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**REED BED TECHNOLOGY FOR
TREATMENT OF TANNERY
EFFLUENT**

Final report on :

**SUPPLY OF BUILDING MATERIAL AND
CONSTRUCTION AT PRESIDENCY KID LEATHER,
KANNIVAKKAM**

AS PER UNIDO CONTRACT 98/132P

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FOR :

**UNITED NATIONS INDUSTRIAL DEVELOPMENT
ORGANISATION, VIENNA, AUSTRIA**

ABSTRACT

UNIDO under its Regional Programme for pollution control in the tanning industry in South East Asia has as part of developing low maintenance, cost effective and eco-friendly technologies for tannery pollution control decided to put a Reed Bed System at Presidency Kid Leather Ltd. Kannivakkam, Chingelpet District, Tamilnadu, India. Supply of building material and the entire civil work was carried out by us M/s GD Construction, Ashok Nagar, Chennai, Tamilnadu

The objective of this PDU is to investigate the viability of applying the reed bed technology (well established for treatment of domestic waste water) for final treatment of tannery effluent. The entire work was completed within 2 ½ months.

Accordingly we had prepared a detailed work plan of civil works details as required, supplied all the building material, constructed the reed-beds, installed all equipment provided by RePO and conducted test runs. Additionally hydraulic tests were successfully completed between 12-19 August, 1998.

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ABBREVIATIONS

KG :	KILOGRAM
LDPE:	LOW DENISTY POLY ETHYLENE
m:	METER
m³ :	CUBIC METER
mm :	MILLIMETER
PCC:	PLAIN CEMENT CONCRETE
PDU :	PILOT DEMONSTRATION UNIT
PVC:	POLY VINYL CHLORIDE
RB :	REED BED
RePO :	REGIONAL PROGRAMME OFFICE
RR :	RANDOM RUBBLE
TD :	TOTAL DEPTH
UNIDO :	UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

1 Introduction

United Nations Industrial Development Organisation (UNIDO) has been setting up Pilot cum Demonstration Units (PDU) for Pollution Control in the tanning industry in South East through its Regional Programme Office, RePO, Chennai, India.

As part of developing low maintenance, cost effective and eco-friendly technologies for pollution control, UNIDO decided to put up a Reed Bed System at Presidency Kid Leather Ltd., Kannivakkam, Chingelpet District, Tamilnadu, India.

As part of the implementation, UNIDO called for tenders for civil, mechanical and electrical works for this project and after evaluation of the tenders received awarded the civil works contract of the project (Subcontractor 2) to M/s GD Constructions, Ashok Nagar, Chennai vide contract no. 98/132P, which was duly signed by us. As per the contractual terms we have prepared the final report after completion of the work.

The objective of this PDU is to investigate the viability of applying the reed bed technology (well established for treatment of domestic waste water) for final treatment of tannery effluent. Accordingly one semi-industrial scale pilot and demonstration unit (PDU) for is to be installed and test run conducted at PKL, Kannivakkam.

2 Preliminary section

2.1 Suggested capacity of the system

The volume to be processed is 50 m³/day.

2.2 Preliminary design details

The detailed design drawings and as built drawings have been prepared separately and attached as Annex 1 and Annex II respectively. The basic details are given below :

- Reed beds have been established in 3 beds operating both in series as well as parallel, each with dimensions 16.0 m x 16.0 m x 1.2 (TD) .
- The inlet to the bed is through pipeline (initially secondary treated effluent and later primary treated effluent is to be admitted into the bed) and distribution of effluent into the bed is through overflow from inlet channel constructed on the inlet side of the bed.
- The bed is filled up with media (8-12 mm pebbles) for a depth of 0.8 meter.
- For preventing any plug flow of effluent, a baffle wall is constructed at the outer side of the bed.
- Overflow from one bed is taken to the next bed through inlet arrangement similar to first bed.

Parallel feeding arrangements is also be made.

- Inlet / outlet of the reed bed is measured through water meters.
- Outlet from the reed bed is collected in a small collection sump from where the same is pumped out as treated effluent or to the treatment units, depending on the degree of purification achieved.
- A meter is fixed on the pumping line to record the daily flow.
- The following general specifications will apply

Three beds in series / parallel of size 16.0 m x 16.0 m x 1.2 m @ 0.8 m media depth, shallow sides at an angle of 40°, the total height of the walls is 1.6 meter; Clay puddling outside zone 2.0 meter, thickness 0.3 m, total volume 90 - 100 cubic meter; Sand layer-1 (sieved sand), thickness 8 cm, volume of sand 20 cubic meter; LDPE sheet, total area 313 square meter, LDPE sheet @ 600 micron 1.6 square meter per kg., total weight of LDPE sheet 195 kg; Sand layer-2 (sieved sand), thickness of layer 8 cm, volume 18 cubic meter; PCC (1:3:6), thickness 8 cm, volume 25 cubic meter; Baffle wall, brick masonry of size 16.0 x 1.2 x 0.2, cement; Inlet flow distribution channel & outlet channel in between beds; Gravel Media, height 80 cm, volume per bed 204.8 cubic meter; Piping, valves etc., total piping length 100 meter (including inlet pipeline); Flow meters, 5 flow (water) meters, treated effluent sump, size 2.0 m x 2.0 m x 1.0 m of brick masonry etc. complete.

