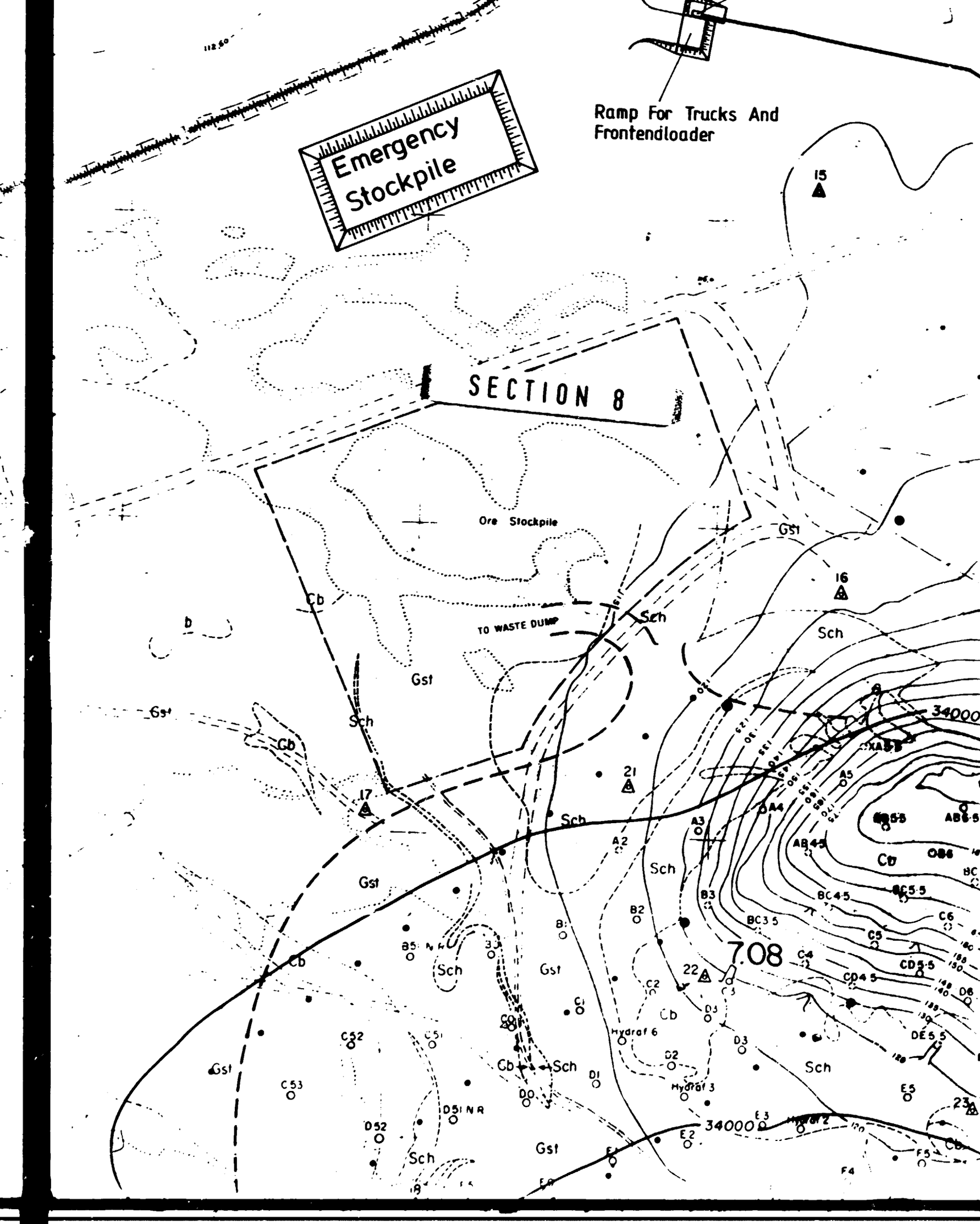
SECTION 4

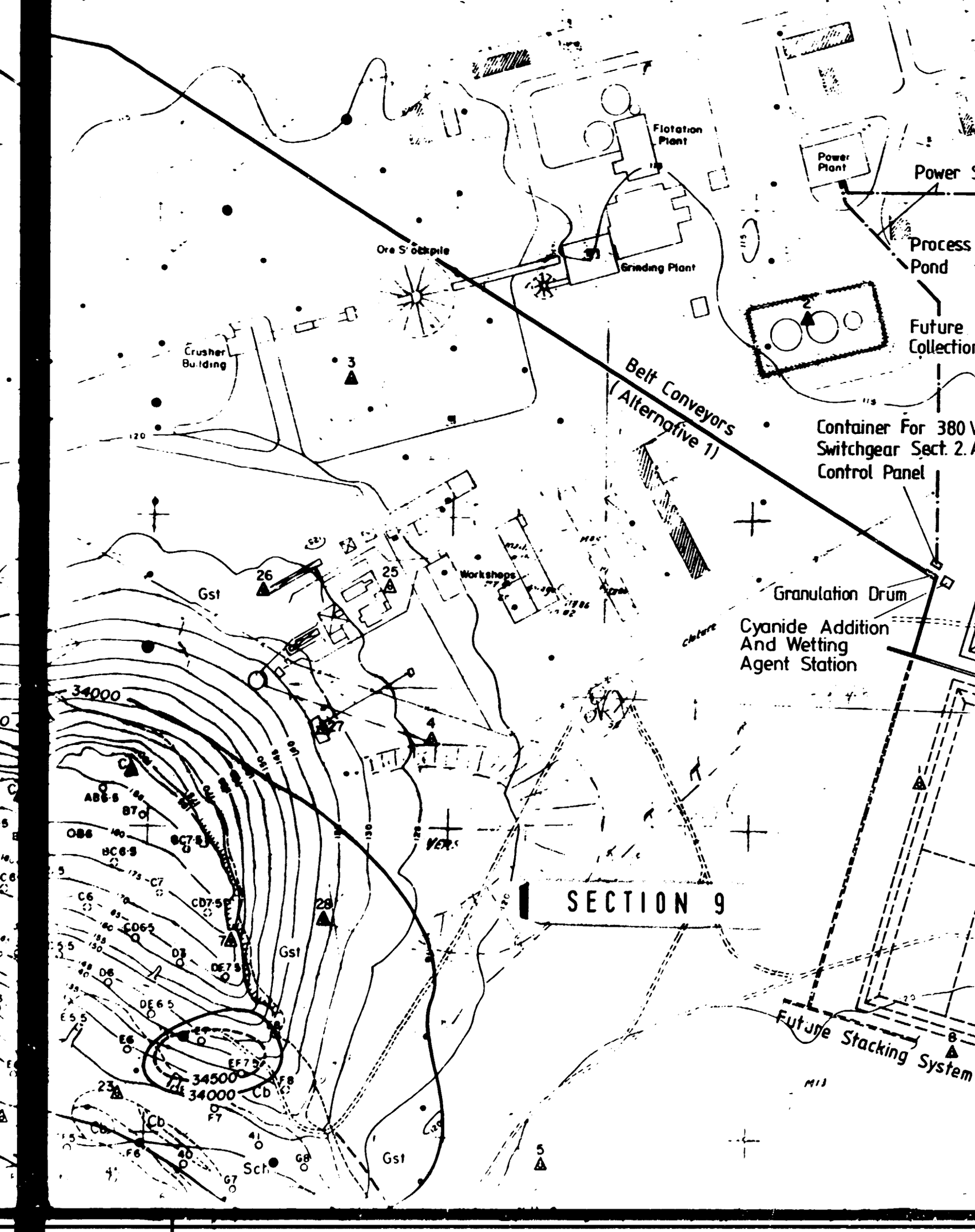
34500

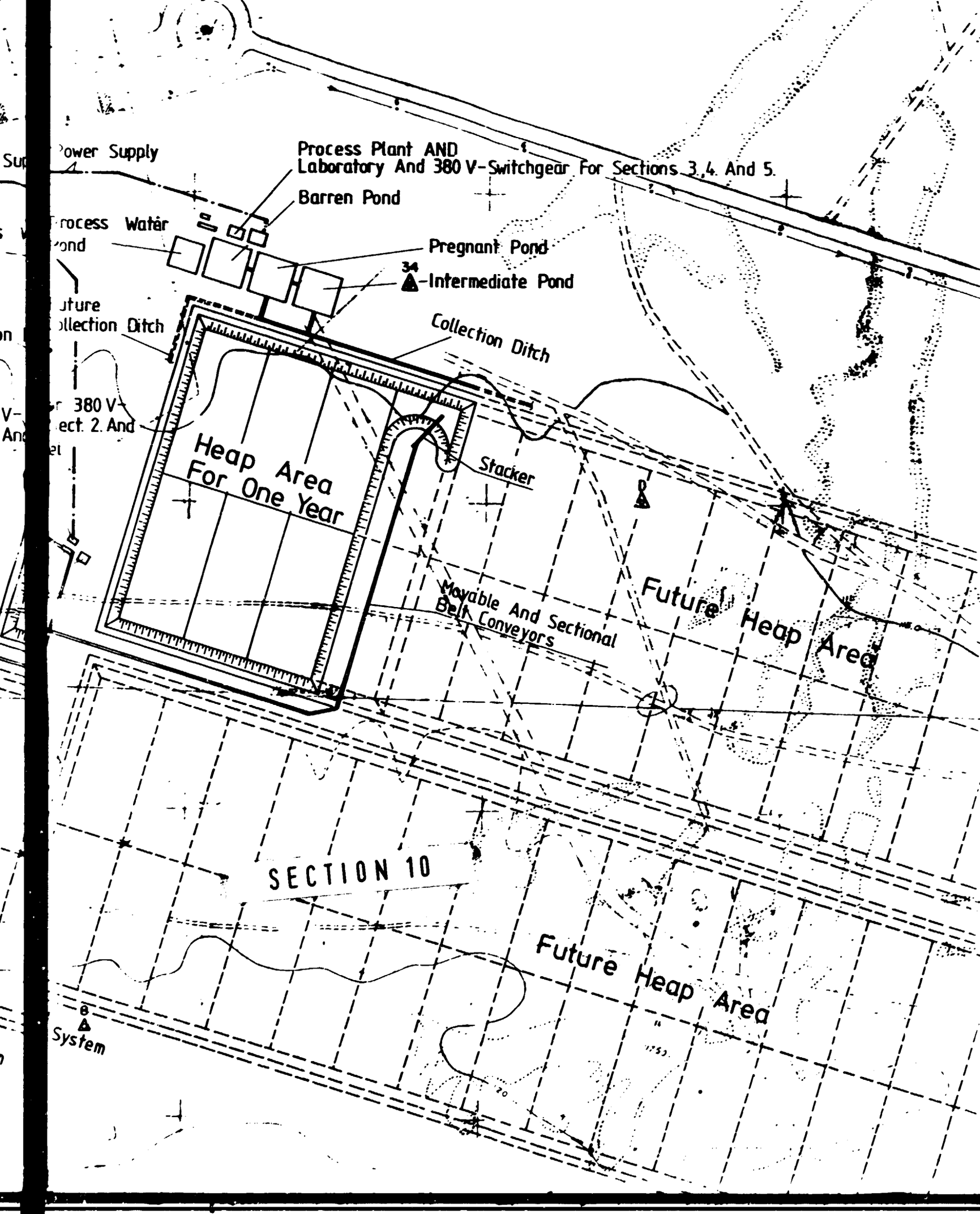

562,800
563,000
563,200
N
34000
7·10
SECTION 5
563,200

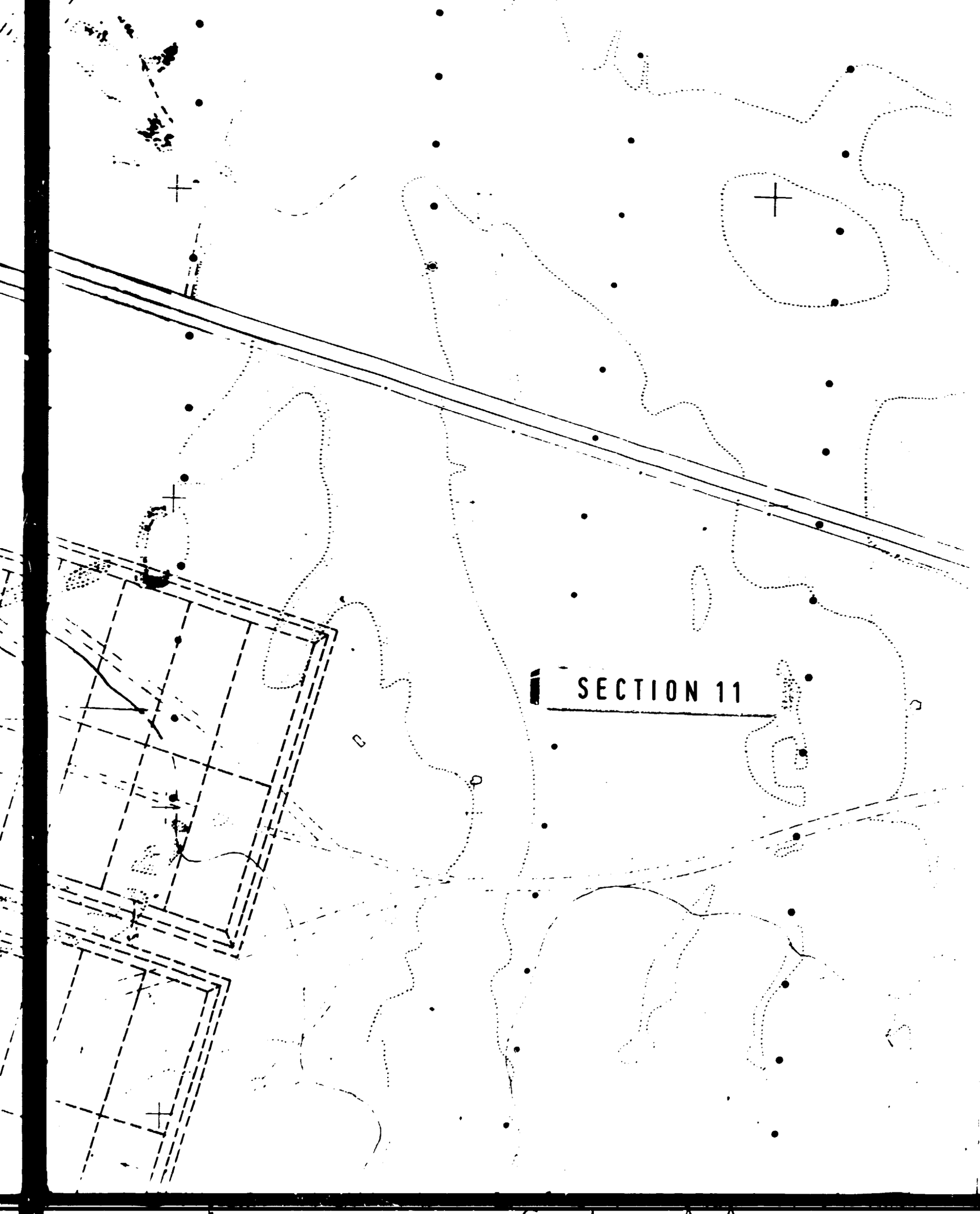

562,800
563,000
563,200
N
34000
SECTION 6
563,200

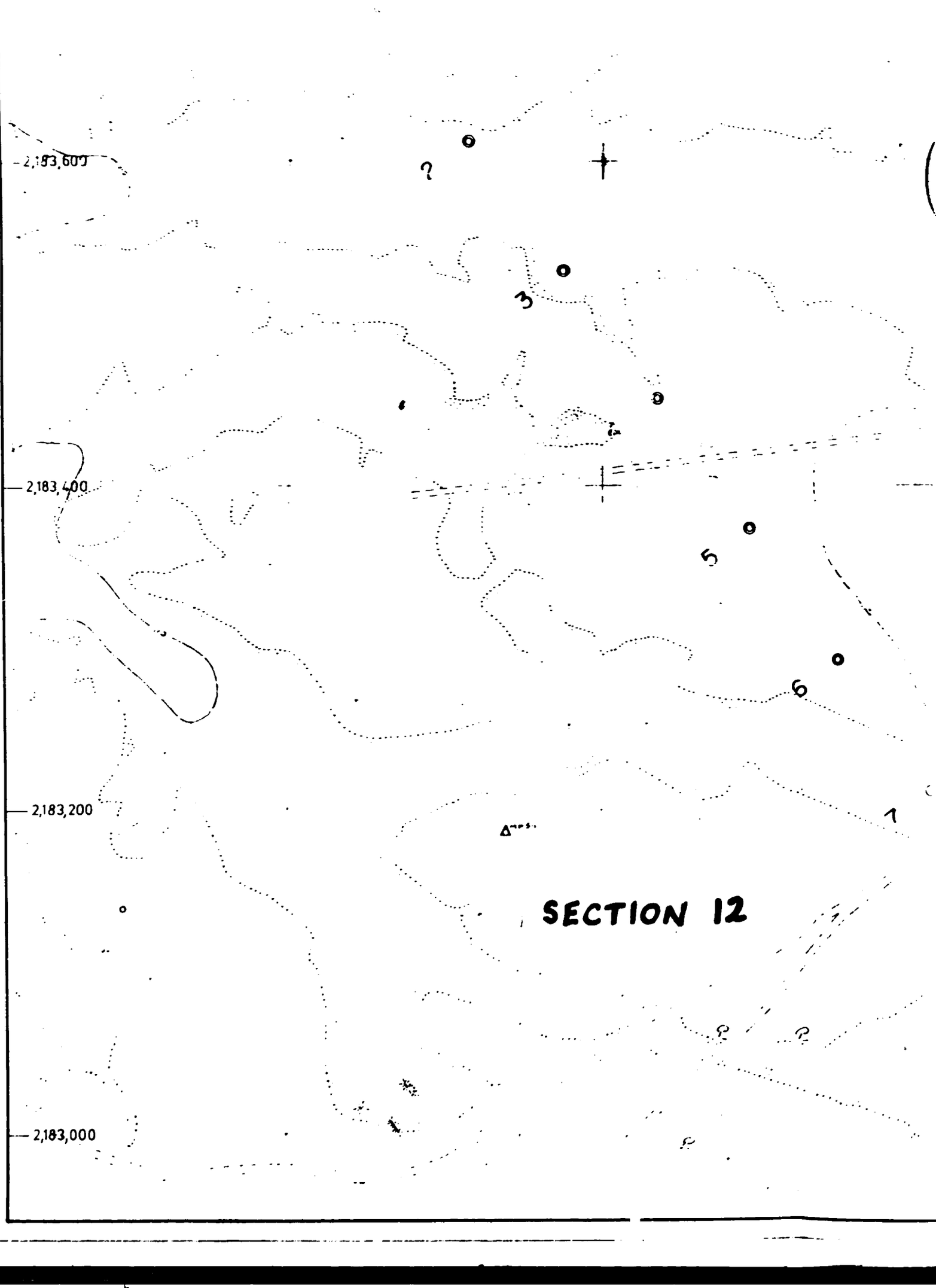

Tailing Aera
2,184,200
2,184,000
2,183,800
2,183,600
SECTION 7

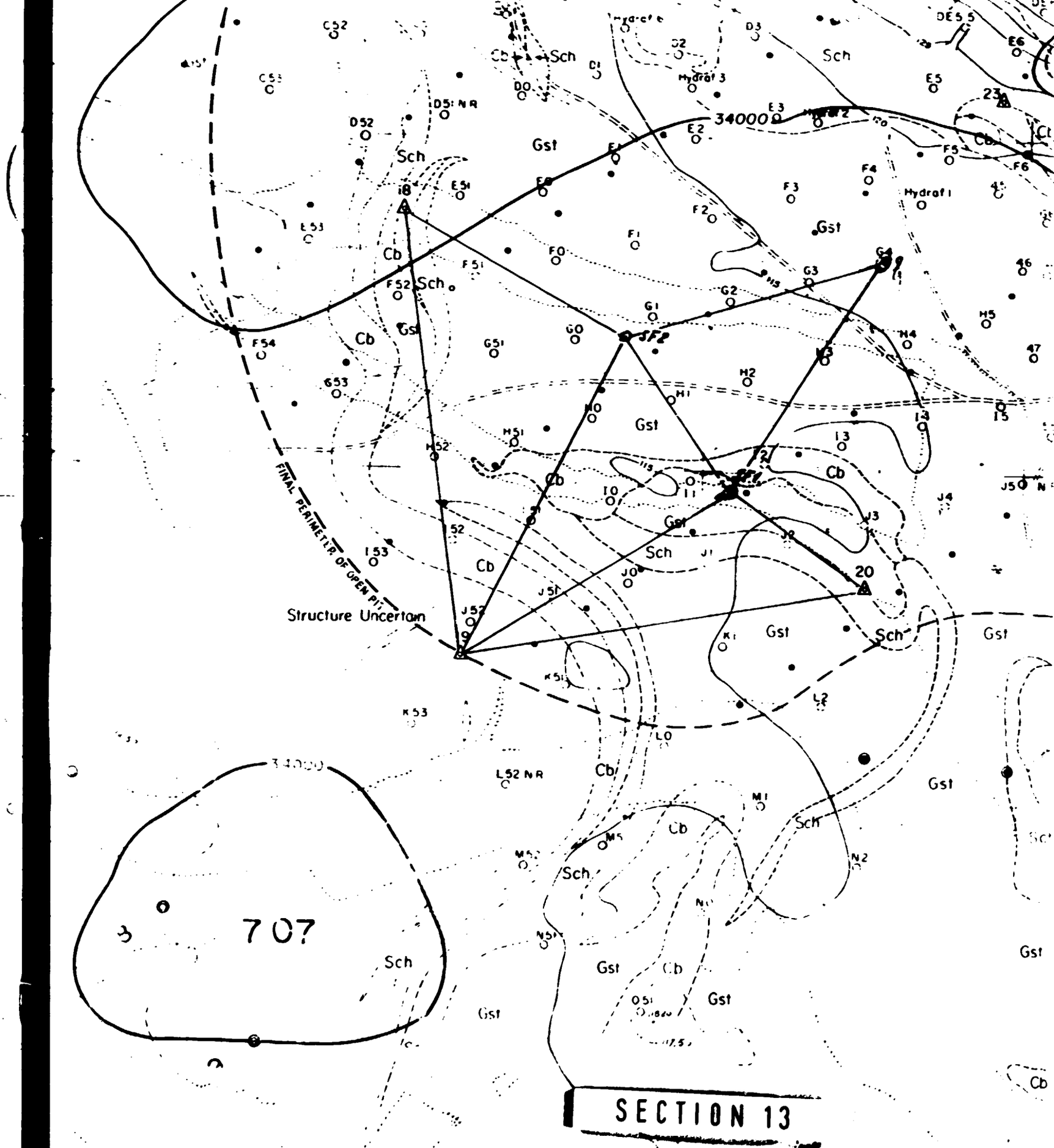

Emergency Stockpile
Ramp For Trucks And Frontendloader
SECTION 8
Ore Stockpile
TO WASTE DUMP
Gst
Sch
Cb
15
16
17
21
22
23
34000
7.08