2.3. Location

The reed-bed has been implemented at the effluent treatment plant at Presidency Kid Leather, Kannivakkam in MGR District, Tamilnadu, India.

3. PROJECT IMPLEMENTATION

On award of the contract the setting out for civil works was done on 22 May, 1998 and the work formally started on 29 May, 1998.

Some amendments were made to the original scope of work (as per the original Tender document) due to the change of the allocation of land within the project site. There were

- inclusion of PCC foundation for RR masonry walls
- increasing the thickness of the PCC layer above the permeable membrane
- reduction in thickness of the sand cushion

These changes were necessitated by the soil characteristics and the higher water table of the new site.

It was difficult to procure, on time, the 0.6 mm jute felt PVC specified in the time schedule since this was not available off the shelf and all major manufacturers of this product informed that the delivery time would be 4-6 weeks from the date of receipt of the order. Hence another material of comparable quality and price, 0.6mm LDPE sheets was used in its place, as advised by sub-contractor 1, The Solutions Centre, Cochin, which was responsible and guidance during implementation of our work.

All the civil works except supply and laying of pebbles and fixing wiremesh gabions were completed by 25 July, 98

The sub-contractor-1 advised us to remove the wire mesh gabion for RB-2 and RB-3 and gave the following reasons :

- i. The wire mesh gabion in RB-1 in spite of having been fabricated in stainless steel started corroding at the welded joints.
- ii. The quality of the large pebbles for the stone collection (60-100 mm) were quite good and adequate care while laying ensured uniform distribution of the influent and effluent.
- iii. The gabion constitutes about 7.5 % of the investment. The PDU is meant to be replicated in future and such reduction in investment will be attractive to the tanners.

There was some difficulty in procuring the media (8-12 mm pebbles), on time, due to the monsoons. However supplying and laying of pebbles for RB-1 was completed by 25 July, 1998 for RB-2 by 29 July, 1998 and RB-3 on 12 August, 98.

RB-1 went on stream on 30 July, 98' RB-2 went on stream on 3 August, 98 and RB-3 on 14 August, 98.

The site was levelled and cleaned and surplus earth removed by 19 August, 98.

4. CONCLUSION

All work has been carried out by us as per the tender documents and completed within the time period of 2 ½ months. Delay in implementation was due to rains which made it difficult for us to implement certain activities as well as to procure the filling material (pebbles) in a timely manner.

Modifications of the design during actual implementation have been made on the recommendation of The Solutions Centre , sub-contractor -1 responsible for supervision and guidance during implementation of our work. The modifications were made to suit the local site conditions. Officials from UNIDO's Regional Programme Office visited the site regularly to inspect progress of work, and they were constantly consulted and gave their approval for any of the modifications made as described in section " project implementation". The as-built drawings have been attached as Annex II.

Hydraulic tests were successfully completed between 12-19 August, 1998

APPENDIX

1. Terms of Reference (Annex 1)
2. Design drawings (Annex 2)
3. As-built drawings (Annex 3)

US/RAS/92/120

**TERMS OF REFERENCE (TOR)
SUBCONTRACTOR 2, PDU/1****REED BED TECHNOLOGY FOR TREATMENT OF TANNERY EFFLUENT
(Supply of building material & construction at PKL, Kannivakkam)****A) Background Information****Brief description of the programme**

The UNIDO Regional Programme of Pollution Control addresses the issue of containment of environmental degradation emanating from the tanning industry in the region. Under this "umbrella project" appropriate cleaner production methods, efficient and cost-effective treatment of tannery effluent, conversion / utilization solid wastes from tanneries and/or disposal etc. are demonstrated through establishing Pilot and Demonstration Units (PDUs).

General aspects

Effluent treatment has become a major concern among tanneries in India over the last few years. Several individual and common effluent treatment plants are now installed and under operation in the state of Tamilnadu. Performance of almost all the CETPs and most of effluent treatment plants are reported to be good. Research activities to find out more efficient and economical treatment methods are in progress.

Reed beds have been used since the 1970s to treat domestic sewage and certain types of industrial waste, mostly in Germany but in the 90s increasingly in the UK and the USA. The perceived advantages are efficient treatment with lower investment, and, in particular, lower operation and maintenance cost in comparison with conventional treatment systems. The major disadvantage is that reed beds system requires more land than conventional treatment systems. However, till date, reed beds technology has not been tested in treatment of tannery effluent under well monitored conditions for .

Reed bed treatment brings out breaks down organic matter mainly by aerobic/anaerobic cycles caused by bacteria present in the root zone of reeds. The gravel media based reed bed system using a variety of *Phragmite* reeds is popular for treatment of domestic sewage and likely to be suitable for partially treated tannery effluent. While many components present in tannery effluents such as ammonium sulphate, lime gypsum and slow release high organic nitrogen products are considered helpful for reed growth, components like salinity may adversely affect the growth. However, these aspects could be verified through a plant scale experiment.

Though there is practically no significant experience in application of reed bed system for treatment of tannery effluent, there appears to be scope for its application. Initially this may be for tertiary treatment and gradually for reducing pressure on the biological treatment. To minimize the risk of survival of the reed due to high TDS (4000 - 5000 mg/l) it is suggested to establish a reed bed nursery at the site to be irrigated with treated effluent. It is suggested to adopt 5 days detention time taking into account 40% as void in the media and horizontal flow with gentle slope for free flow to avoid any anaerobic condition. Should the reed bed be able to take up high BOD/COD load, the unit cost of operation of the biological treatment would be reduced.

It has been proposed to set up one reed bed for tertiary treatment (polishing) of 50 m³ per day of treated effluent from the Presidency Kid Leather (PKL) tannery at Kannivakkam processing semi-finished hides and skins into finished leather.

B) Objective/output

In conformity with information and explanation provided earlier, the objective is to investigate the viability of applying the reed bed technology (well established for treatment of domestic waste water) for final treatment of tannery effluents. One semi-industrial scale pilot and demonstration unit (PDU) at the suggested location will be installed and practical testing conducted.

C) System suggested

C.1 Suggested capacity of the system

The volume to be processed is 50 m³/day of effluent emanating from the existing, fully-fledged effluent treatment plant (ETP).

C.2 Basic design, Bill of Quantities

Detailed description of civil works, quality standards, equipment specifications including Bill of Quantities and basic design drawings) have been prepared by the SUBCONTRACTOR I and are attached under the title Tender Documents (Annex I & Annex II).

The basic information about the system is given below:

- Reed beds would be established in 3 beds operating both in series as well as parallel with dimensions 16.0 m x 16.0 m x 1.2 (TD).
- The inlet to the bed is through pipeline (initially secondary treated effluent and later primary treated effluent would be admitted into the bed) and distribution of effluent into the bed will be through overflow from inlet channel constructed on the inlet side of the bed.
- The bed is filled up with media (5-10 mm pebbles), depth 0.8 meter.
- For preventing any plug flow of effluent, a baffle wall would be constructed at the outer side of the bed.
- Overflow from one bed is taken to the next bed through inlet arrangement similar to first bed. Parallel feeding arrangements will also be made.
- Inlet/outlet of the reed bed is measured through water meters.
- Outlet flow from the reed bed is collected in a small collection sump from where, depending on the degree of purification achieved, it is pumped out and discharged as fully treated effluent or sent back to the treatment units.
- A meter fixed on the pumping line will record the daily flow.

The following general specifications will apply:

Three beds in both series & parallel, size 16.0 m x 16.0 m x 1.2 m @ 0.8 m media depth, shallow sides at an angle of 40°, the total height of the walls is 1.6 meter; Clay puddling outside zone 2.0 meter, thickness 0.3 m, total volume 90 - 100 m³; Sand layer-1 (sieved sand), thickness 8 cm, volume of sand 20 m³; LDPE sheet, total area 313 m², LDPE sheet @ 600 micron 1.6 m²/kg., total weight of LDPE sheet 195 kg; Sand layer-2 (sieved sand), thickness of layer 8 cm, volume 18 m³; PCC (1:3:6), thickness 8 cm, volume 25 m³; Baffle wall, brick masonry of size 16.0

x 1.2 x 0.2, cement; Inlet flow distribution channel & outlet channel between beds; gravel media, height 80 cm, volume per bed approx. 205 m³; piping, valves etc., total piping length 100 meter (including inlet pipeline); Flow meters: 5 flow (water) meters, treated effluent sump, size 2.0 m x 2.0 m x 1.0 m of brick masonry etc. complete.

C.3 Proposed location

The effluent treatment plant at Presidency Kid Leather, Kannivakkam in MGR District, Tamilnadu, India has been selected. The site for the reed bed has been pre-identified at the ETP.