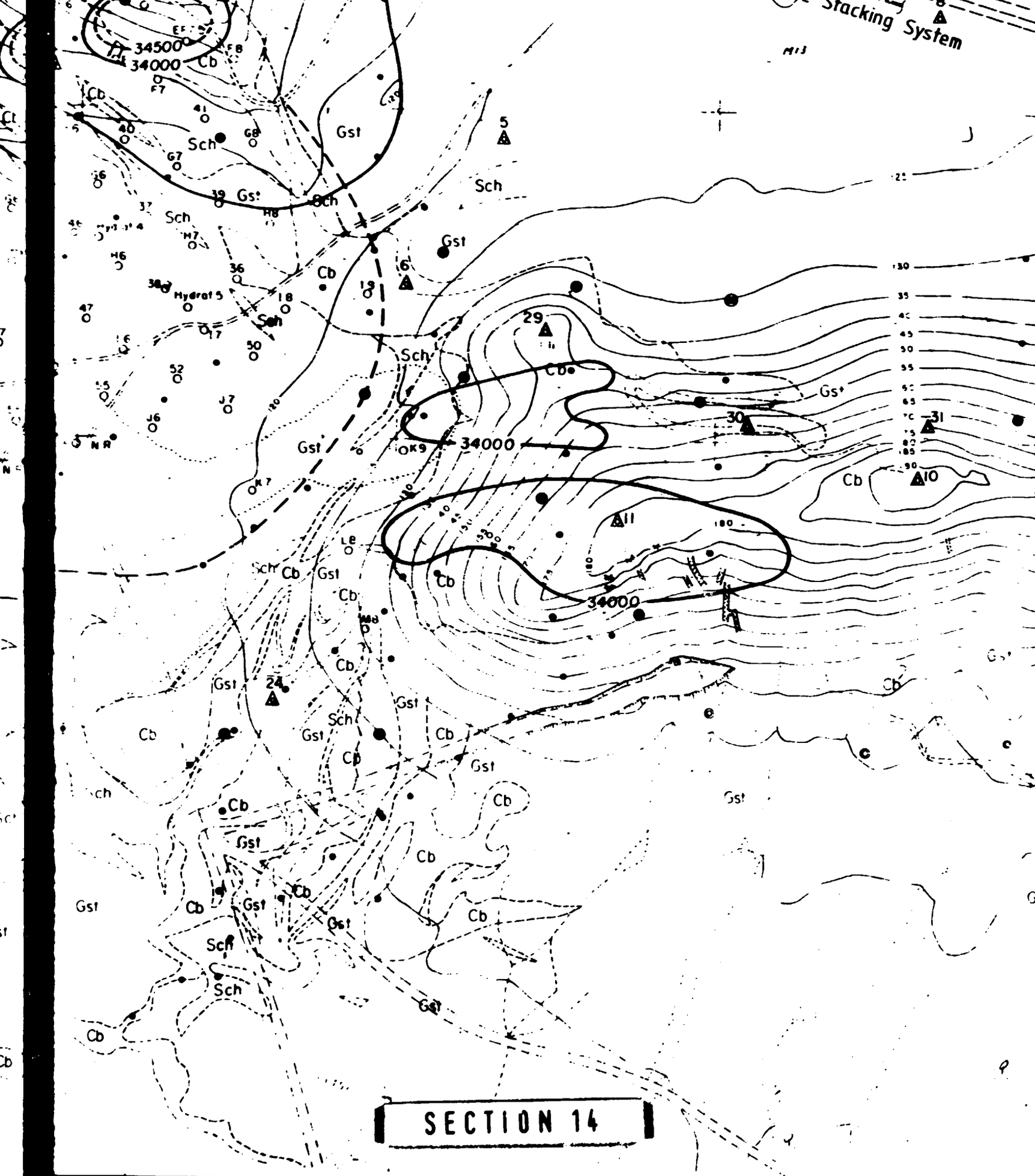

Flotation Plant
Power Plant
Power S
Process Pond
Future Collection
Ore Stockpile
Grinding Plant
Crusher Building
Belt Conveyors (Alternative 1)
Container For 380 V Switchgear Sect. 2. A Control Panel
Workshops
Granulation Drum
Cyanide Addition And Wetting Agent Station
SECTION 9
Future Stacking System
Gst
Cb
Sch
34000
34500


Power Supply
Process Plant AND
Laboratory And 380 V-Switchgear For Sections 3, 4. And 5.
Barren Pond
Process Water
Pond
Pregnant Pond
34
Intermediate Pond
Future
Collection Ditch
Collection Ditch
380 V-
Sect. 2. And
Heap Area
For One Year
Stacker
Movable And Sectional
Belt Conveyors
Future Heap Area
SECTION 10
Future Heap Area
System

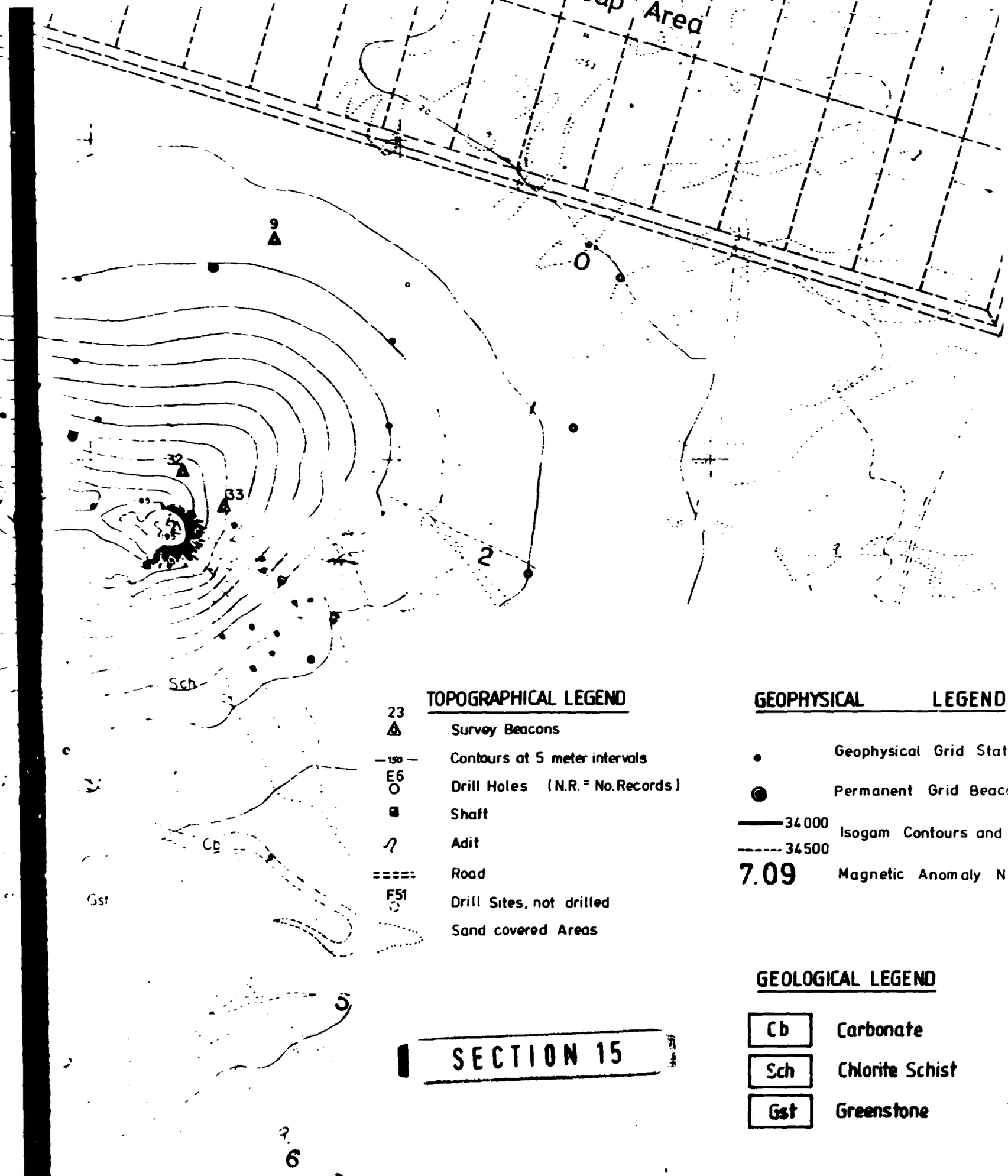

SECTION 11

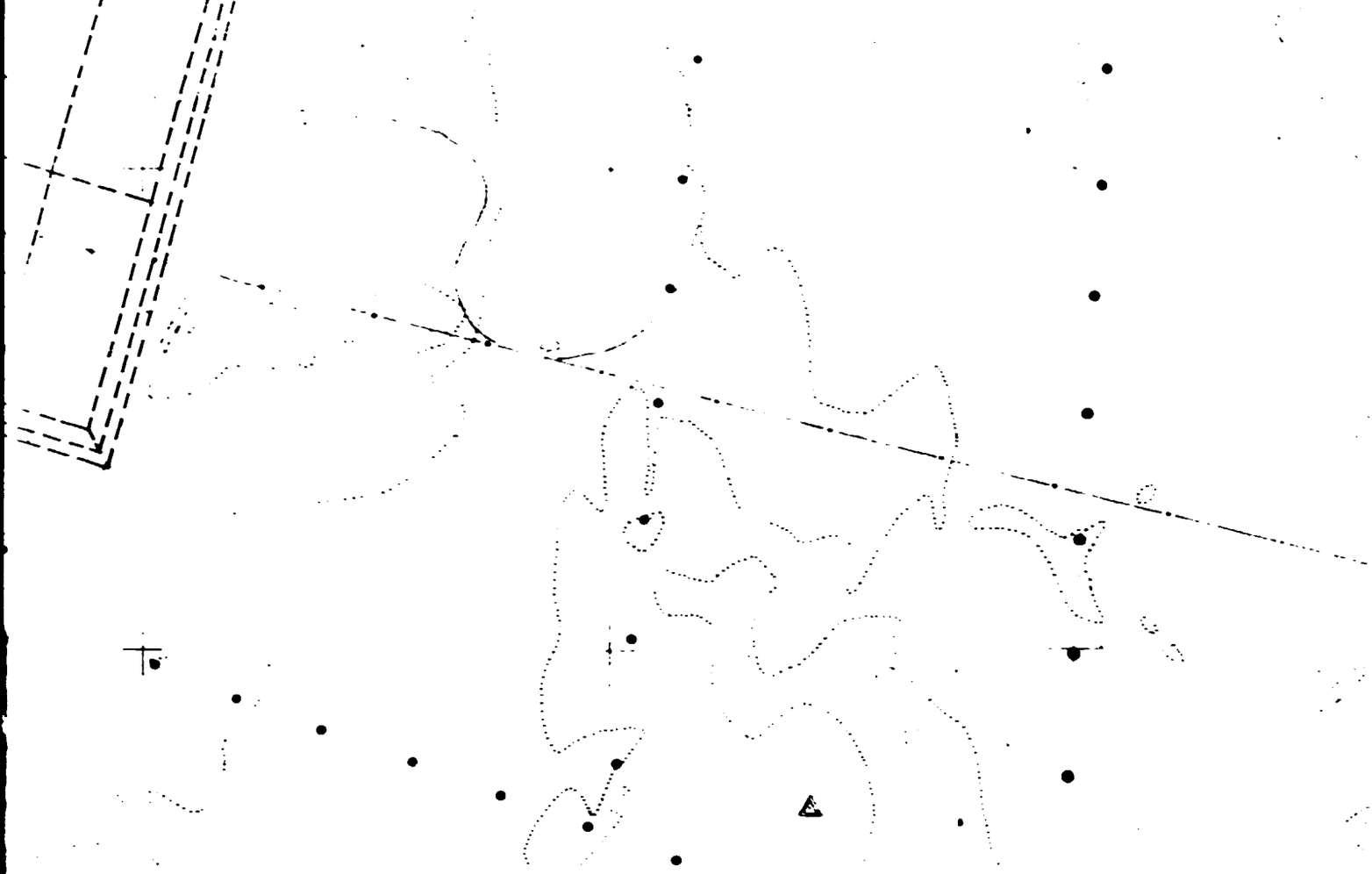

2,183,600
2,183,400
2,183,200
2,183,000
SECTION 12


FINAL PERIMETER OF OPEN PIT
Structure Uncertain
34000
Gst
Sch
Cb
707
SECTION 13


Stacking System
34500
34000
Cb
Gst
Sch
5
6
29
30
31
10
11
24
34000
Hydrat 5
NR

SECTION 14


Area
9
32
33
Sch
Cb
Gst
5
6
2
TOPOGRAPHICAL LEGEND
23
Survey Beacons
Contours at 5 meter intervals
E6
Drill Holes (N.R. = No. Records)
Shaft
Adit
Road
F51
Drill Sites, not drilled
Sand covered Areas
GEOPHYSICAL LEGEND
Geophysical Grid Stat
Permanent Grid Beac
34000
34500
Isogam Contours and
7.09
Magnetic Anomaly N
GEOLOGICAL LEGEND
Cb
Carbonate
Sch
Chlorite Schist
Gst
Greenstone
SECTION 15



SECTION 16

AKJOUJT, MAURITANIA

LEGEND

rid Station

id Beacon

urs and their Values

maly Numbers

ist

Gold Heap Leach Plant for Tarco Tailings

GENERAL LAYOUT

1:2500

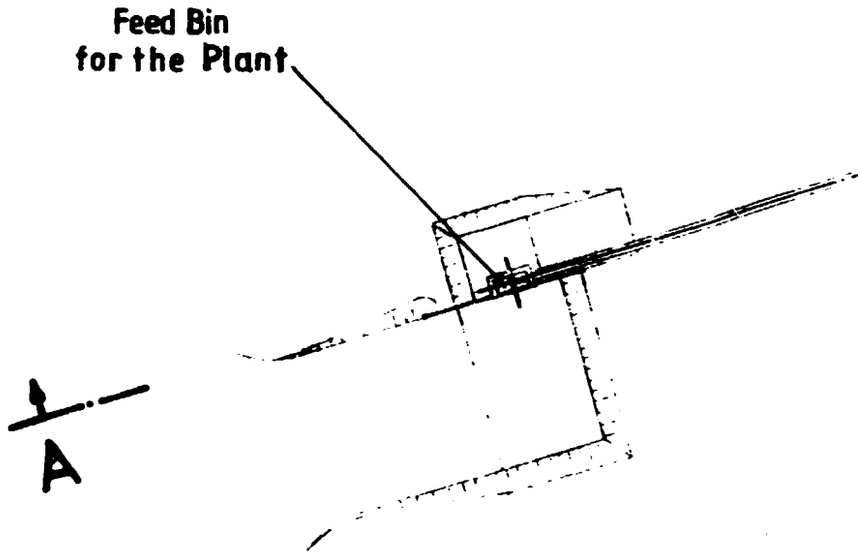
9-2121-5-0154

801-11-298 UA

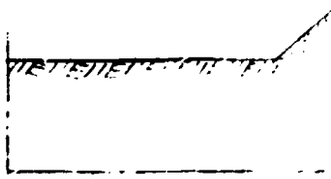
KHD Humboldt Wedag AG

Kappes, Cassiday & Associates

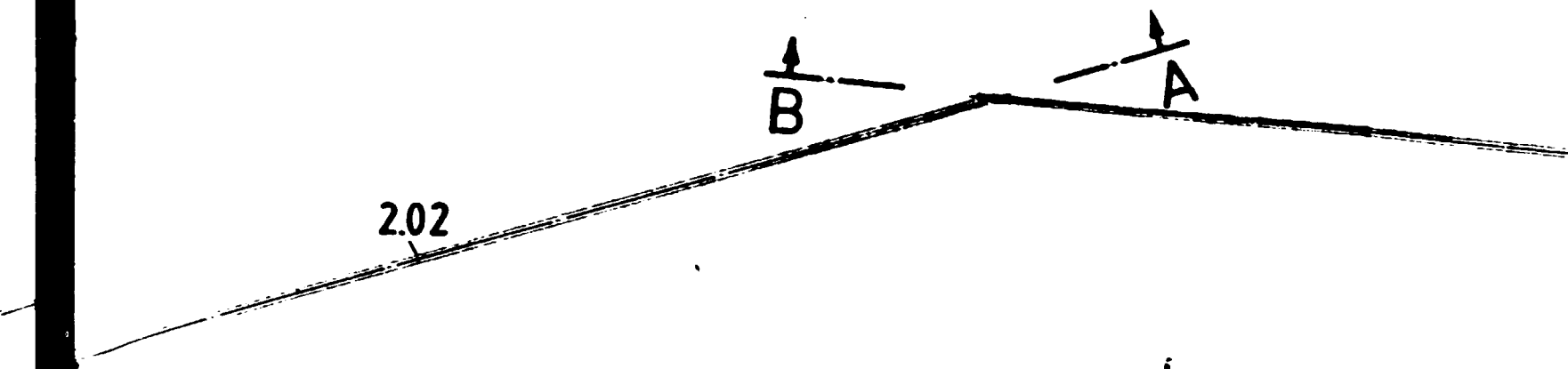
DRAWING No.