D) Services to be provided:

D.1 Responsibilities of the subcontractor

Guided by RePO and SUBCONTRACTOR 1, the subcontractor will:

- Prepare a detailed work plan civil works details as required.
- Supply the all the building material according to RePO/SUBCONTRACTOR 1 specifications.
- Construct reed beds, install all equipment provided by RePO and conduct a test run.
- Conduct an additional, ten days hydraulic loading test run and complete commissioning of the site.

The subcontractor will also provide a written one year Performance Guarantee to UNIDO/user ETP for the agreed capacity of 50 m³ of free flow through reed bed system using tannery effluent.

The subcontractor shall provide all services as per TORs including Annex I and Annex II on a turn-key basis.

The beneficiary, Presidency Kid Leather, Kannivakkam will provide free access to the site.

D.2 Report

The subcontractor will prepare and submit the Final Report on services provided including all drawings, sketches, layout etc..

E) Time schedule for project implementation

The preliminary work/time schedule:	Duration
Briefing at RePO, Madras of subcontractor's team leader/specialists and review of drawings, equipment specifications, work plan etc.	2 days
Supply, construction and installation works	4 weeks
Test run, hydraulic testing and commissioning of the site	2 weeks
Review of the work by RePO/SUBCONTRACTOR 1 and beneficiary	3 days

Preparation of draft final report and review
of the same by RePO/SUBCONTRACTOR 1 2 weeks

Final report submission 1 week

F) Modalities of implementation

The subcontractor will in its work be guided, primarily through its Team Leader by the Regional Programme Office of UNIDO located in Madras, India and will interact closely with the team leader and staff of Reed bed SUBCONTRACTOR 1 (design, plant selection and

- Description of work to be carried out, quality of materials including bill of quantities etc. (Annex I)
- Drawings (Annex II)

PART I

Monitoring as well as with the main subcontractor for technical inputs under the project, i.e. CTC, France as well as with the selected tannery/ETP. The RePO will be in close liaison with the project Manager at UNIDO, Vienna.

1. Period: Approximately 2 months, from May to end June 1998

2. Time input:

Field :	Total
Team Leader	1 w/m
Civil Engineer	2 w/m
Support staff	8 w/m
Total	11 work months

Project team:

- One senior civil engineer, specialist in construction, Team Leader
- One civil engineer for supervision at site
- Support staff and labour for construction and installation work

Reporting

Reporting will consist of papers containing specific technical inputs such as design, equipment specifications, cost estimates etc.; technical comments, suggestions from studies and activities prepared and/or implemented. One final report will be submitted as per the format prescribed by UNIDO. At the end of the period a draft final report will be submitted and following evaluation of the draft final report the subcontractor will submit a final report.

Work plan

The subcontractor will prepare the preliminary work plan and detailed action plan which will be elaborated in more detail in co-operation with the Programme Coordinator, RePO. The work plan and detailed action plan will only be updated, if special need arises.

Implementation Arrangement

Regional Programme Office, UNIDO, 1ST Floor, TNPCB Building, 100, Anna Salai, Guindy, Madras 600 032, India. (Tel: 91-44-2353158/2354518, Fax: 91-44-2353156, E-mail: unido@giasmd01.vsnl.net.in) will implement the project under the guidance of Leather Unit of UNIDO, Vienna. The main subcontractor for technical inputs under the project US/RAS/92/120 (CTC, France), the selected tannery, tannery associations and concerned government departments in India and other countries participating in the regional programme for pollution control in the tanning industry in South East Asia will also be actively associated in the process of implementation of the project.

Annex I: Tender documents

AnnexII: Drawings

**TENDER DOCUMENTS
FOR IMPLEMENTATION OF SUBCONTRACT 2**

The tender documents comprise: Description of civil works, quality standards and Bill of Quantities (Annex I) and drawings (Annex II)

A. DETAILED DESCRIPTION OF UNITS

1. Reed beds

Three reed beds each of dimensions 16 x 13 x 1.2m has to be constructed. Excavation upto 400mm from the lowest designated floor level is required for filling with sand. Reinforced PVC .6mm preferably of bluish grey colour is to be laid on the top sand cushion. The side wall along the periphery of the reed bed has to constructed as per specifications indicated elsewhere in this document. The bottom of RR masonry work should reach at least the bottom level of the sand cushion. The reinforced PVC sheet of the reed bed are to be covered with 50mm thick PCC M10 (1:3:6) for joining of PVC sheets a small overlap of 5-10cm may be given. Care should be taken while joining the sheet to avoid any damage due to overheating.

Stainless steel wire mesh gabion .5m wide is to be provided along the width of the reed beds at the inlet and outlet sides. Washed gravel 5-10mm is to be used for filling the reed beds. Inside the wire mesh gabion, washed gravel/pebbles 60-100mm size is to be used.

2. Treated Effluent Collection Sump

One collection sump for collecting effluent treated in the reed bed is to be constructed. The entire structure with dimensions dia 2.5 x 2m is to be of RCC M20 (1:1½:3).

B. STRUCTURAL DESIGN DATA

For structural Design, the following conditions have been considered:

Maximum Water Table is at	:	1.0m below existing Ground level
Formation Level	:	0.5 m above maximum level of existing ground level
Safe Bearing Capacity of Soil	:	15 ton/m ²

Bidders shall inspect the site and assess site for soil data, sub-soil water at working conditions etc. Their prices shall include any other data that may be required for execution purpose but not included in tender.

The Tenderer should check the structural adequacy of drawings furnished before construction. If the tenderer feels that the designs are not adequate, he shall bring out the same with reasons.

C. SPECIFICATION FOR CONCRETE WORK

General

All materials and workmanship shall in general comply with the relevant clauses of Indian Standards: 456-1978 Indian Standard Code of Practice for Plain and Reinforced Concrete/Equivalent British Standards. All the relevant codes referred shall be the latest unless otherwise specified.

Notwithstanding what is stated in the specifications herein, detailed drawings and notes appended thereon shall be deemed to form part of the specifications and to supersede the same in case of discrepancy.

1. REINFORCED CONCRETE:

Grade of concrete in all RCC works shall be M20 with minimum cement content of 360 kg/m^3 and with a maximum water cement ratio of 0.45. The concrete shall be vibrated one.

2. CEMENT:

All concreting for Water retaining structures and plastering for water contact surfaces shall be done using sulphate resistance cement conforming to Indian Standards 6909 - 1973 and other structures/items using ordinary portland cement conforming to Indian Standards 269-1976.

The bags shall be stored in a suitable water tight shed clear of walls by at least 300mm and on 300mm raised dry floor. Any cement which has become wet, showing any signs of caking or deterioration or contamination of any kind shall not be used, and shall be immediately removed from the site.

3. AGGREGATES:

Aggregates shall consist of natural sand and gravels, broken natural stone or other suitable material and shall conform to Indian standards 383-1970 and Indian Standards 515-1959. They shall be angular and with sharp corners, well graded and hard, strong and durable. They shall be reasonably clean and free from clay, organic matter, sea shells, coal or coal residues, copper slag, soluble sulphates, porous material or any other materials that is likely to decompose or change in volume when exposed to the weather or to affect the reinforcement.

If natural sand is used, same shall be obtained from an approved source and shall be screened at site, if required.

All aggregate shall be suitably graded from the maximum specified gauge to the minimum. In general, for reinforced concrete work, the maximum size of aggregates shall be restricted to 20 mm.

In heavily reinforced beams and other members, smaller size aggregates will be allowed with the permission of the owner.

Fine and coarse aggregates shall be stored in separate open bins according to sizes.

4. WATER:

Water used for mixing as well as curing shall be conforming to the requirements of Indian Standards 456-1978. Water shall not contain any impurities such as oil, acids, salts etc., that are likely to have an adverse effect on cement or steel in case of reinforced concrete.

5. ADMIXTURE:

Admixture (such as accelerators, retarders, water proofing agents, etc.) may be used only with the specific permission of the owner/engineer in charge.

6. MIXING:

All concrete, whether plain or reinforced, ordinary or controlled shall be mixed in a mechanical mixer of approved type. Mixing shall be continued for at least two minutes to result in concrete of uniform colour and consistency. When special cements are used, the time may be altered as per the manufacturer's requirements in consultation with the owner.

7. STRUCTURAL JOINTS:

The placing of concrete on either side of an expansion joint shall be done separately after an interval of at least seven days. All construction joints in a liquid retaining structure shall be provided with approved quality water stopper.

8. CURING:

The concrete shall be cured either by covering all exposed surfaces with wet canvas, Hessian or any other absorbent material or by making small bunds of mortar or clay maintaining about 15mm deep pools of water, to prevent the concrete from drying out, for at least 15 days.

When rapid hardening or high aluminium cements are used, special attention shall be given to the maintenance of moist conditions of curing in consultation with the owner.

9. INSERTS:

The contractor shall fix all necessary steel plates, pipe holes, pockets, dowels, etc. in the shuttering of concrete work, to enable subsequent fixing of supports, brackets, ceiling, precast members, etc. as indicated in the drawings or as required by owner.

10. TESTING:

Specimens of the concrete used in the works shall be taken at regular intervals for crushing strength and density requirements. Work test cubes shall be cast and cured strictly in accordance with Indian Standards 5-16. The number of samplings to be taken for each grade of concrete per day shall be as directed by owner.