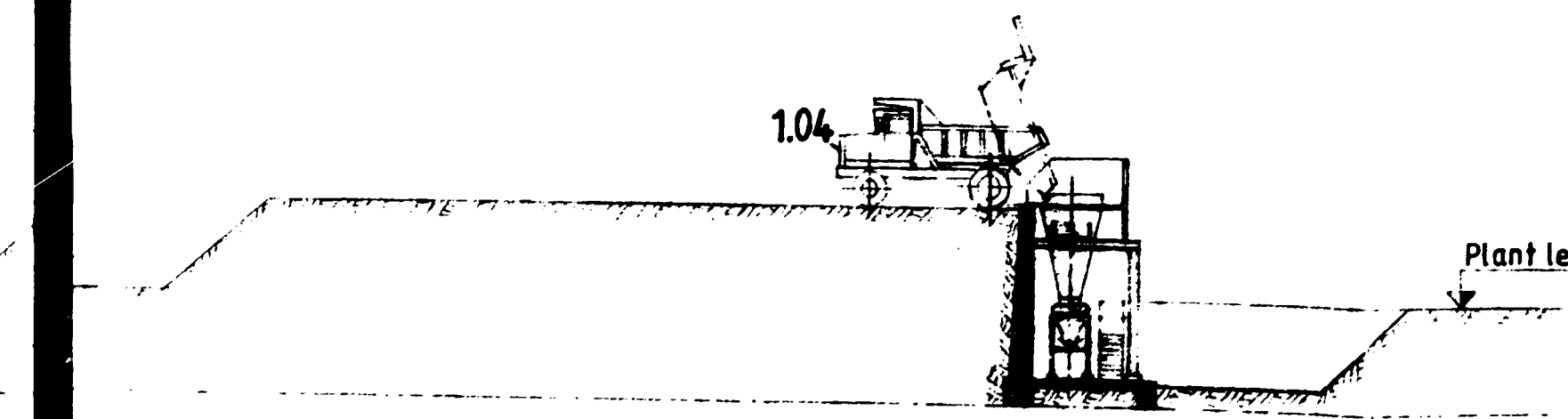
SECTION 1



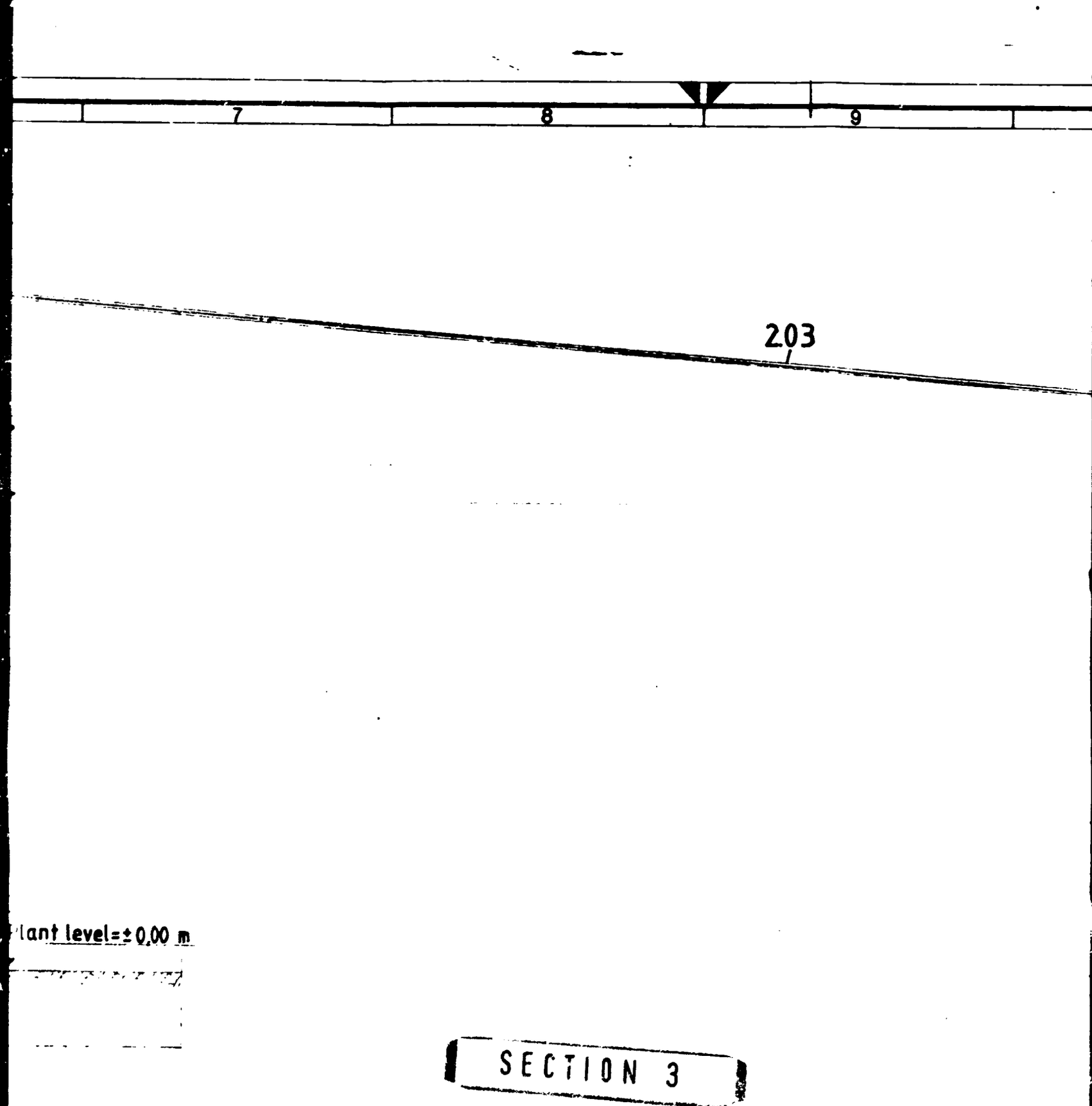
D
D



Section D-D



SECTION 2



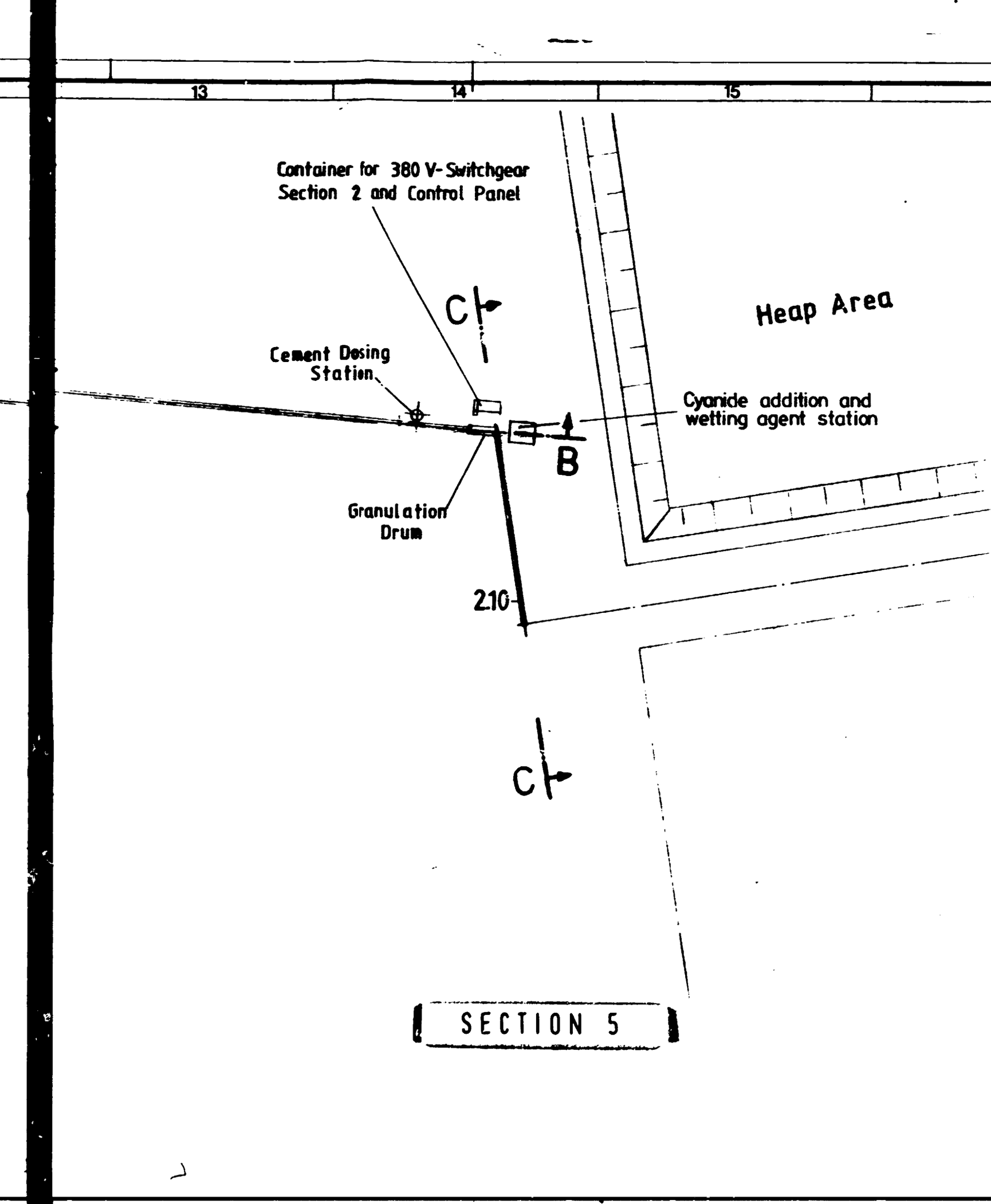
Section A-A

10 11 12

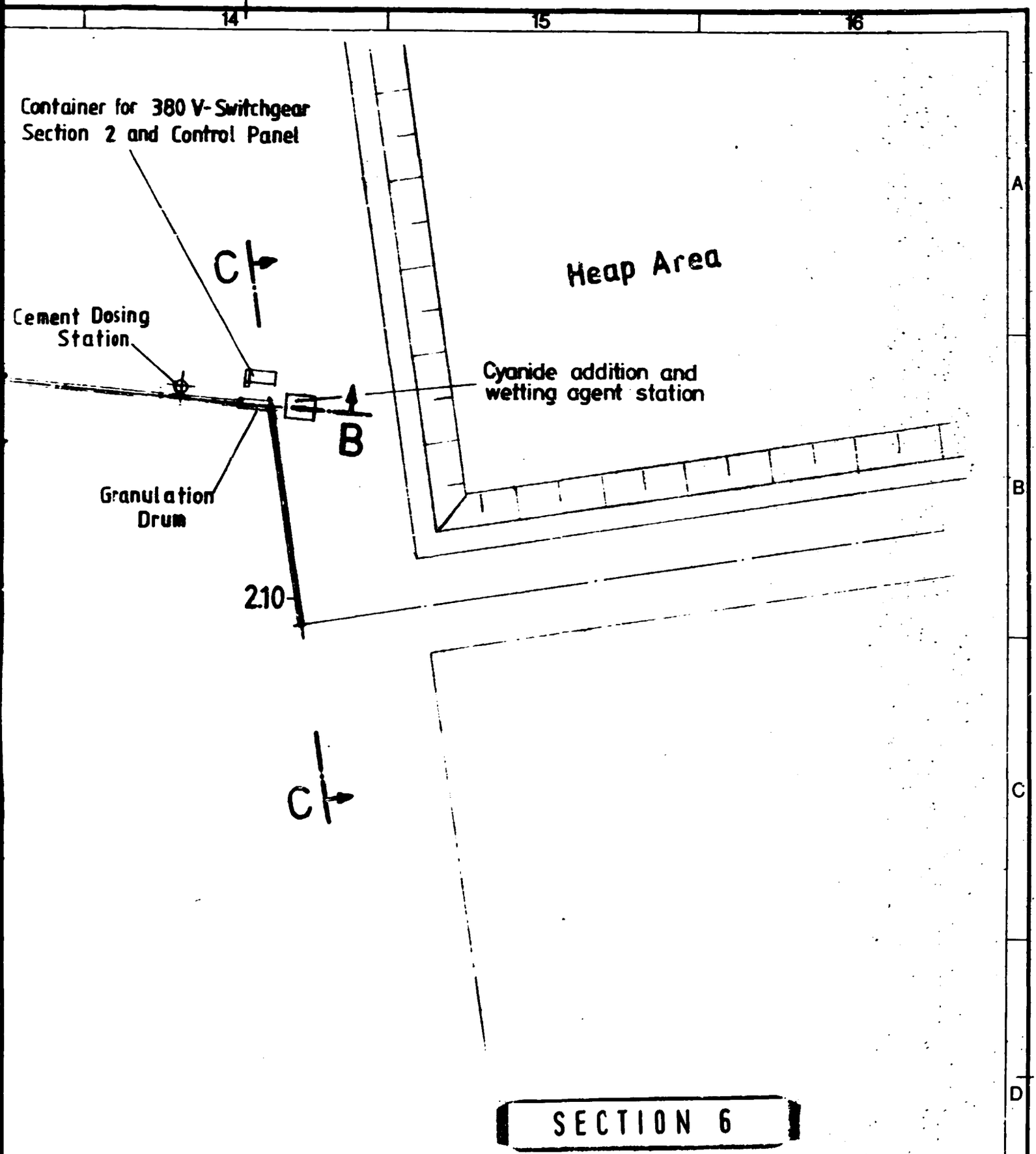
Top view

scale 1:1000

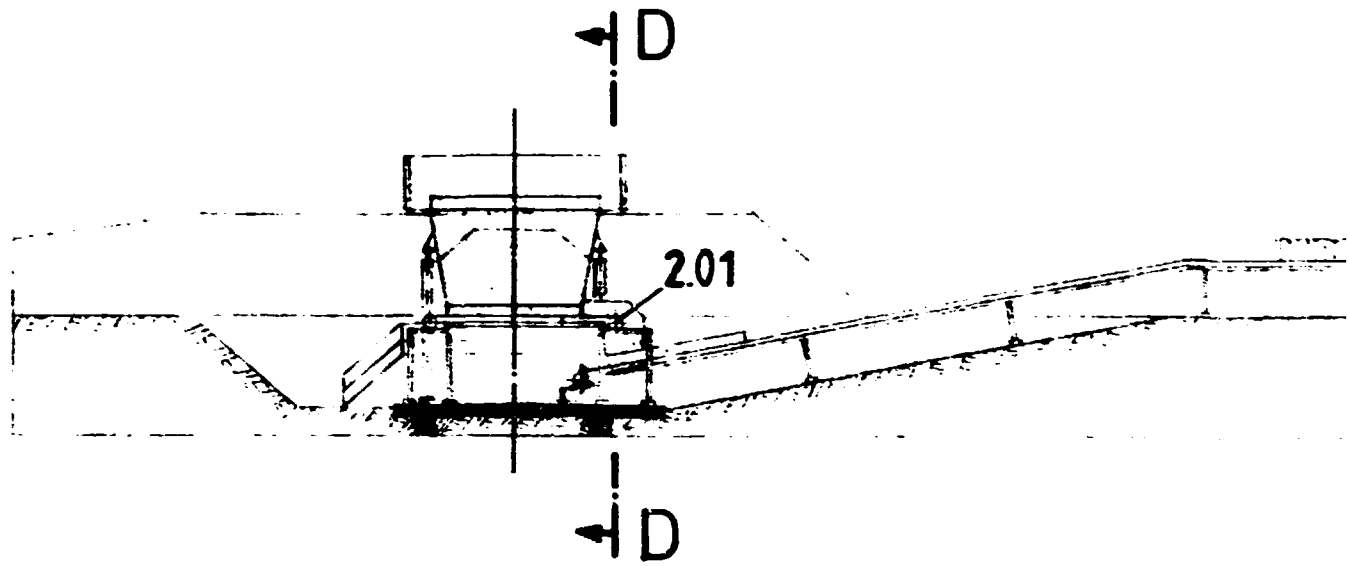
SECTION 4

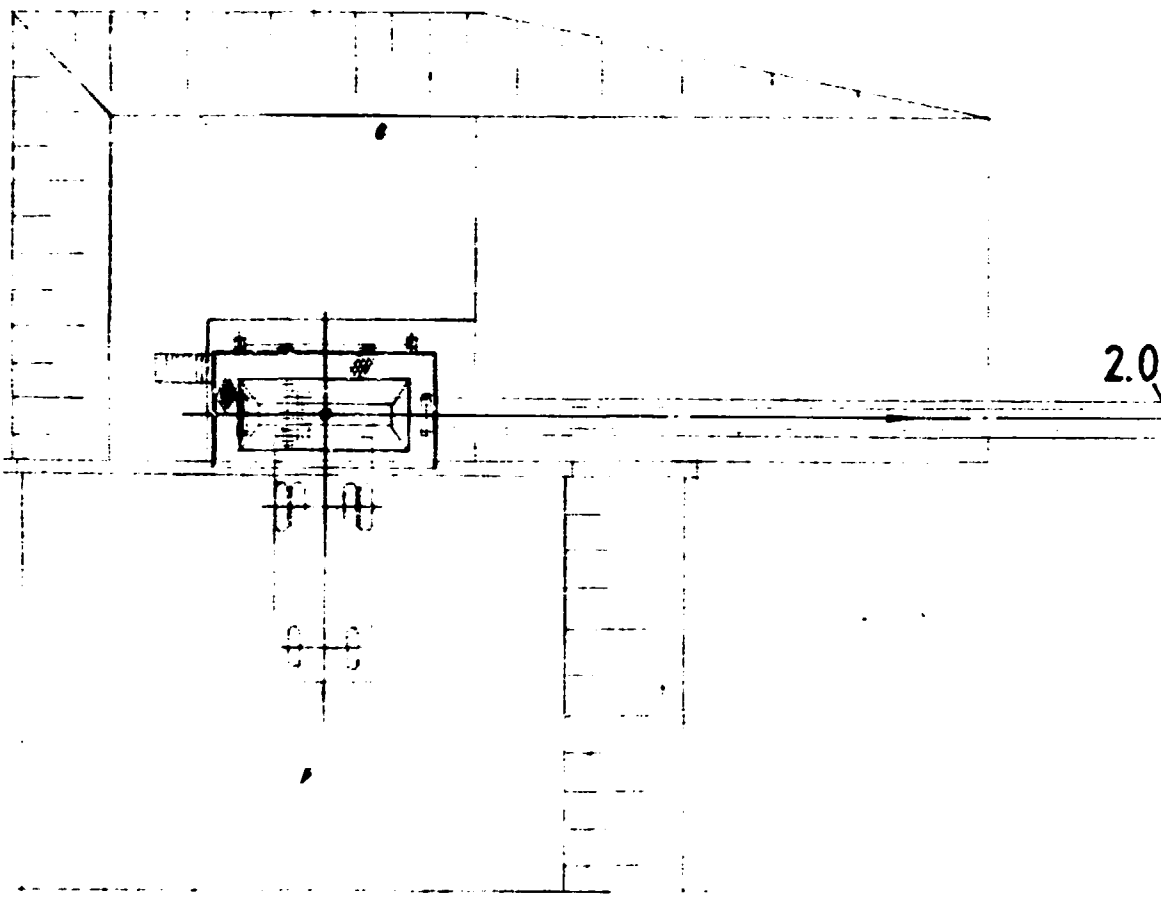

13
14
15
Container for 380 V-Switchgear Section 2 and Control Panel
C
Heap Area
Cement Dosing Station
Cyanide addition and wetting agent station
B
Granulation Drum
2.10
C

SECTION 5

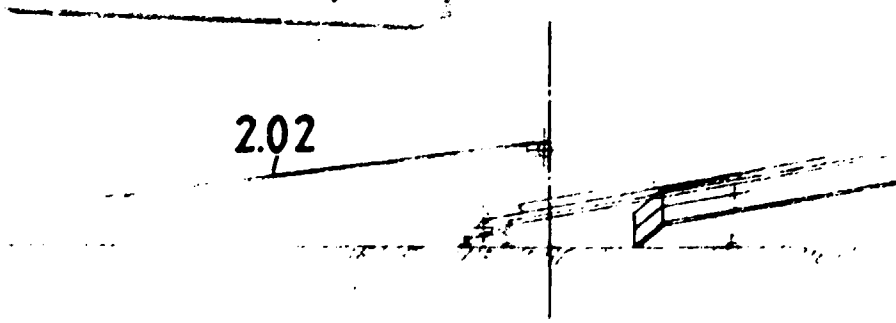

14
15
16
A
B
C
D
Container for 380 V-Switchgear Section 2 and Control Panel
C
Heap Area
Cement Dosing Station
Cyanide addition and wetting agent station
B
Granulation Drum
2.10
C