At least 2 cubes should be made for each sampling. One cube shall be tested at an age of 7 days and the remaining at an age of 28 days, if required.

In case of failure of test cubes to meet the specified requirements, the owner may take one of the following actions:

- 1) Instruct the contractor to carryout additional test and/or works and ensure the soundness of the structure at the contractor's expenses.
- 2) Accept the work; any decision to accept the work shall be at the discretion of the owner, who may make a reduction in the rate of the appropriate item.

11. REINFORCEMENT:

The steel reinforcement shall be Fe415 Grade conforming to Indian Standards 1139/Indian Standards 1786.

Fabrication shall be accurately cut to the dimension, spacing and rigidly held in position and securely tied by means of approved 18 gauge annealed steel wire. Cement mortar (1:2) cubes or rings shall be provided to maintain adequate cover to reinforcement. An adequate number of HYSD chairs and spacer bar reinforcement should be provided. All joints, splices and lengths of over lap in MS/HYSD reinforcement shall be strictly in accordance with the structural drawings.

The contractor shall submit bar bending schedules for the approval of the owner at least 17 days prior to commencement of earth works. These will indicate the accurate dimensions and bending of bars as required on the structural drawings. If during construction, any deviations are made from the bar bending schedules, these shall be recorded by the owner.

12. COVER TO REINFORCEMENT:

- i) At each end of reinforcing bar, not less than 40mm nor less than twice the diameter of bar.
- ii) For a longitudinal reinforcing bar in a beam, not less than 25mm nor less than the diameter of the bar.
- iii) For a longitudinal reinforcing bar in a Column, not less than 40mm nor less than the diameter of the bar.
- iv) For vertical or horizontal reinforcement in side walls of all liquid retaining structure not less than 25mm nor less than the dia of the bar.
- v) For members either in contact with the liquid or enclosing the space above liquid minimum cover should be 25mm or the dia of the bar whichever is greater.

13. FORM WORK:

Form work shall be erected true to line and to the shapes and dimensions required for the work. It shall be designed to carry without deformation the full weight of wet concrete and other incidental live loads. It should also withstand the effect of vibration, without deflection, bulging, distortion or loosening of its component parts. The contractor shall be responsible for the sufficiency of all form work, centering and moulds. All joints shall be tongued and grooved and sufficiently tight to prevent leakage of cement paste. All form work shall be removed without shock or vibration such as would damage the concrete. Before the soft forms and props are removed, the contractor shall ascertain that the concrete has hardened sufficiently and shall be removed with the approval of the owner. Concrete surfaces which are to be finished with cement rendering shall be thoroughly hacked with approved hand tools immediately after removal of form work so as to bring adequate bond between the concrete and cement rendering.

D SPECIFICATION FOR PIPING

General

- a. All pipe works shall be carried out as per the supplied P & I diagram.
- b. Piping shall also comply with applicable state, local or other Government law codes. In case of conflict with these specifications, the more rigid specification govern.
- c. All works shall be performed in accordance with the best modern practice for this of work and shall be of the highest quality of workmanship.

14. STANDARDS:

The following standards shall be applicable.

- i. IS 4985 - 1988 Indian Standards specification for Unplastic PVC pipes for potable water supplies.
- ii. IS 7634 - 1975 Code of practice for plastics pipe work potable water supplies.
Part - I Code of practice for choice of material and general recommendations.
Part - III Code of practice for laying jointing of Unplasticized PVC Pipes.
- iii. IS 780 - 1984 Specification for sluice valves for water works purposes (50mm - 300mm size).
- iv. IS 5312 - 1969 Specification for swing check type reflux (no return) valves.
- v. IS 638 - 1955 Indian Standards specification for rubber for flanged joints.

15. TESTING OF PIPES:

For pipes, the field test pressure to be imposed should not be less than the greatest of the following:

- i) 1.5 times the maximum sustained operating pressure;
- ii) 1.5 times the maximum pipeline static pressure;
- iii) The field test pressure should wherever possible be not less than two-thirds of the works test pressure appropriate to the class of pipe and should be applied and maintained.

16. TESTING OF GRAVITY FLOW CONDUITS:

For gravity pipes, the pipeline shall be subject to a test pressure of 2.5m - 5.0m head of water at the highest point of the section under test for 10 minutes. The leakage of quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 litres/mm of pipe-diameter per kilometer length per day.

17. PIPING:

Transportation and Stacking, Handling and Laying:

Straight lengths only should be supplied. They can be stored on levelled ground. Dragging pipes over rough surfaces should be avoided.

18. UNDERGROUND INSTALLATION:

Wherever gradual curves are involved in pipe alignment, care should be taken to see that the radius of curvature of the trench alignment is about 20 to 40 times the diameter of the pipes, depending on the size.