SECTION 6

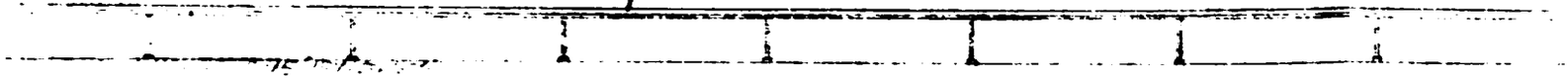




SECTION 7



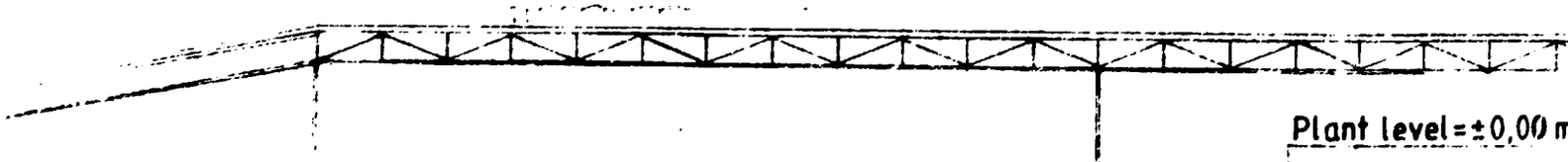
2.02



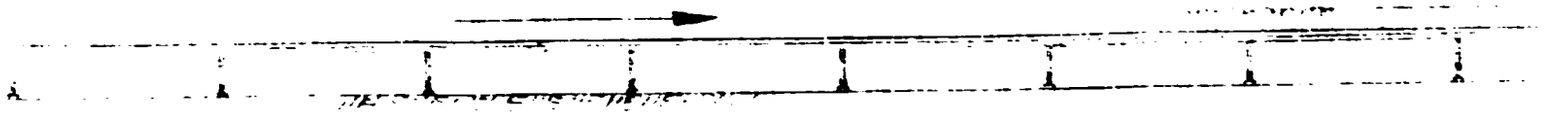
2.02

02

SECTION 8

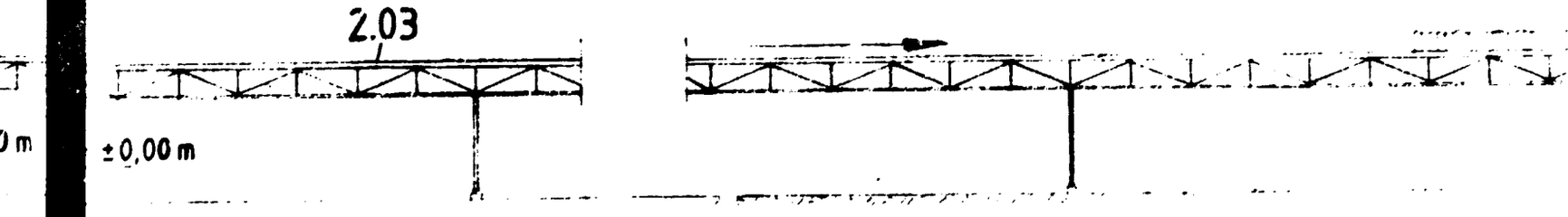


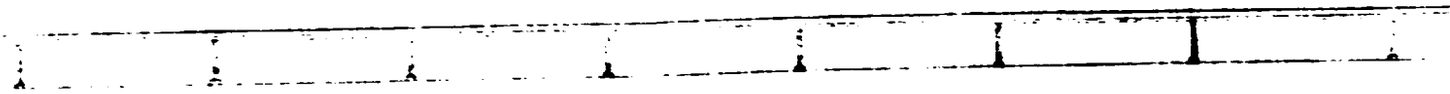
Section A-A



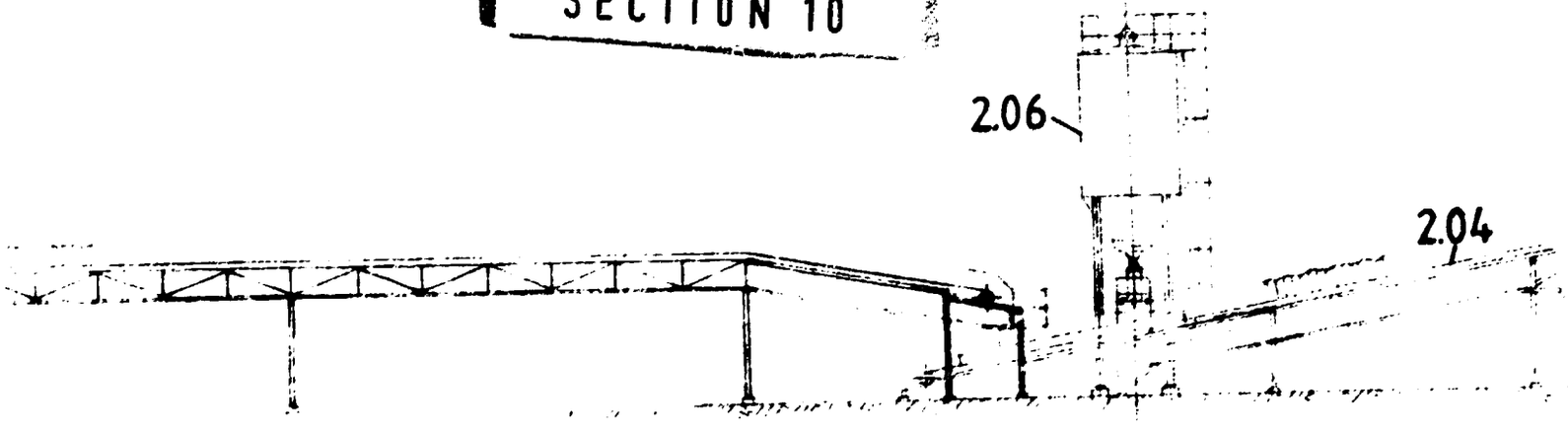
SECTION 9

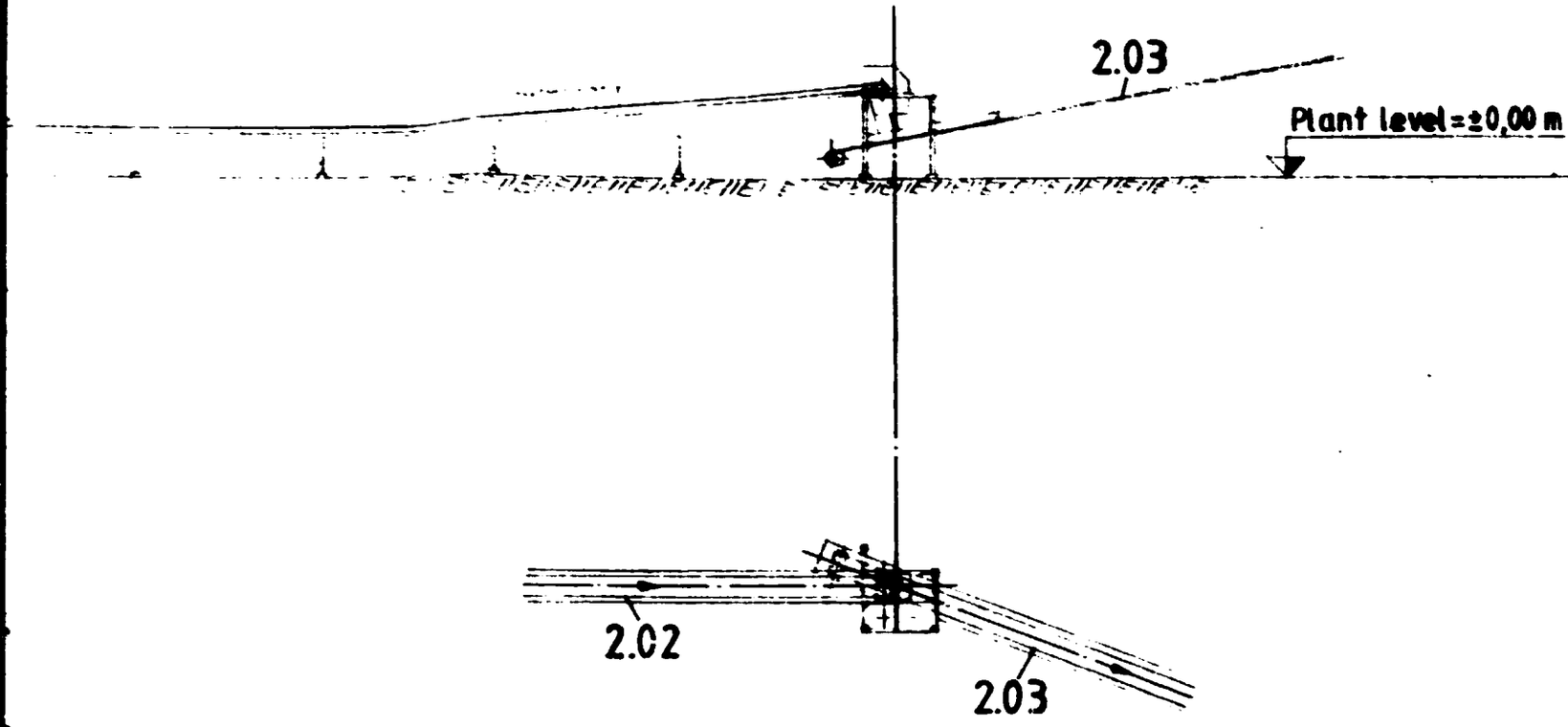
Section B-B



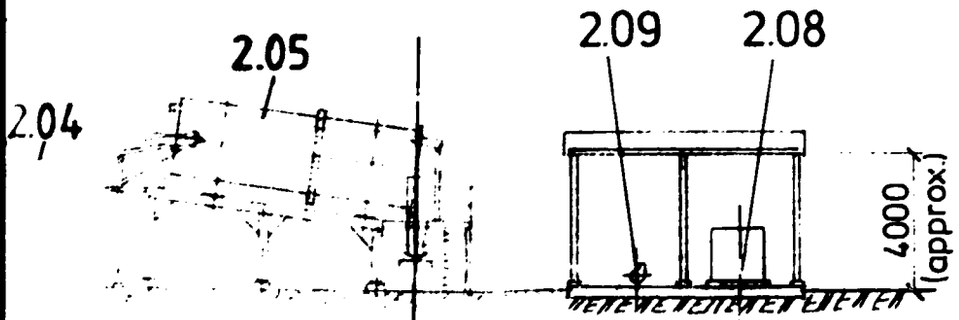


SECTION 10

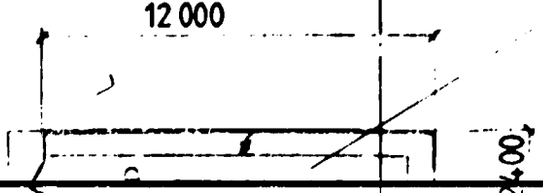


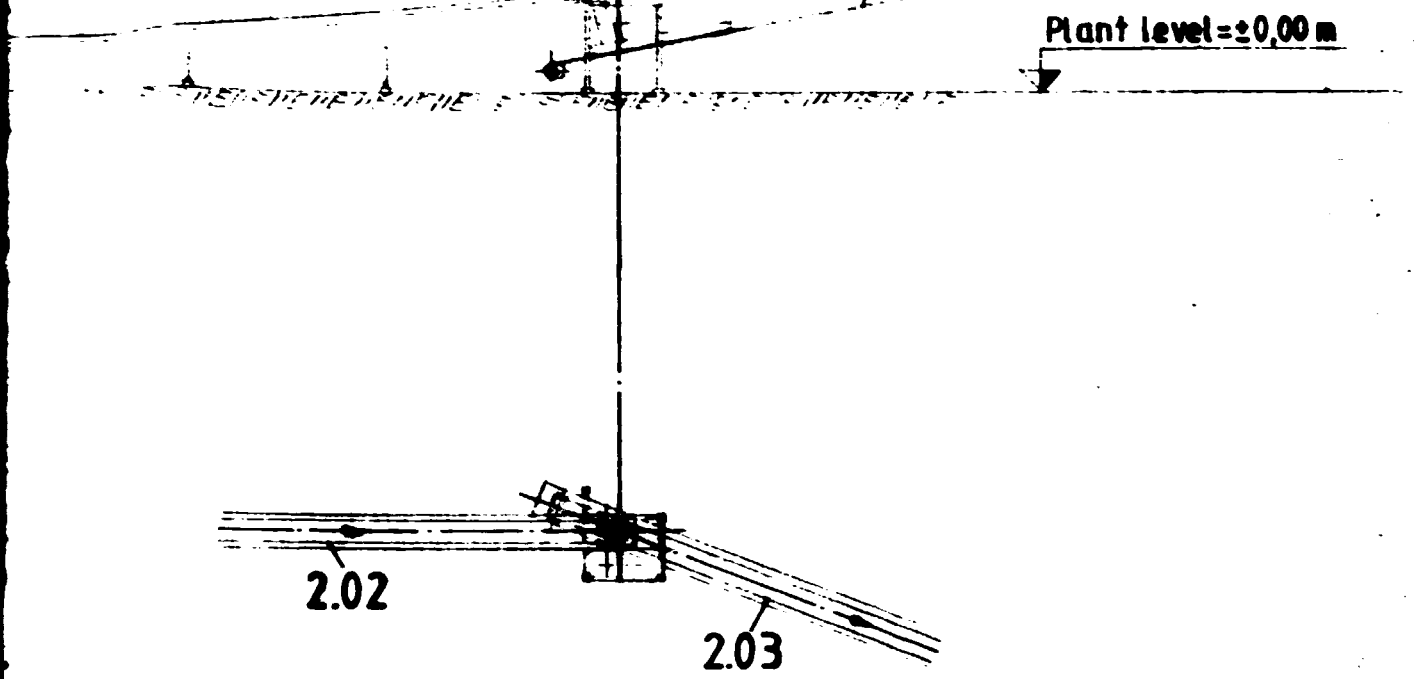


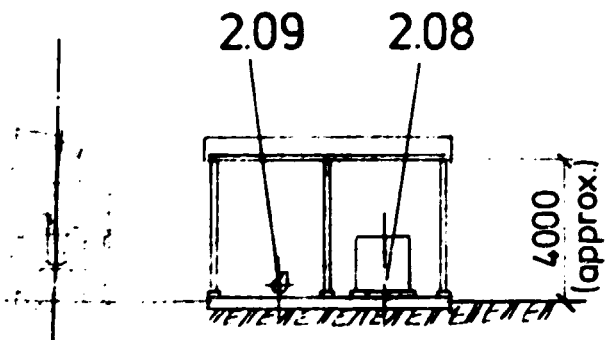
SECTION 11



Container for 380 V - Switchgear Section 2.
and Control Panel

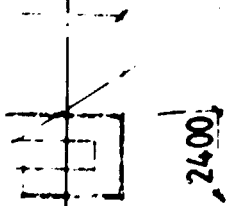






SECTION 12

Container for 380 V - Switchgear Section 2.
and Control Panel



M L K J

1 2 3

SECTION 13

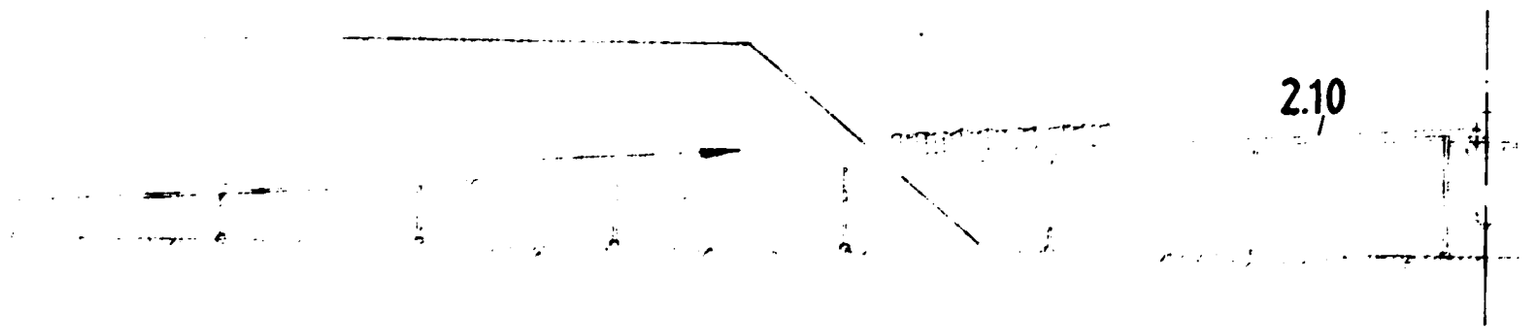
800 approx.

2900

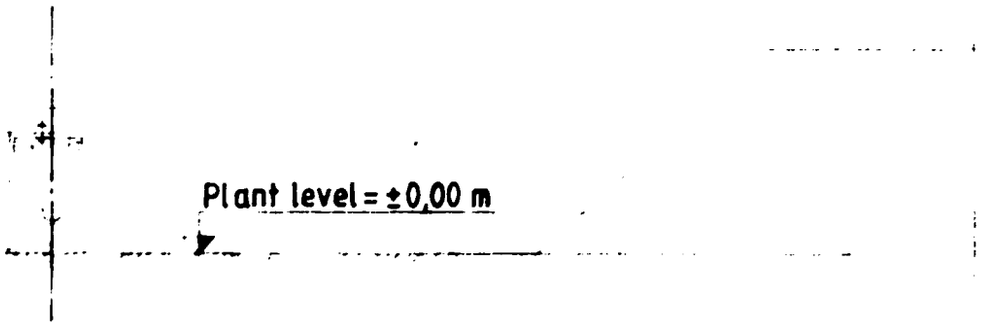
2.05

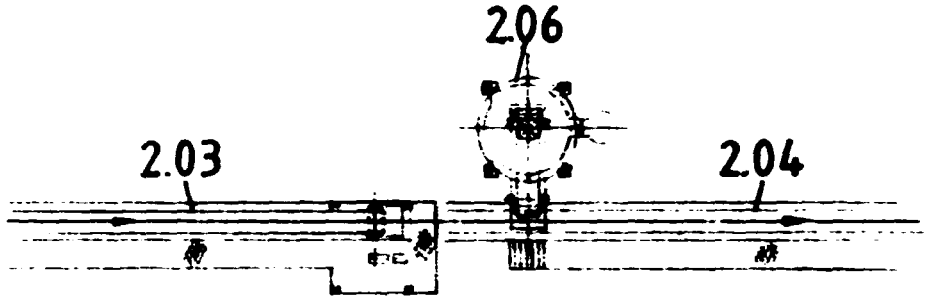
SECTION 14

Section C-C

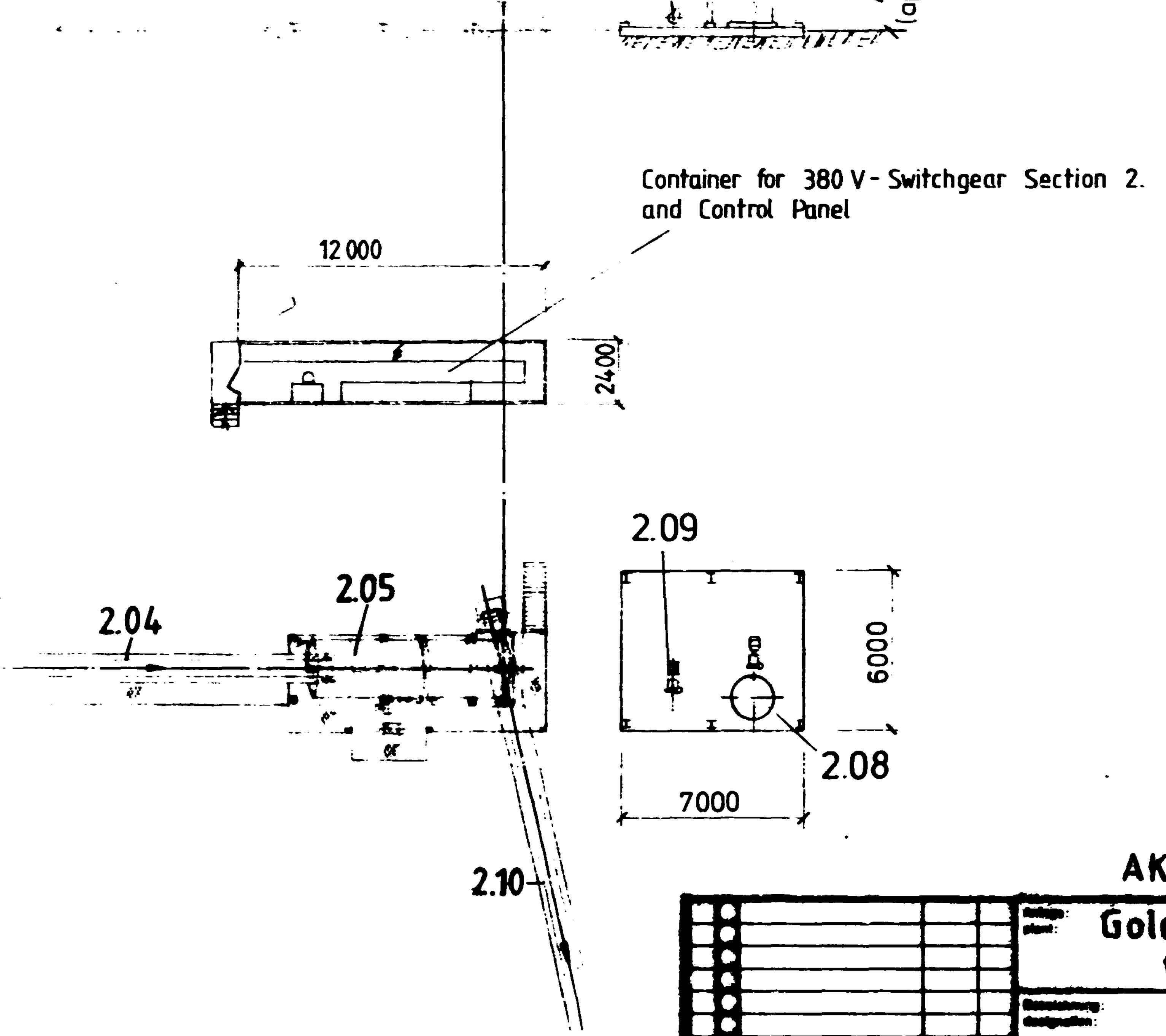


SECTION 15





SECTION 16



AKJOUJT

Gold Hea
for To

LAY

PLANT FEEDI

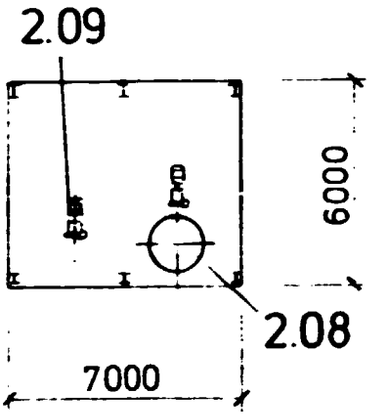
SECTION 17

1:2
1:

03.12.85

Container for 380 V - Switchgear Section 2.
and Control Panel

2400



2.10

SECTION 18

AKJOUJT / MAURITANIA

Gold Heap Leach Plant
for Torco Tailings

LAYOUT FOR

PLANT FEEDING AND GRANULATION

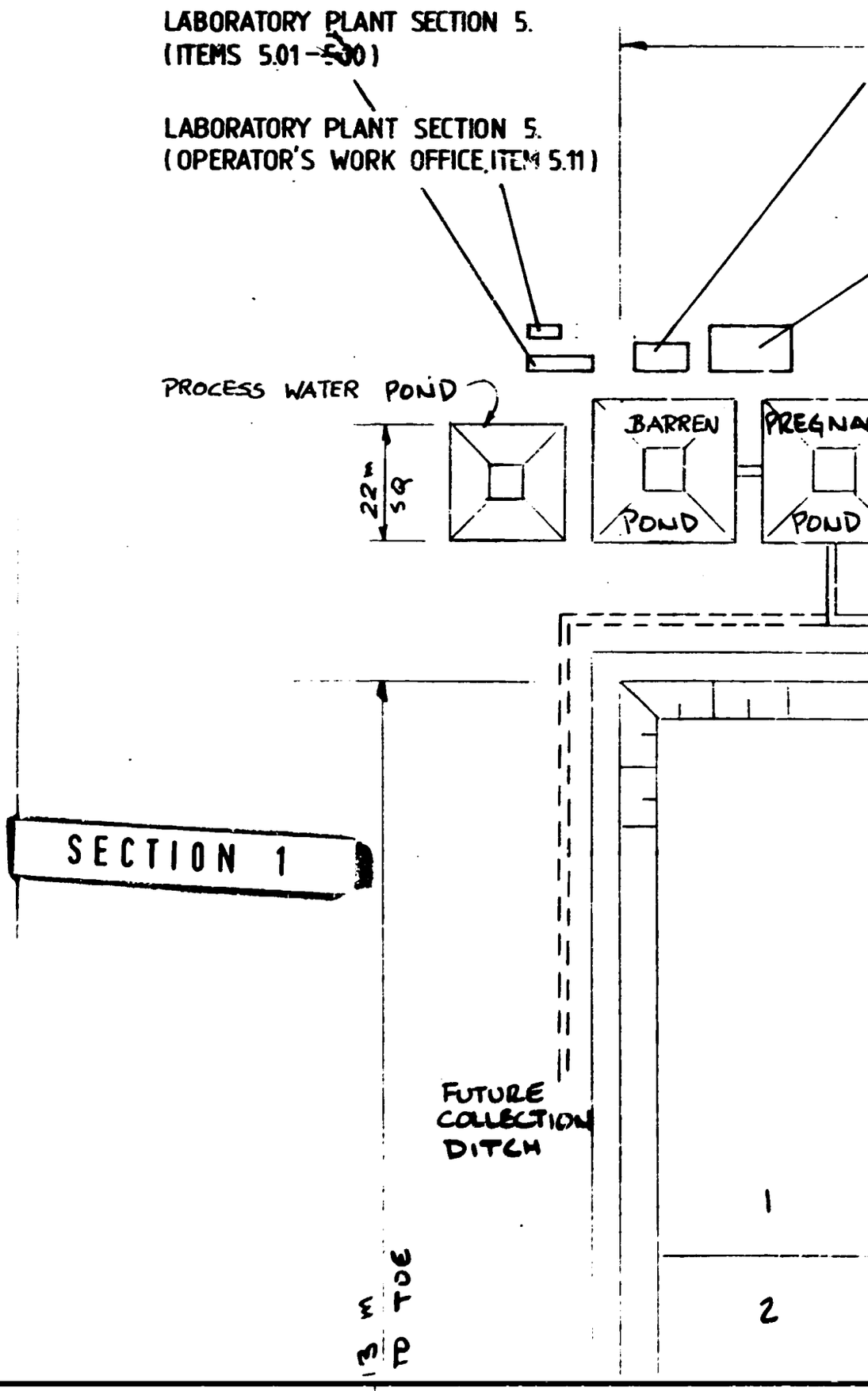
1:20
1:

9-2121-5-0156

801-11-299 UA

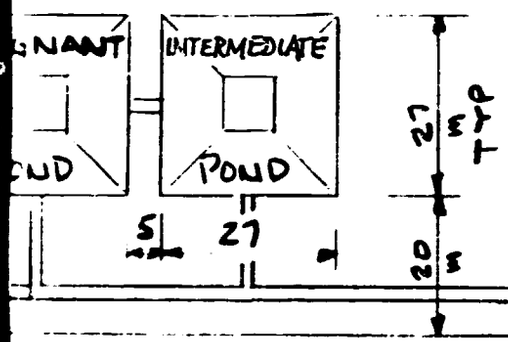
Hatch, Cassidy & Associates

J
K
L
M


LABORATORY PLANT SECTION 5.
(ITEMS 5.01 - 5.00)
LABORATORY PLANT SECTION 5.
(OPERATOR'S WORK OFFICE ITEM 5.11)
PROCESS WATER POND
22m SQ
BARREN POND
PREGNA
POND
SECTION 1
FUTURE COLLECTION DITCH
1
2
EDGE

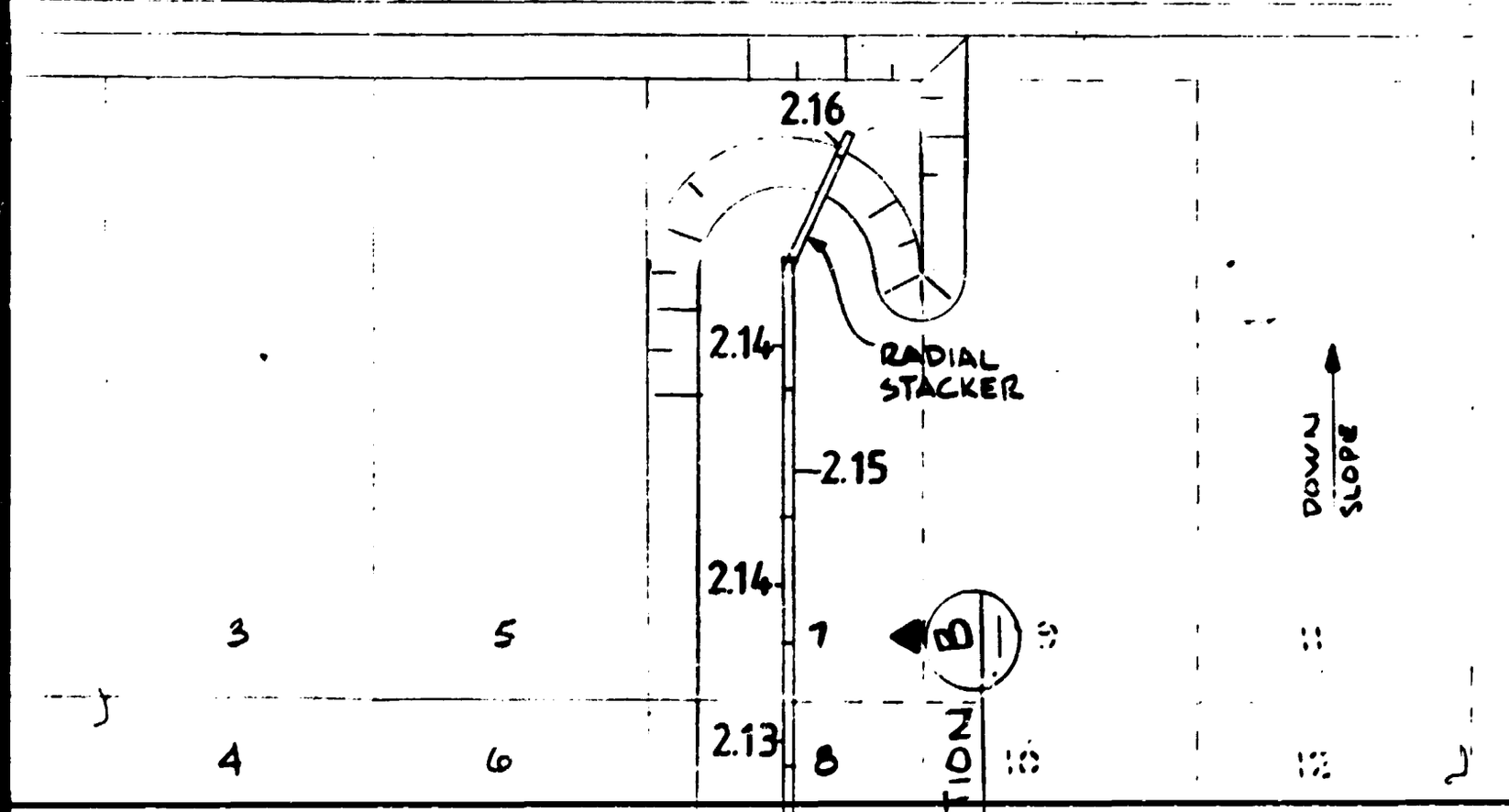
ITEMS 4.09 - 4.15 ALTERNATIVE EXECUTION : STEELSTRUCTURE ROOFING

ITEMS 2.07, 3.01, 3.02, 3.03, 4.01 - 4.08



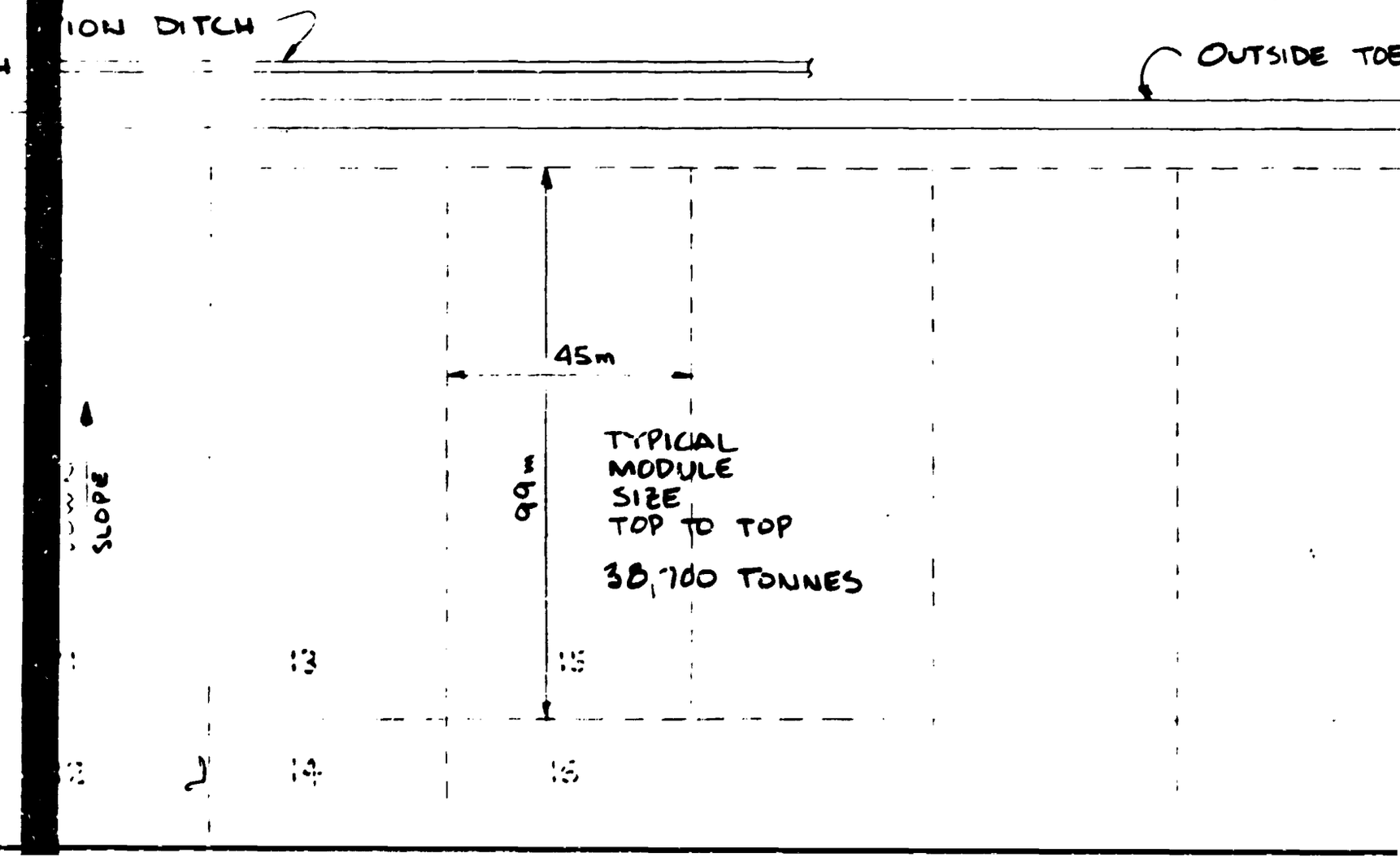
SECTION 2

COLLECTION DITCH



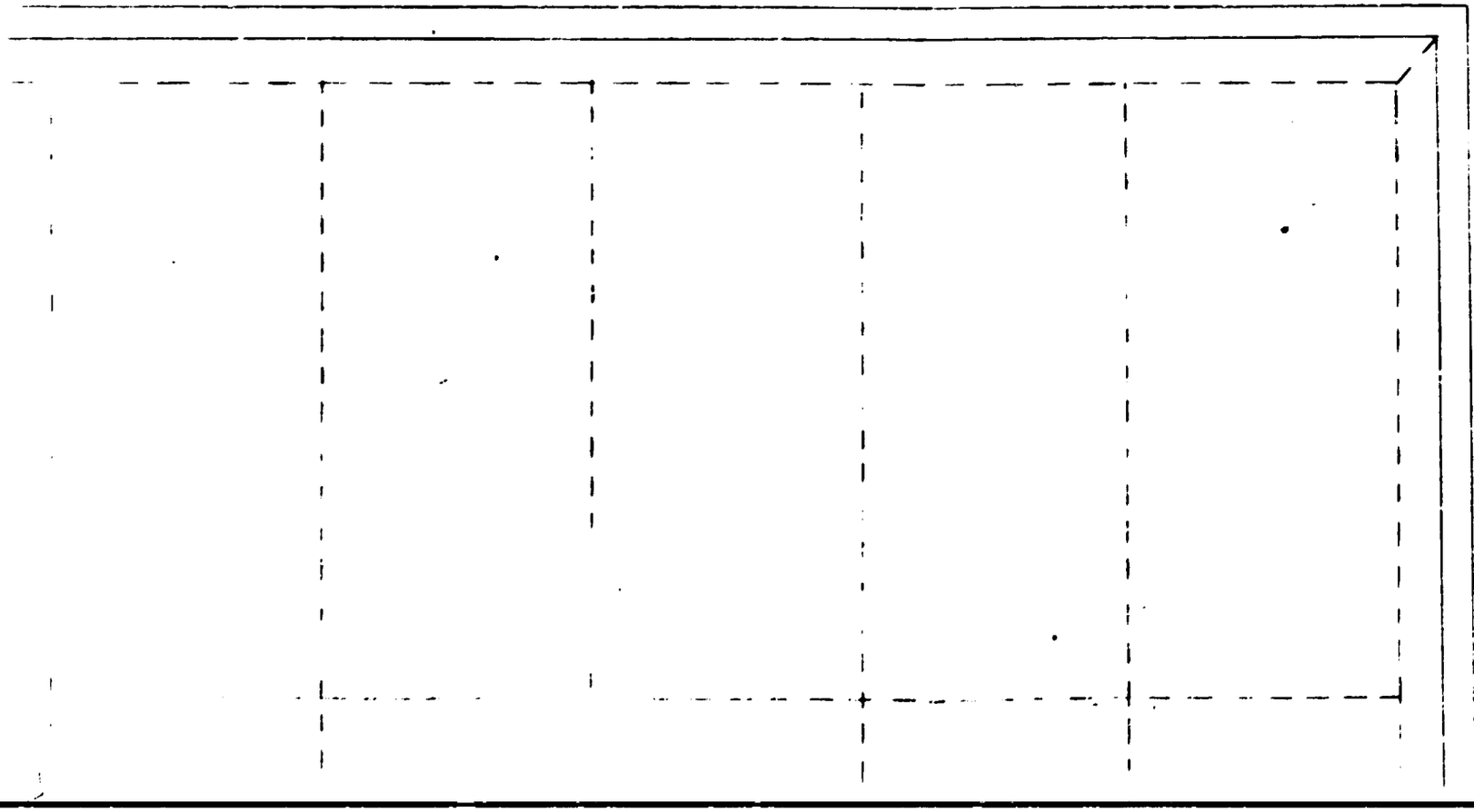
135 m TOE TO TOE

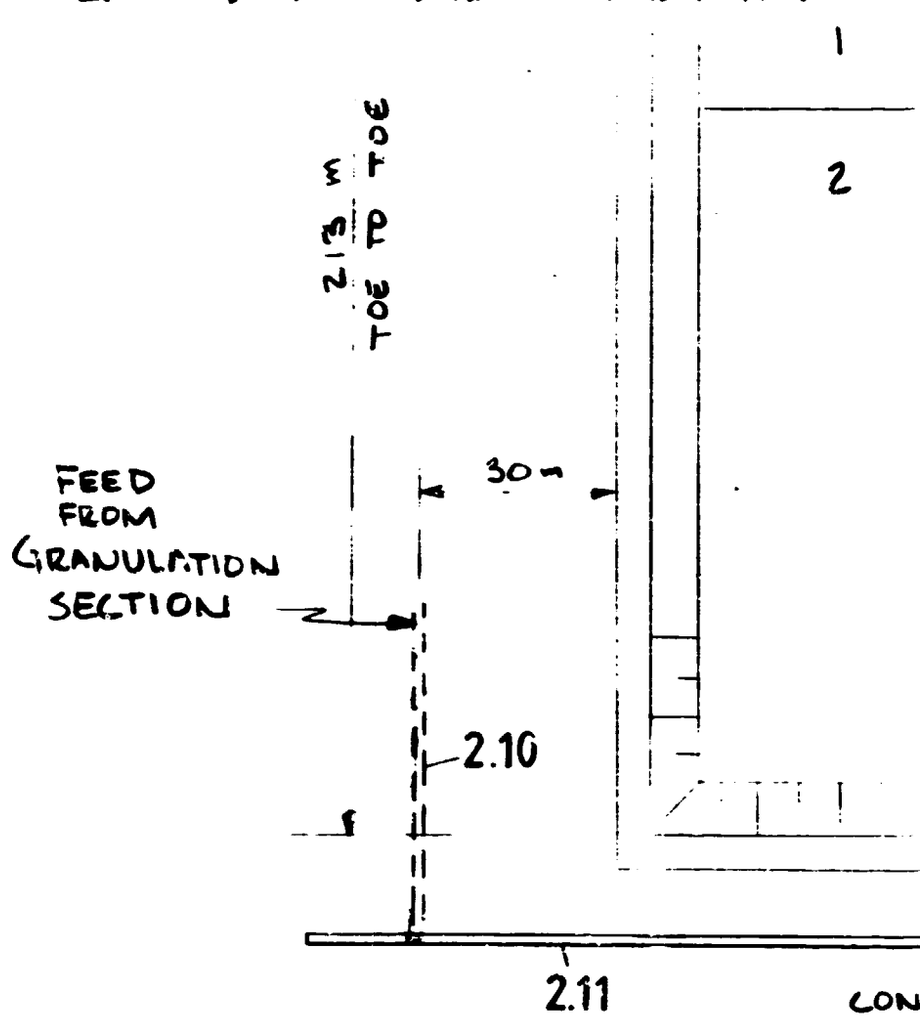
SECTION 3



SECTION 4

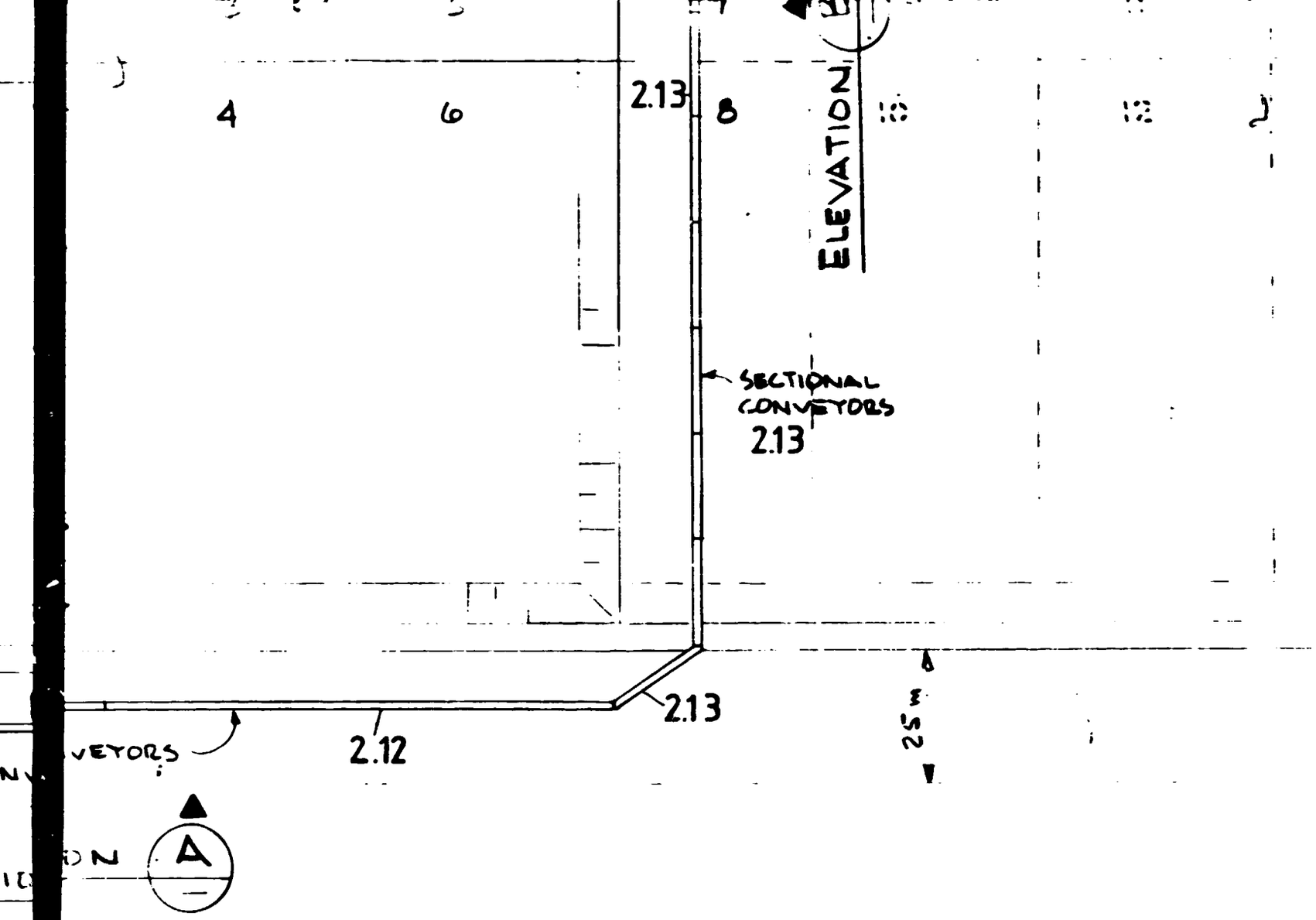
TOE OF BERM



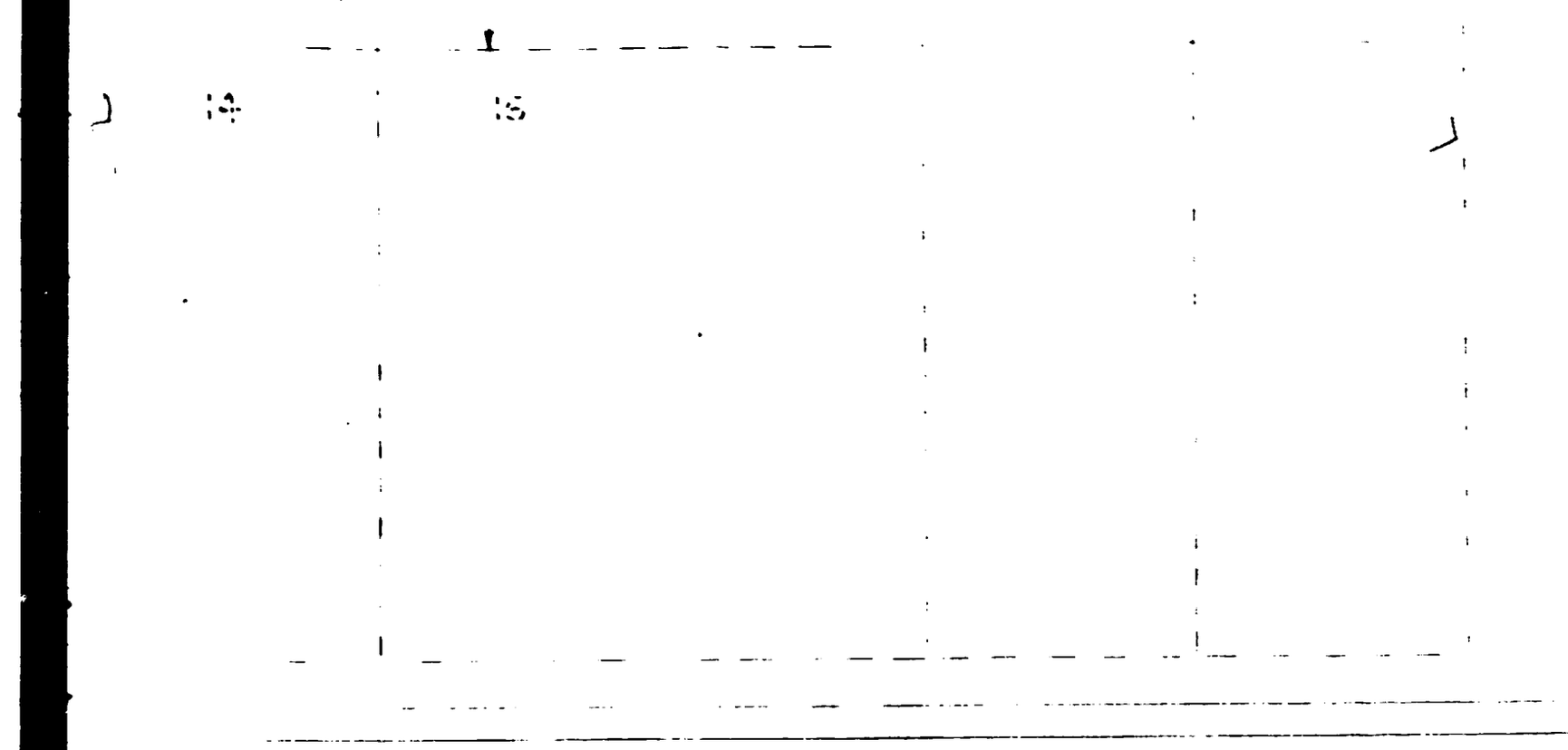


SECTION 5

ELEVATI

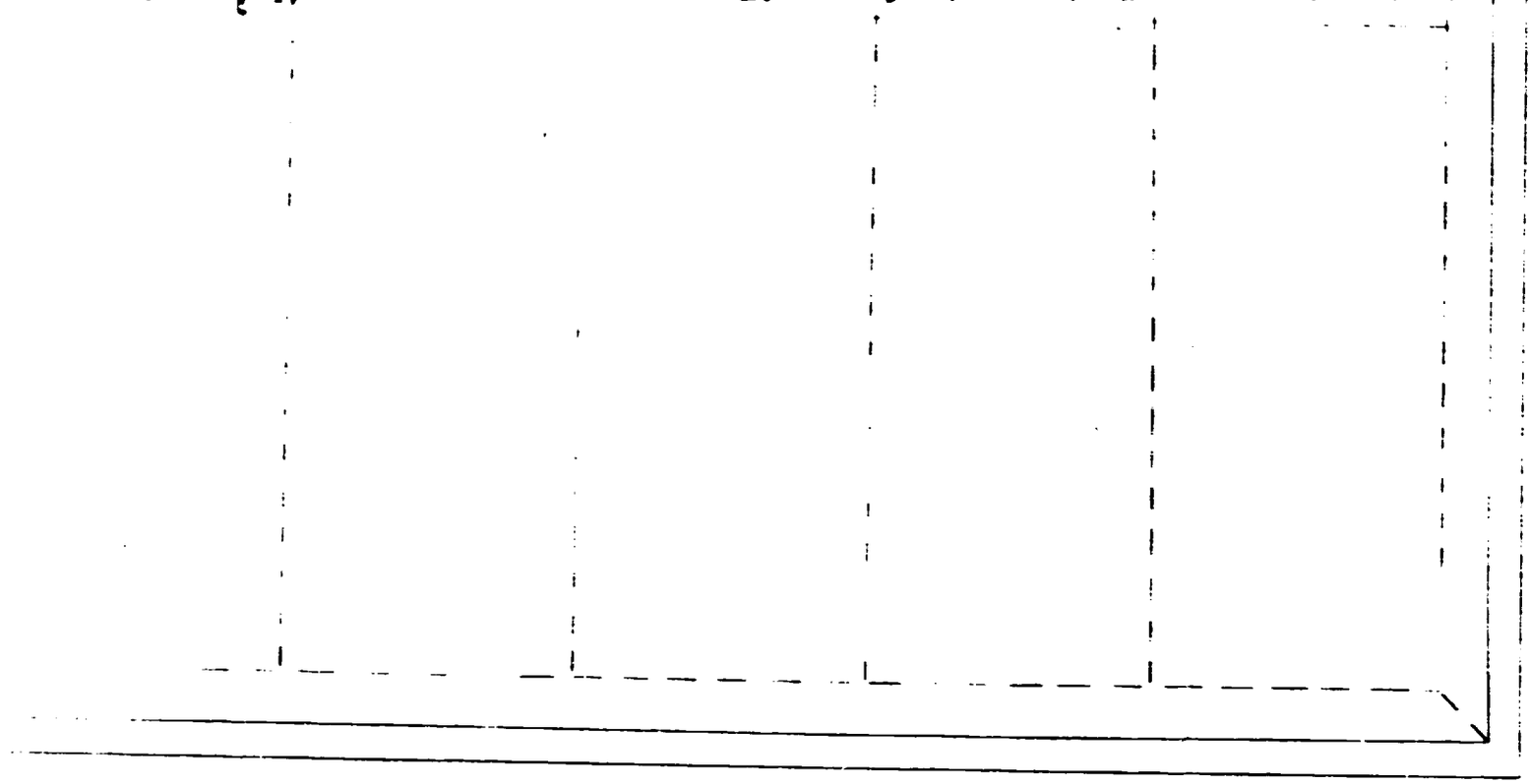


SECTION 6



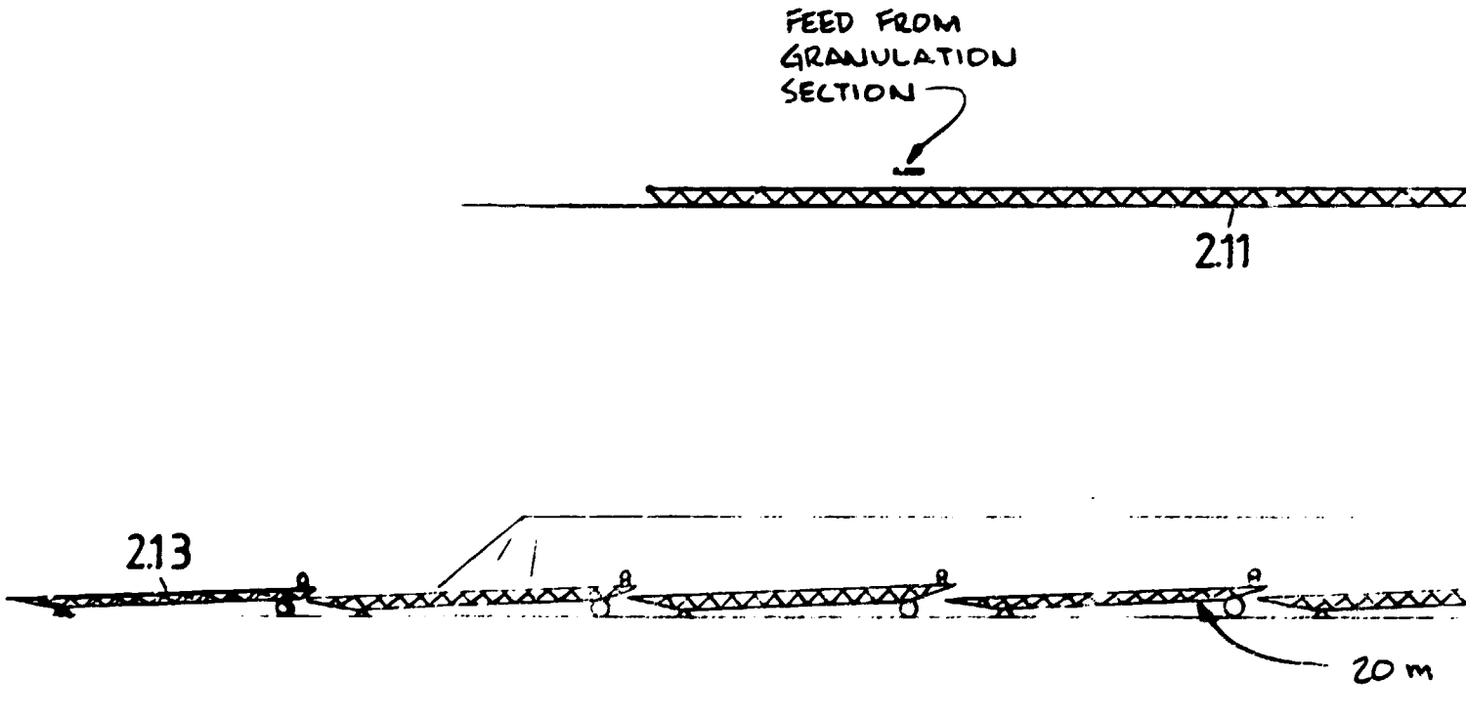
SECTION 7

FUTURE HEAP AREA

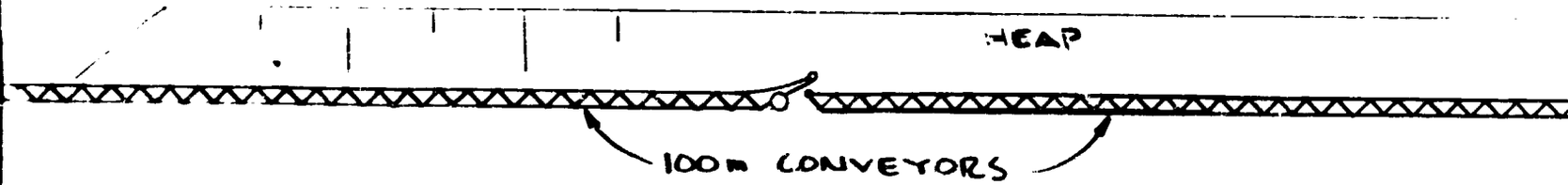


SECTION 8

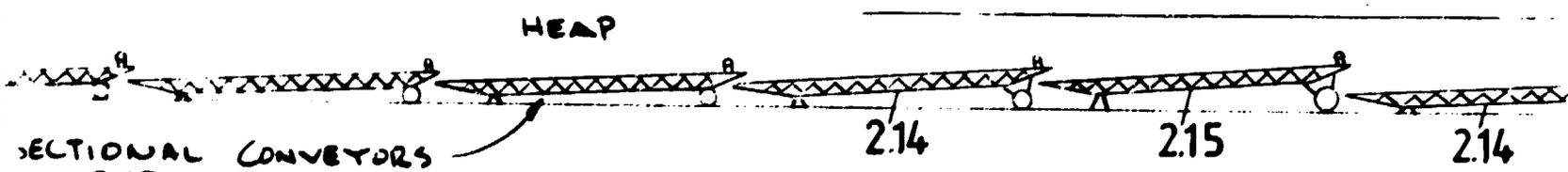
SECTION 9



SECTION 10

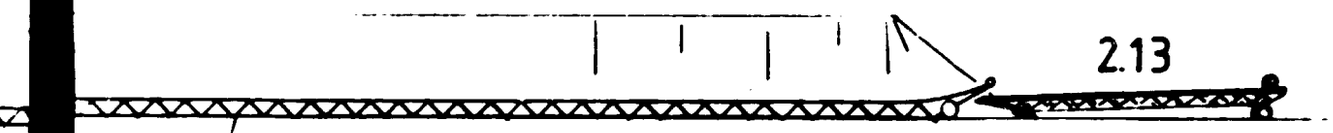


ELEVATION A
1:400

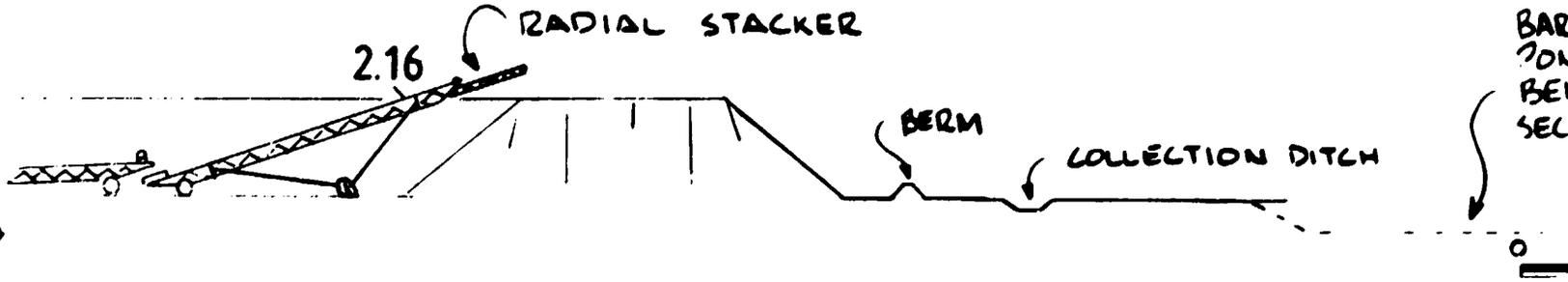


ELEVATION B
1:400

FUTURE HEAP AREA

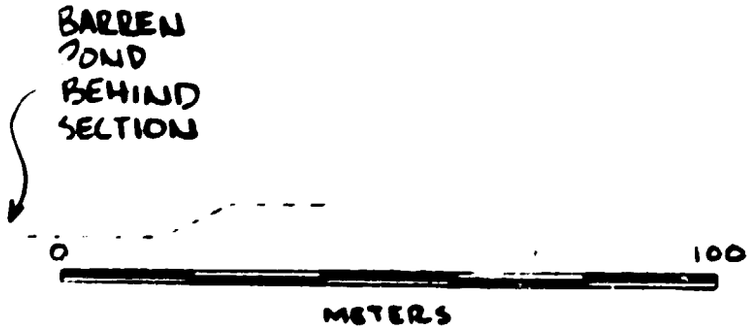


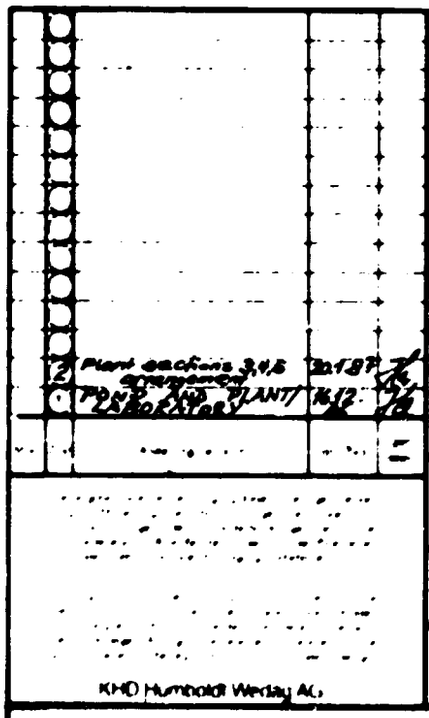
SECTION 11



AKJOUST,

SECTION 12

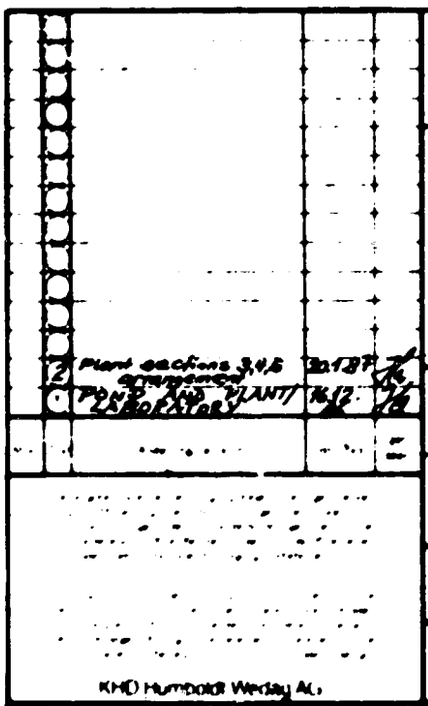




Kappes, Cassiday & Ass

SECTION 13

AKJOUJT, MAURITANIA



Anlage plant: GOLD HEAP LEACH PLANT FOR TORCO TAILINGS

Bezeichnung designation: LAYOUT FOR LEACHING & RECOVERY SECTIONS

Maßstab scale: 1:1000

Angebots Nr quot No / Auftrags Nr comm No: 9-2121-5-0154

Gezeichnet drawn: RS

Zeichnungs Nr drawing No: 801-11-300 UA

Geprüft checked:

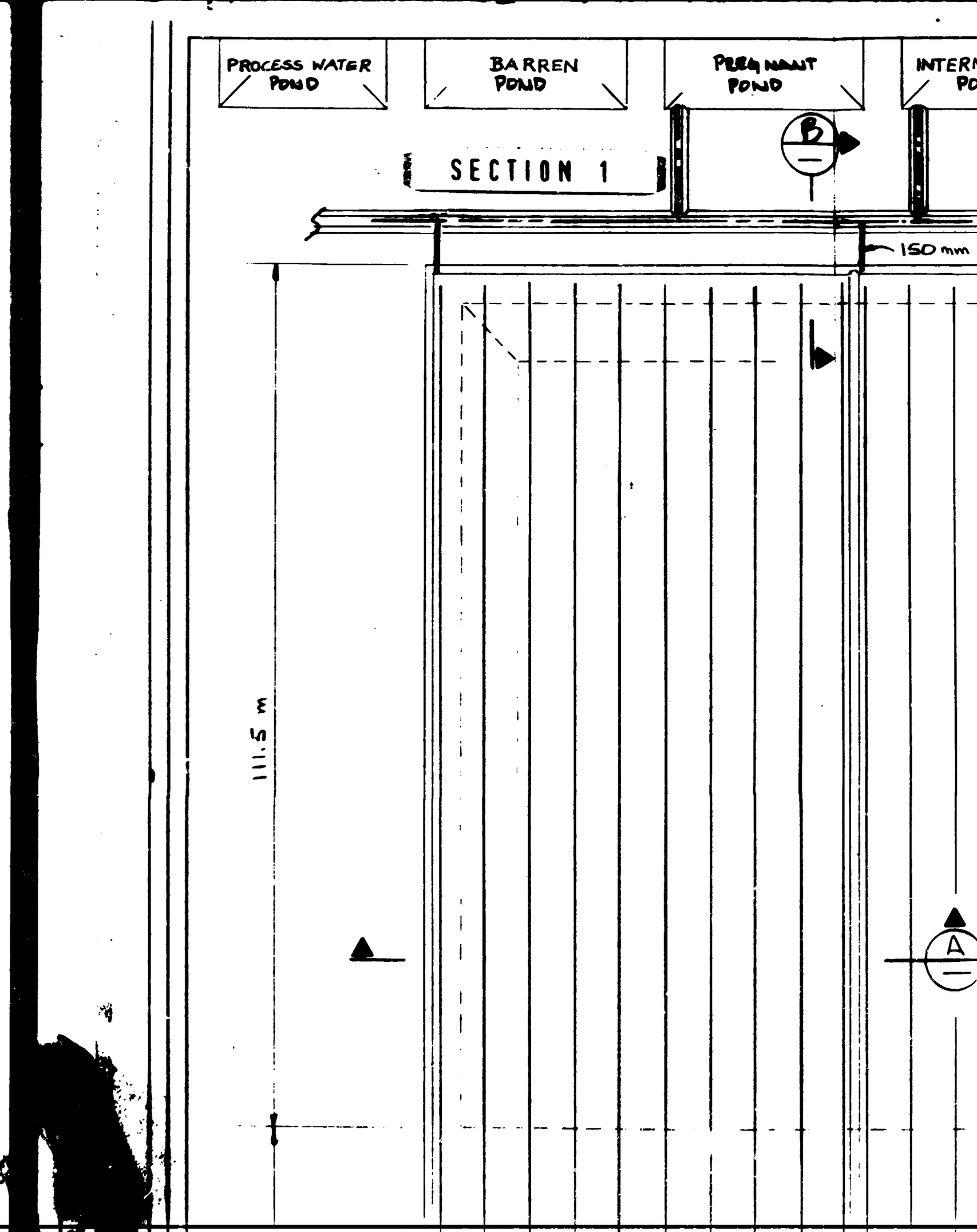
Bemerkung note:

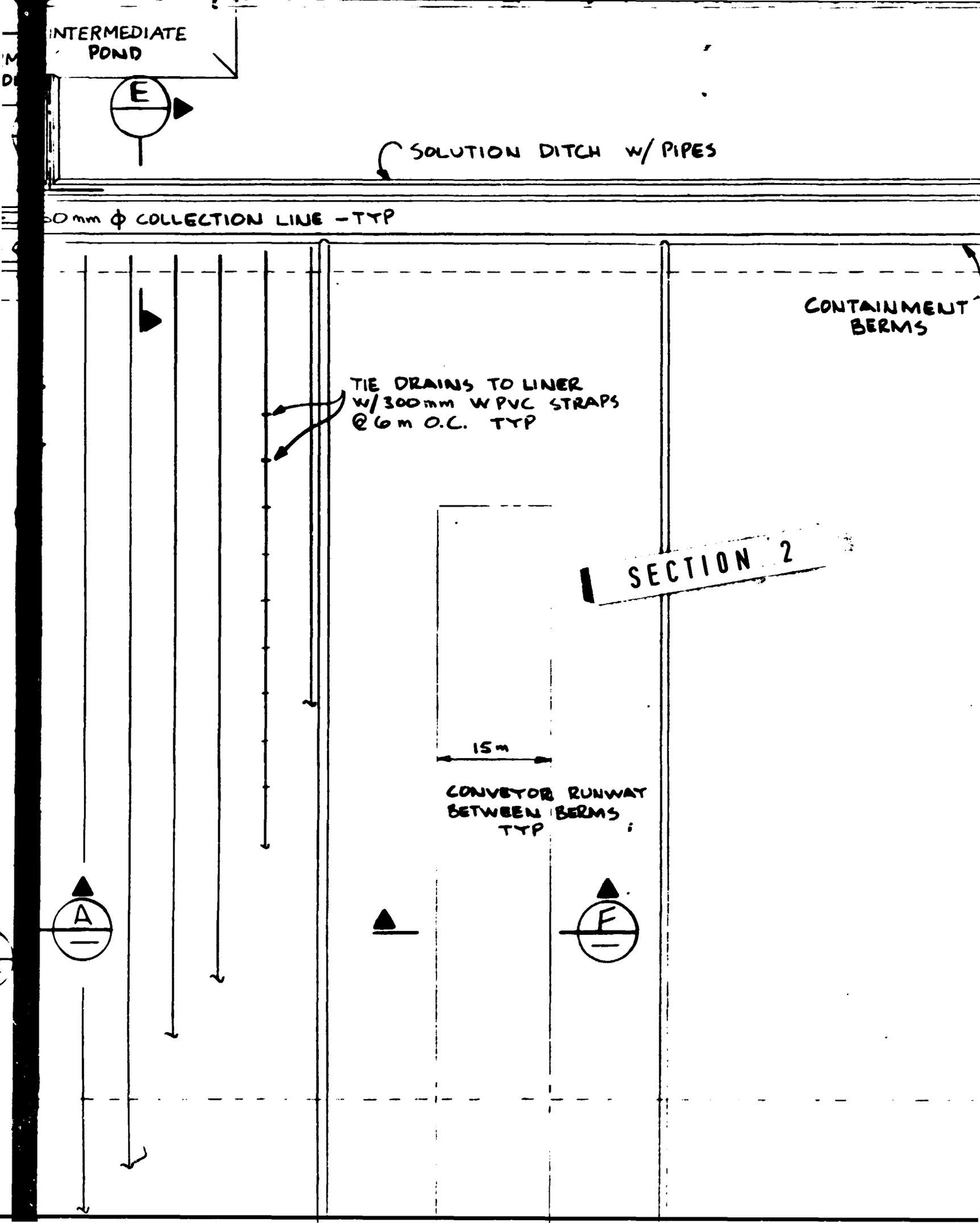
KHD HUMBOLDT WEDAG AG

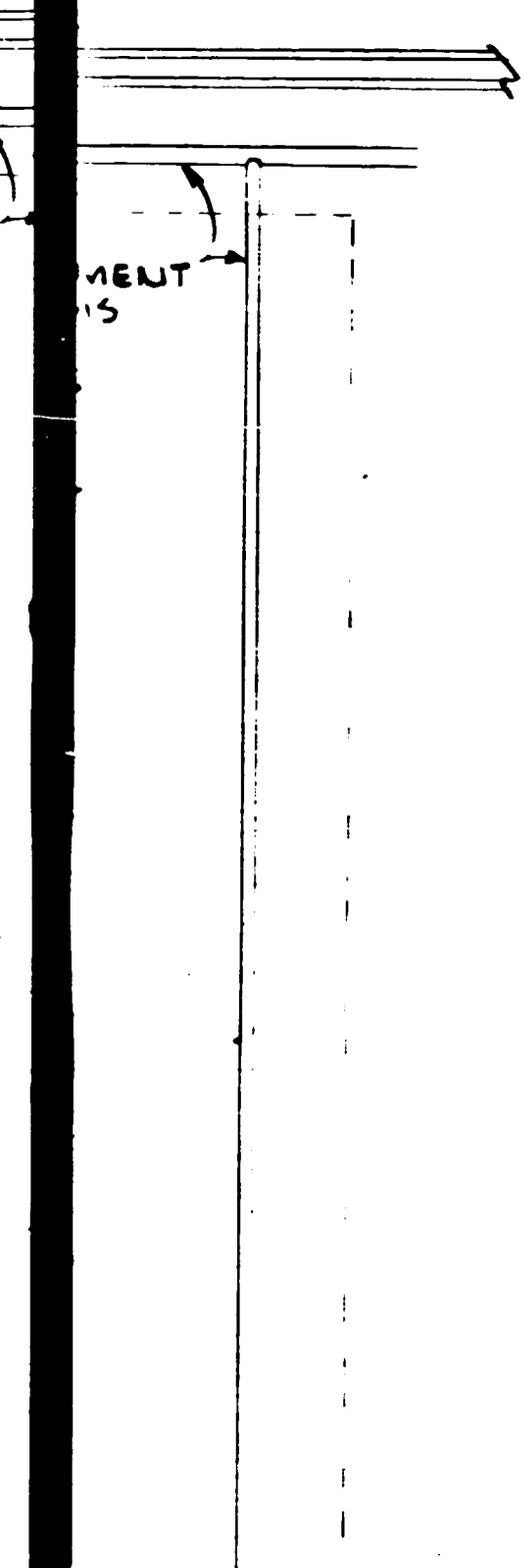
KHD Humboldt Wedag AG

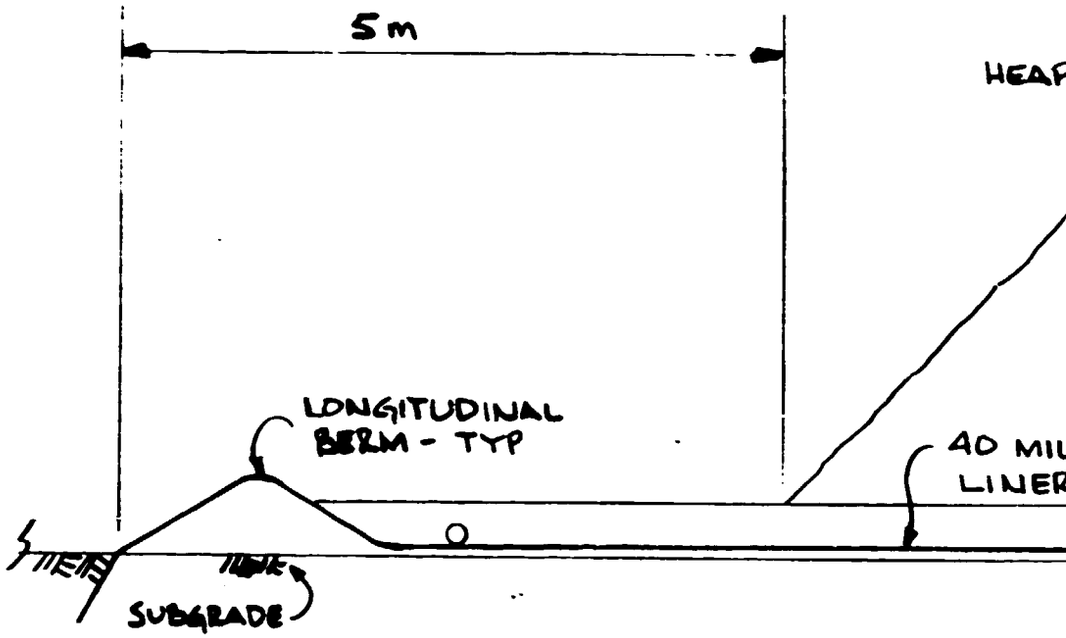
Kappes, Cassiday & Associates

DRAWING No. 1728-5


PROCESS WATER POND
BARREN POND
PREGNANT POND
INTERN PO
B
SECTION 1
150 mm
111.5 m
A

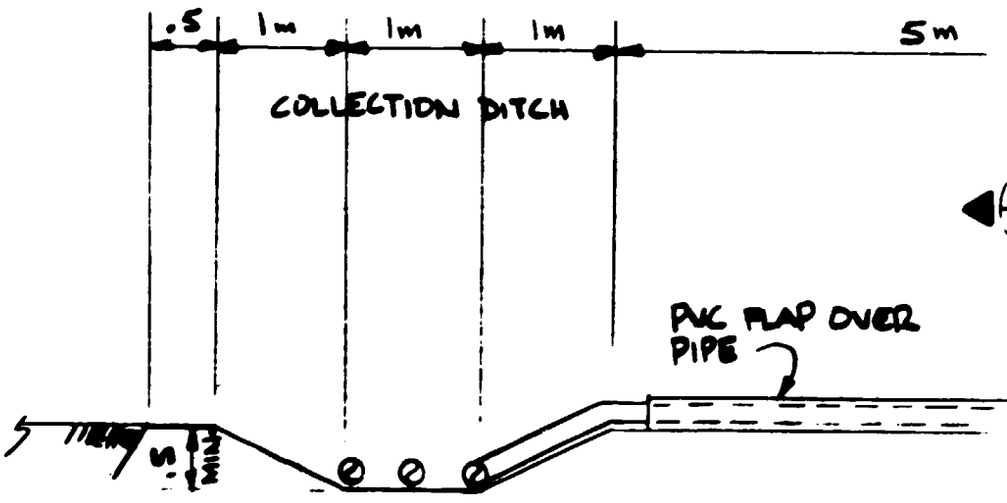

INTERMEDIATE POND
E
SOLUTION DITCH w/ PIPES
50mm ϕ COLLECTION LINE - TYP
CONTAINMENT BERMS
TIE DRAINS TO LINER w/ 300mm W PVC STRAPS @ 6m O.C. TYP
SECTION 2
15m
CONVEYOR RUNWAY BETWEEN BERMS TYP
A
F

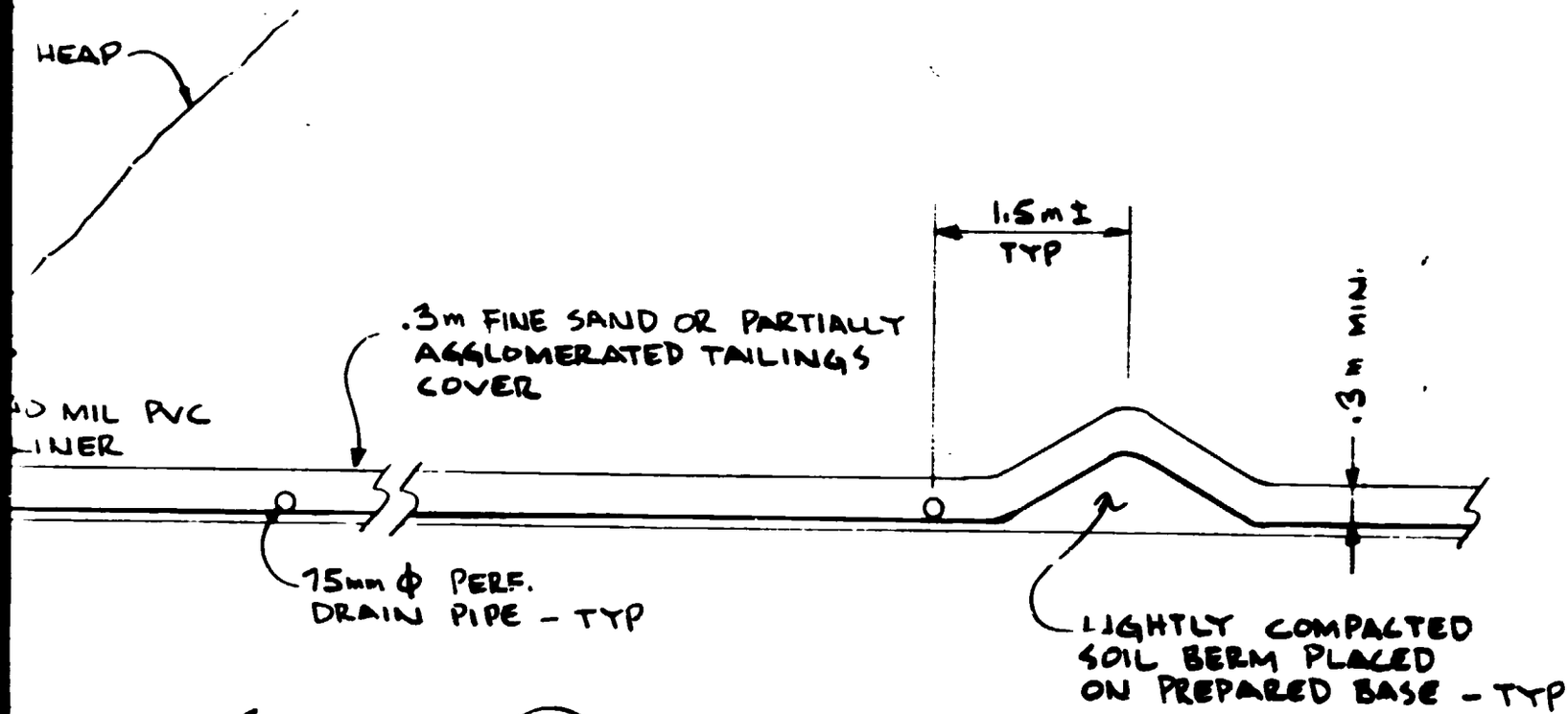




TYPIC

SECTION 3

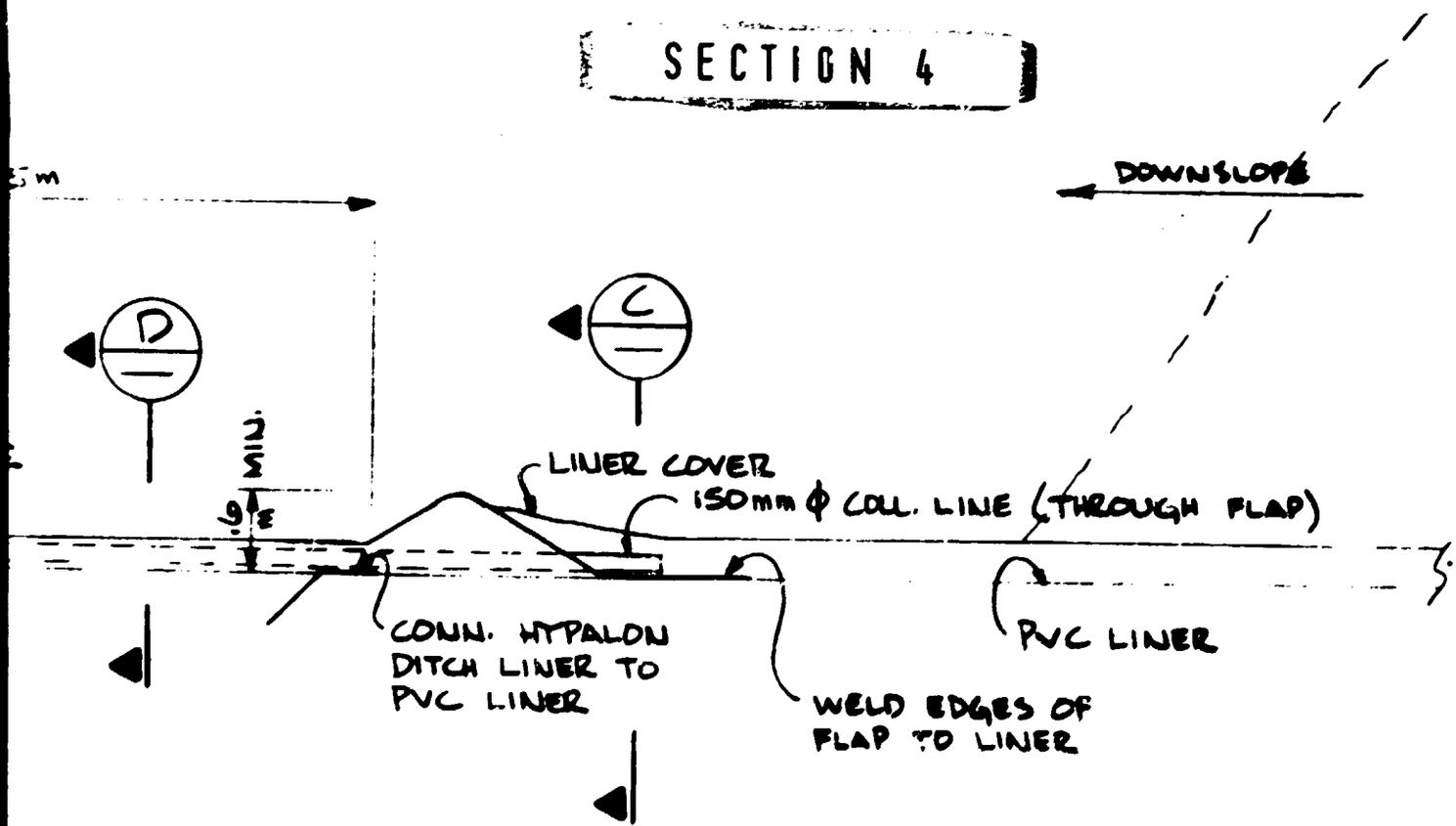


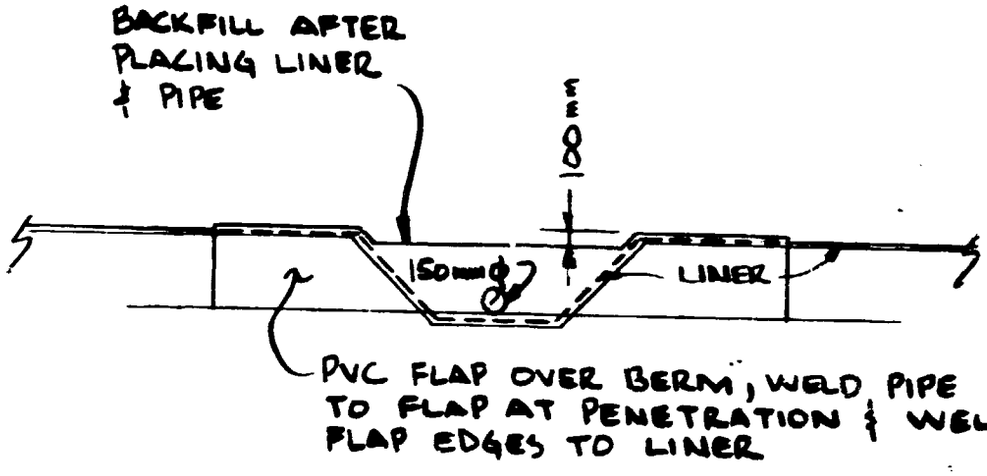


TYPICAL SECTION (A)

1:50

SECTION 4

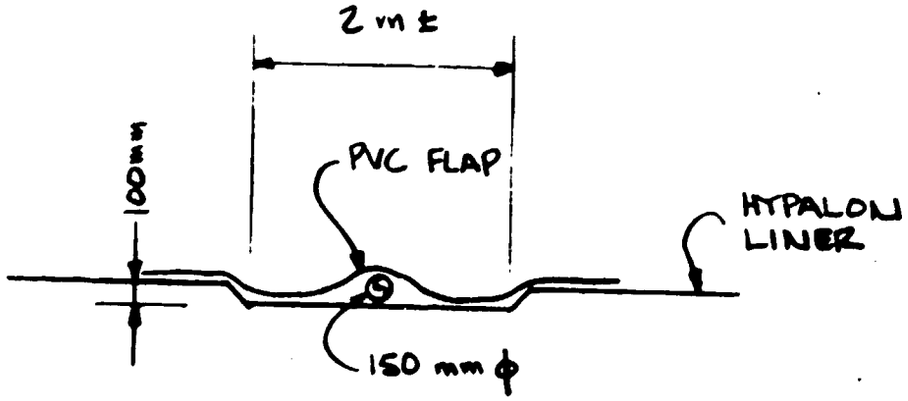




SECTION C AT BERM

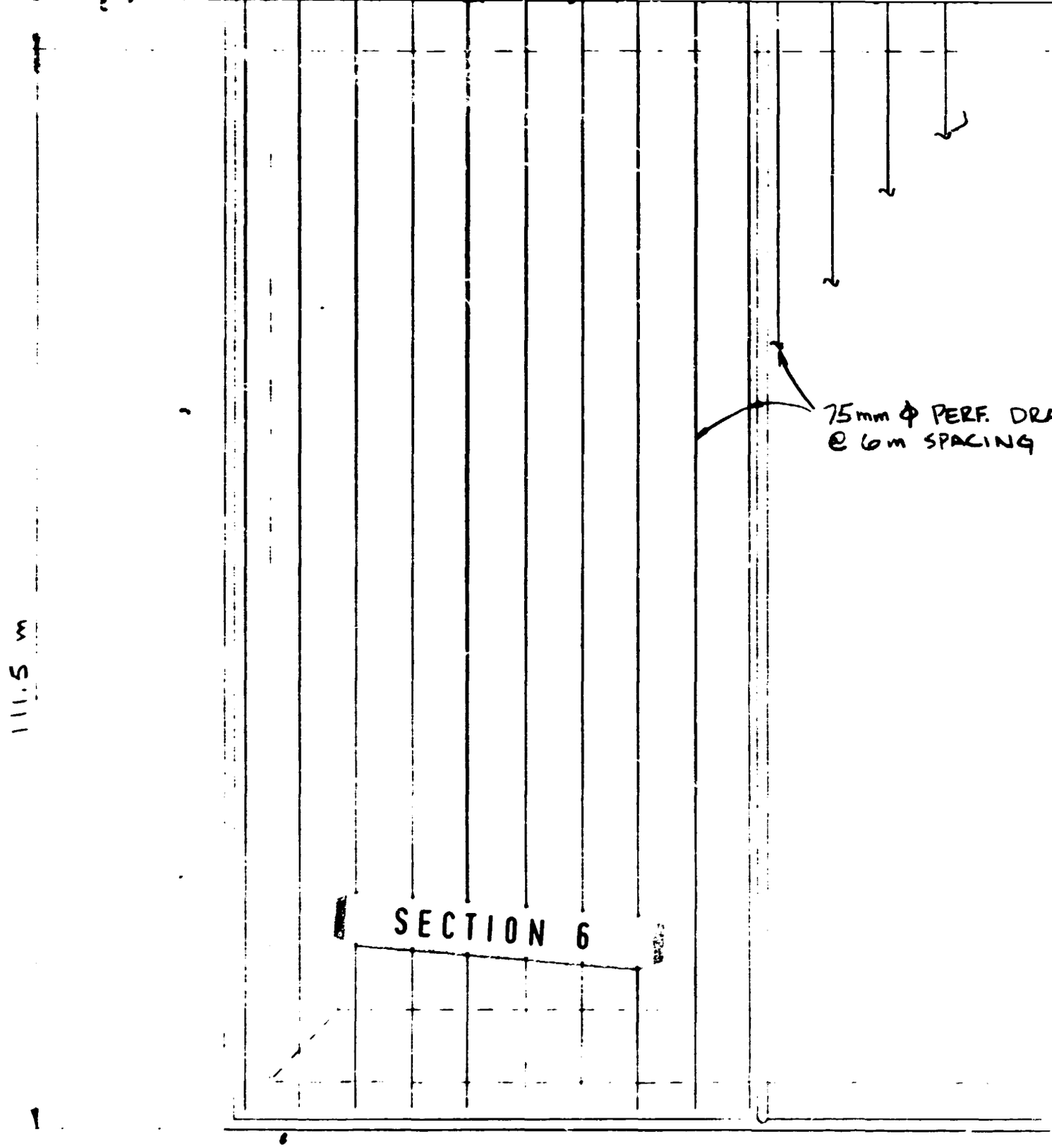
1:50

SECTION 5



SECTION D BETOND BERM

1:50



PAD SECTIONS

1.5m — 9 SPA. @ 6m = 54 m — 1.5m TYP.