These methods benefit the pipes flexibility and thereby reduce the occurrence of any sharp bends.

The pipes should be capable of taking care of buckling pressures due to earth pressures on the pipes when laid at depth below ground level during both flow through pipes and no flow through pipes.

19. TRENCH PREPARATION:

Trench width at the crown of the pipes should be as narrow as is practicable. But it should not be less than the outside diameter of the pipe plus another 300mm to allow proper compaction of the sidefill. Above the crown of the pipe, the trench may be of any convenient width.

Pipes, especially higher sizes of pipes, may be laid directly on the trimmed bottom of a trench. However, this should be done in uniform, relatively soft fine grained soils free from large flints or stones or other hard objects, and where the bottom can readily be brought to an even finish to provide uniform support for the pipes over their length. In other cases, the trench should be excavated to a sufficient depth below the bottom of the pipe, to allow for filling with necessary thickness of the selected bedding materials.

20. BACKFILLING:

Materials excavated from the trench, if found suitable, may be used for the remainder of the back-filling. It should be compacted in 300mm layers. Alternatively, it should be in compliance with the requirements of owner. To avail a higher factor of safety in load distribution, the trench preparation and back-filling procedure shall be as per Indian Standards 4127 - 1983 is to be followed.

Where the trimmed bottom is not suitably smooth for direct laying, there should be a sand bed cushion of at least 150mm, as well as on the sides. Where the material excavated is not suitable for back-filling, at least two layers of 150mm clear sand cushion should be provided.

21. VALVES:

i) General:

- 1) Wherever practicable, valve stems shall be installed in a direction suitable for easy operation.
- 2) Control valve shall be located and installed so as to provide the following clearances:
 - i) Below Valves - 300 mm minimum
 - ii) Above Valves - Sufficient to remove bonnet with edge.

ii) **Cleaning of Valves:**

Valves will be cleaned before installation. All possible precautions shall be taken to prevent contamination and valves shall be inspected immediately prior to installation. If a valve is found to be contaminated in any way, it shall be cleaned by the contractor to the satisfaction of owner.

22. **GENERAL NOTES ON ERECTION OF PIPING:**

- i) All piping shall be erected as shown in the construction drawings and in accordance with the specifications.
- ii) Arrangement drawings shall show general location and shall indicate special dimension, location of valves, fittings etc.
- iii) Special attention shall be given to the handling and erection of piping to prevent damage and ensure the continued cleanliness of such piping.
- iv) All assembled piping shall be installed in place without spinning or forcing.
- v) Piping connection to equipment shall be made in conformity with details on the drawing.
- vi) Slopes of piping specified on drawings shall be maintained. Where no slope is required or where a required slope approaches the horizontal, piping shall be checked for sag with a level not less than 1 metro long equipped with a graduated bubble vial. All low points where liquid may be entrapped shall be removed.
- vii) After piping is erected in final position, it shall be cleaned, tested for water tightness and dried out where required as described in this specification.
- viii) Pipe supports wherever necessary and requested by the owner has to be provided.
- ix) Pipes above ground shall be either along the wall and at levels specified by the owner above ground level.

23. **LAYING AND JOINTING FOR PVC PIPES:**

Socket and spigot joint is usually preferred for all PVC pipes. The socket length should be at least one and half times the outer dia for sizes upto 100mm dia and equal to the outer dia for larger sizes. For pipe installation solvent - gluing is to be done. The surfaces to be glued are thoroughly scoured with emery cloth. If the pipes have become heavily contaminated by grease or oil, methylene chloride or similar solvent may be used for cleaning. Then the cement should be applied with a brush evenly to the outside surface of the spigot on one pipe and to the inside of the socket on the other. The spigot should then be inserted immediately in the socket upto the shoulder and thereafter a quarter (90°) turn is given to evenly distribute the cement over the treated surface. The excess cement which is pushed out of the socket must be removed at once with a clean cloth. Jointing must be carried out in minimum possible time, the time required for making a complete joint not exceeding one minute. The freshly glued joint should not be disturbed for at least 5 minutes. Gluing should be avoided in rainy or foggy weather.

24. **SITE CLEANING AND UPGRADATION OF THE SITE:**

The Tenderer has to include in his price the cleaning of site before and after the work. The entire site shall be suitably levelled so as to drain all the rain water to the storm water drains/natural courses as approved by RePO, UNIDO. The contractor's scope is also to include planting of trees/decorative plants so as to create a green environment for the entire ETP site.