57.5 m — 45 m TYP

P

F. DRAINS
ING - TTP

SECTION 7

7 SPA @ 6m = 42m TYP

205 m 1ST YR. LINER LIMIT

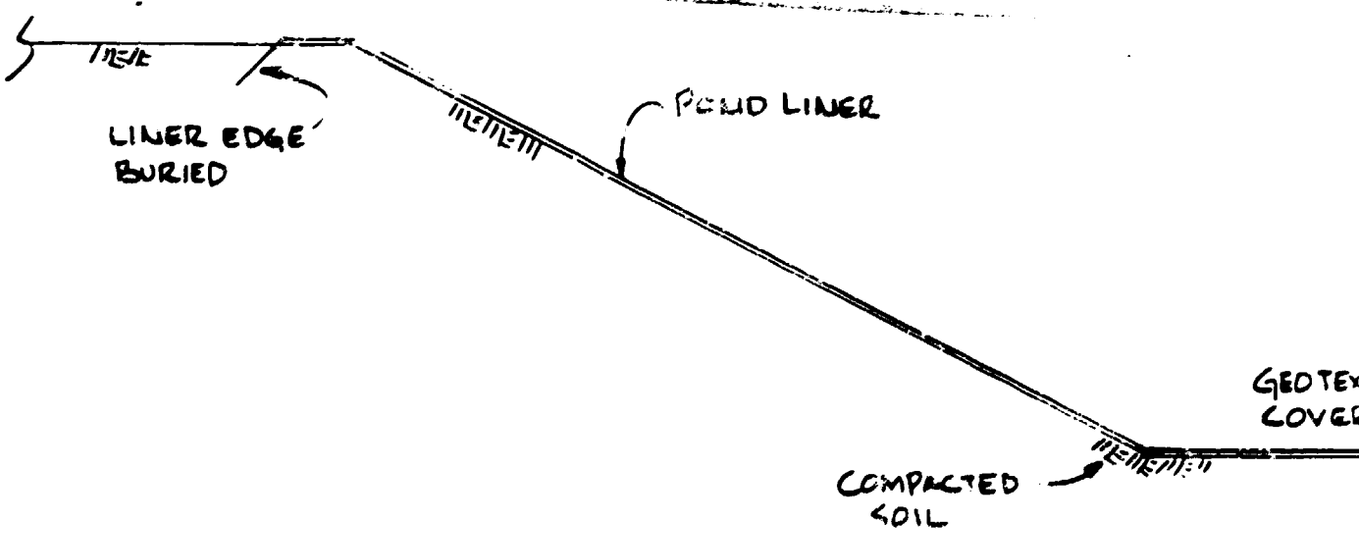
PLAN

1:500

CONTAINMENT
BERM

SECTION B
1:50

SECTION B



AT COLLECTION LINE

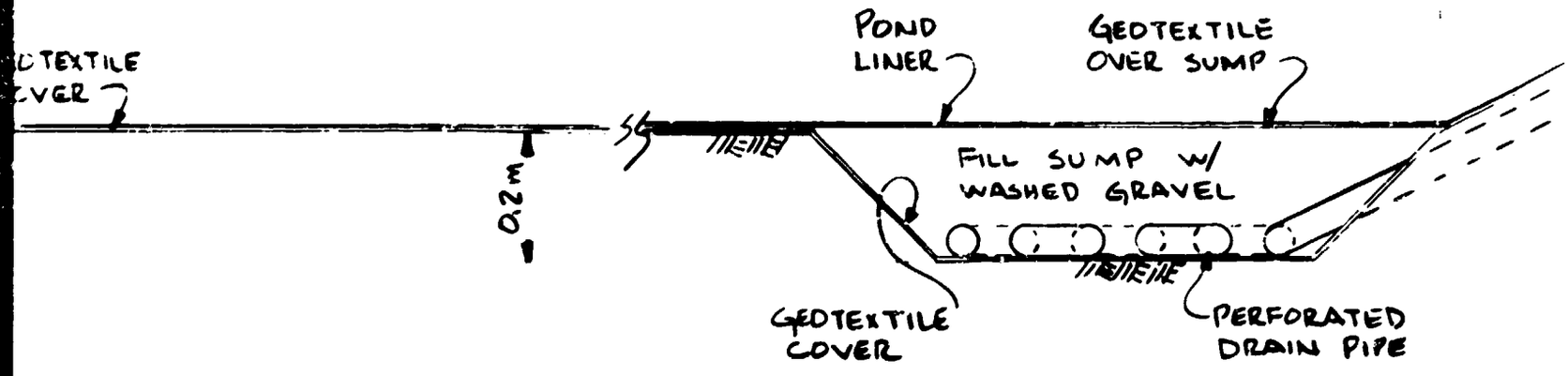
27 m SQ TYP

25 m SQ. FRESH WATER POND ONLY

SECTION 9

1 m Sq.

SUMP

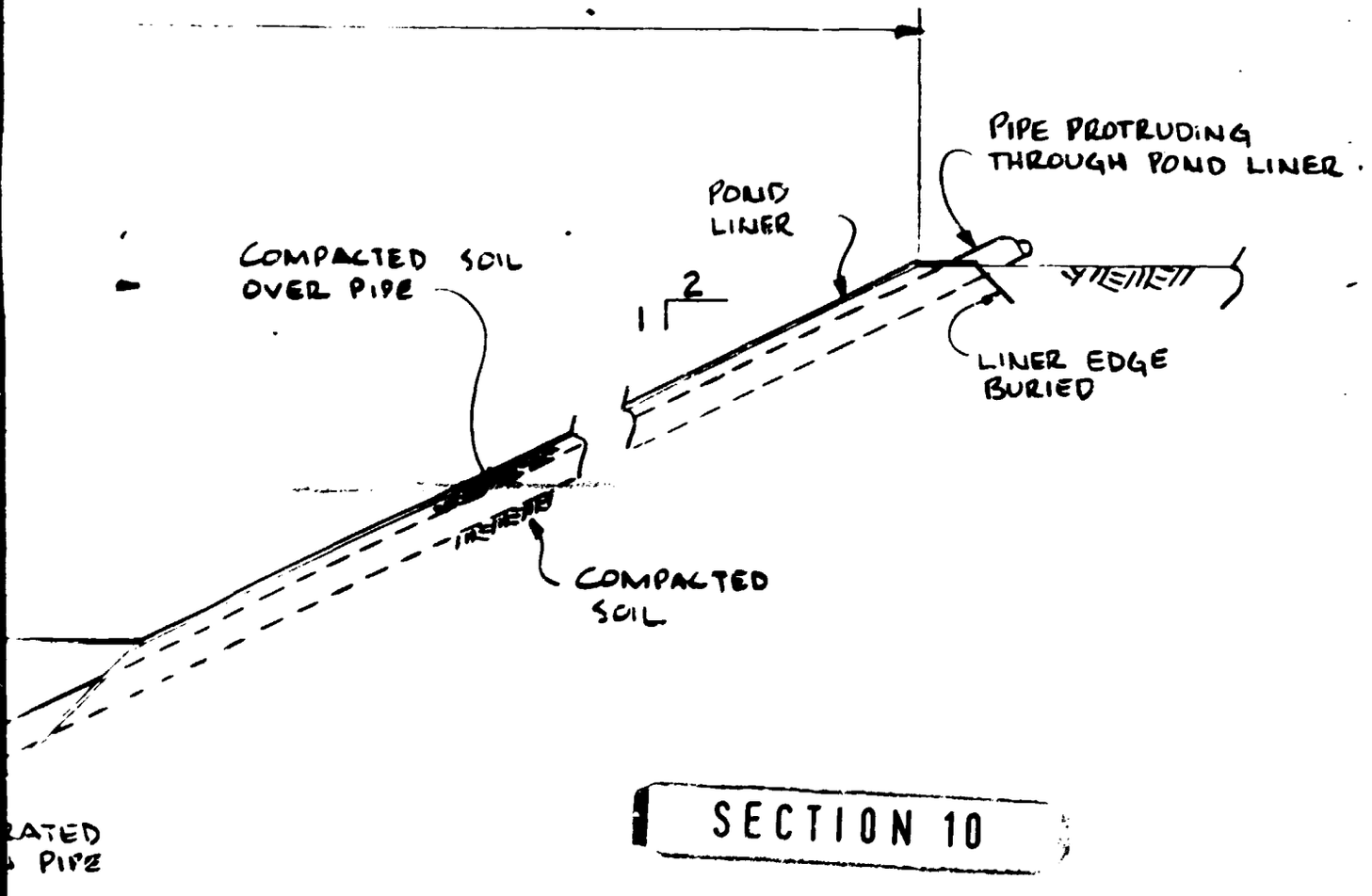


LEAK DETECTION SUMP

1:10

SECTION (D) BEYOND BERM

1:50



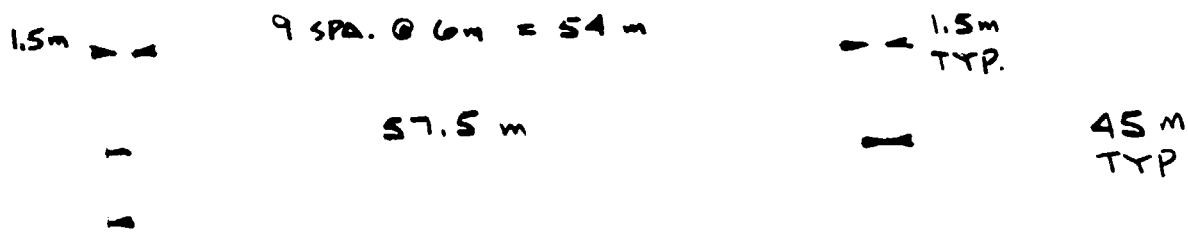
SECTION 10

ATED
PIPE

JMP (LOWER CORNER OF POND)

10

PAD SECTIONS



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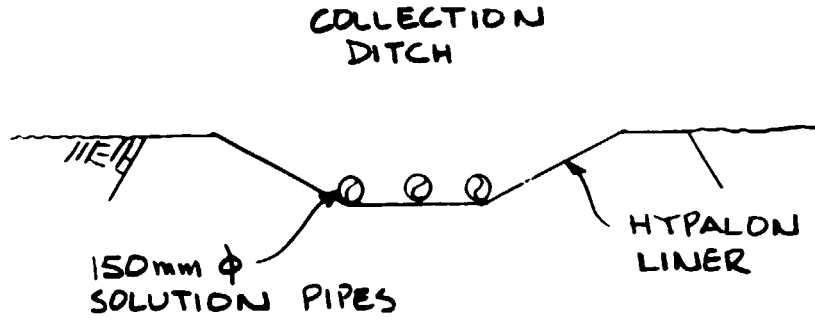
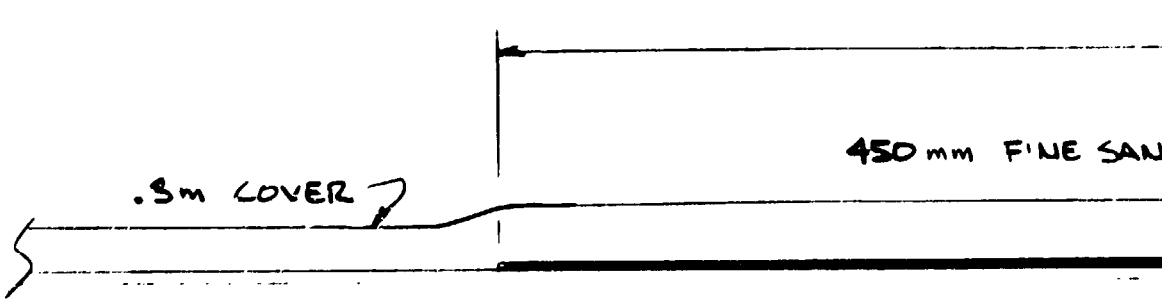


SECT

SECTION 11



F

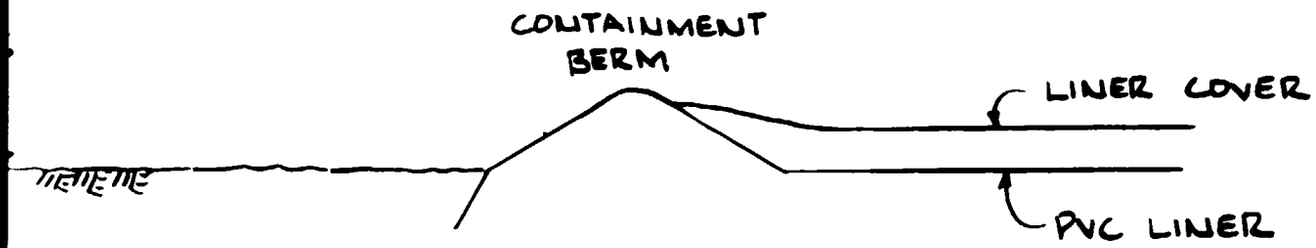
SE

7 SPA @ 6m = 42m TYP

205 m 1ST YR. LINER LIMIT

PLAN

1:500



SECTION E

1:50

SECTION 12

15 m WIDE CONVEYOR RUNWAY

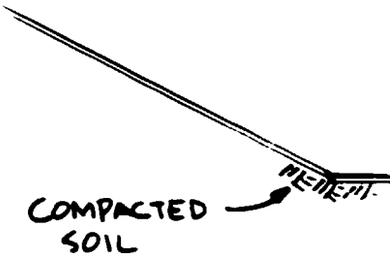
OR PARTIALLY AGGLOMERATED TAILINGS

PVC LINER

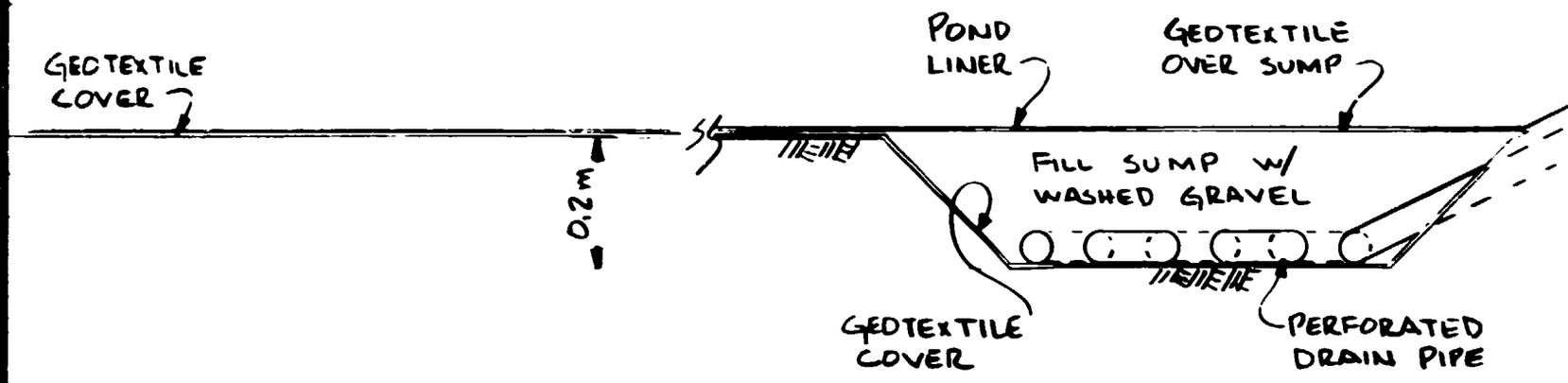
GEOTEXTILE OVER LINER

SECTION F

1:50



SECTION 13



LEAK DETECTION SUMP

1:10

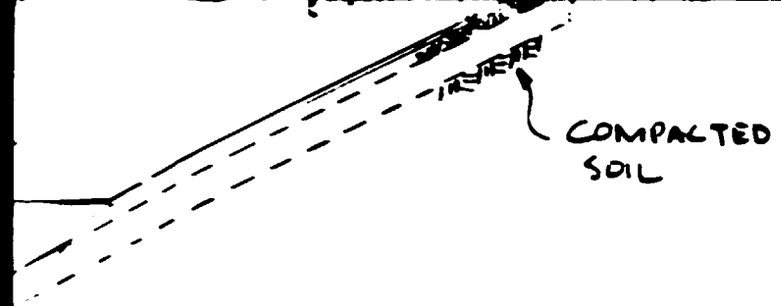
TYPICAL POND SECTION

1:10

SECTION 14

0 50

METERS



ED
IPE

MP (LOWER CORNER OF POND)

SECTION 15

AKJOUJT, MAURITANIA

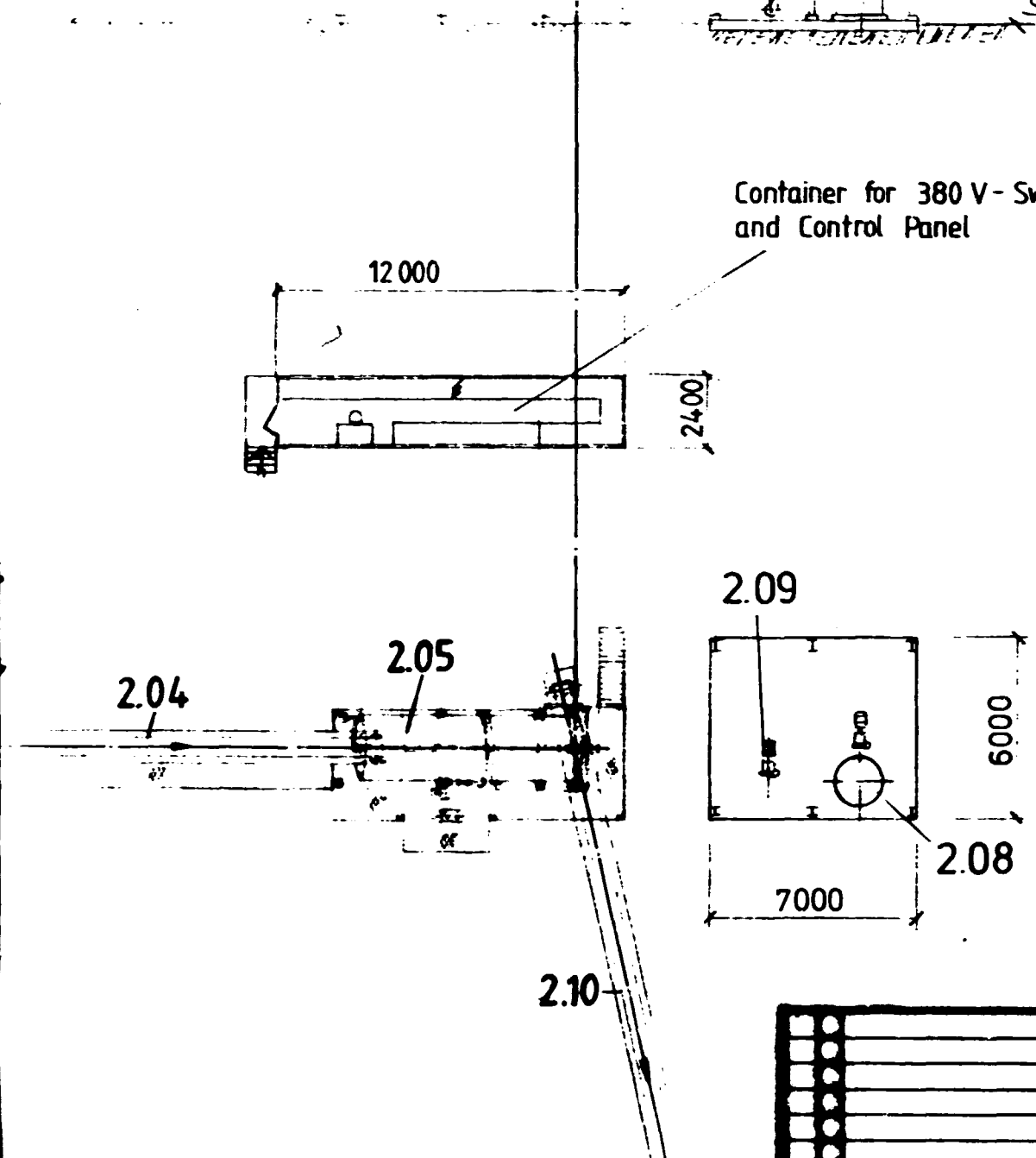
Anlage plant	GOLD HEAP LEACH PLANT FOR TORCO TAILINGS
Bezeichnung designation	HEAP / POND LINER & DRAIN CONSTRUCTION DETAILS
2 POND ARRANGEMENT TYP POND SECT.	
Massstab scale	1:500
Angebots Nr quot No / Auftrags Nr comm No	9-2121-5-0154
Gezeichnet drawn	RS
Zeichnungs Nr drawing No	801-11-301 UA
Geprüft checked	
Bemerkung note	

KHD Humboldt Wedag AG

KHD HUMBOLDT WEDAG AG

Kappes, Cassiday & Associates

DRAWING No.
1728-6



AKJOUJT

Gold Mea
for To

LAY

PLANT FEEDI

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08.12.85

SECTION 17