E. MASONRY WORKS

25. APPLICABLE CODES AND SPECIFICATIONS:

The following codes, standards and specifications are made a part of this specification. All standards, tentative specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

IS: 1077	- Common burnt clay building bricks
IS: 3102	- Classification of burnt clay bricks
IS: 2180	- Burnt clay building bricks, heavy duty.
IS: 3495	- Method of sampling and testing clay building bricks
IS: 2691	- Burnt clay facing bricks
IS: 2221	- Code of practice for brick work
IS: 2185	- Load bearing hollow concrete blocks
IS: 5490	- Lime-cement cinder solid blocks
IS: 3115	- Lime-cement cinder solid blocks
IS: 1597	- Code of practice for construction of stone masonry (Part I)

26. PROVIDING AND CONSTRUCTING BRICK MASONRY IN CM IN FOUNDATION AND UPTO PLINTH LEVEL:

Bricks used in works shall be bricks of specified crushing strength as described in the Schedule of Quantities. They shall have the following general properties: They shall be sound, hard, homogenous in texture, well burnt in kiln without being verified, table moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square edges and paralleled faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing unground particles and which absorb water more than 1/5th of their weight when soaked in water for twenty four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. These bricks shall give a clear ringing sound when struck.

Samples of bricks shall be submitted before starting the brickwork to the Engineer in charge for approval. Bricks supplied shall conform to these approved samples. Bricks sample shall be got tested as per IS: 3495 by Contractor at no extra cost. Bricks rejected by Engineer in charge shall be removed from the site of works within 24 hours.

Mortar

i) Mix for cement mortar shall be as specified in the respective items of work. Gauge boxes for sand shall be of such dimensions that one complete bag of cement containing 50 Kgs. of cement forms one unit. The sand shall be, free from clay shale, loam, alkali and organic matter and of sound, hard, clean and durable particles. Sand shall be approved by the Engineer in charge. If so directed by the Engineer in charge, sand shall be thoroughly washed till it is free of any contamination.

ii) For preparing cement mortar the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall preferably be machine mixed, through mixing in a thorough manner may be allowed. The mortar so mixed shall be used within 30 minutes of mixing. Mortar left unused in the specified period shall be rejected.

iii) The Contractor shall arrange for test on mortar samples if so directed by the Engineer in charge retempering of mortar shall not be permitted.

Workmanship

i) All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 250mm thick and over shall be laid in English bond unless otherwise specified. While laying bricks shall be pressed in to the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with props uppermost.

ii) All brick work shall be plumb, square and true to dimensions. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230mm both faces shall be kept in vertical planes. No broken bricks shall be used except as closers. Care shall be taken that the bricks forming the top corners and ends of the wall shall be properly radiated and keyed into position. Holes kept in masonry for scaffolding shall be closed before plastering. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work where this is not possible, the work shall be raked back accordingly to bond (and not raw toothed) at an angle not exceeding 45°.

iii) Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6mm and not more than 10mm. The face joint shall be raked to a minimum depth of 12mm by raking tools daily during the progress of work when the mortar is still green so as to provide a proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If the mortar in the lower course has begun to set the joints shall be raked out to a depth of 12mm before another course is laid.

iv) All brick work shall be built tightly against columns, floor slabs or other structural member.

v) Where drawings indicate that structural steel columns are to be fireproofed with brick work the brick shall be built closely against all flanges and webs with all spaces between the steel and bricks works filled solid with mortar. Steel members partly embedded in brickwork and not indicated to be fireproofed with concrete shall be covered with not less than 12mm thick mortar unless directed otherwise by Engineer.

vi) The work shall be cured for 15 days.

27. PROVIDING AND CONSTRUCTING 115 MM BRICK MASONRY IN PARTITION IN CM:

The bricks shall be laid with stretchers. The proportion of the mortar shall be as specified in the item description. The quality of the bricks shall be as specified in the item 5.01. The bricks shall be well soaked in water before using them. The brick work shall be plumb and square. Two nos. of 6mm dia MS bars of 25mm x 1.2mm deep iron band kept at every fourth course of 115mm thick brick work. This shall be provided by the Contractor.

28. PROVIDING AND CONSTRUCTING 75MM PARTITION WALL IN CM:

The general specification shall be same as per item 3.

29. PROVIDING AND CONSTRUCTING HONEYCOMB BRICK WORK:

The specification for the material and the workmanship shall be as specified in the Items 2 and 3 depending on the thickness of the brick work.

30. PROVIDING AND CONSTRUCTING FACING BRICKWORK:

Facing bricks of the type specified shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks. No facing brickwork shall at anytime be more than 600mm above the backing brickwork. Facing work shall be pointed as the work proceeds and internal faces of the brickwork shall be pointed with neat joint to give a fair face.

Faced work shall be kept clean and free from damage, discoloration etc. at all times. The Contractor shall carefully plug all holes with bricks similar to the surrounding.

For facing brickwork double scaffolding shall be used and no holes in brickwork for scaffolding shall be permitted.

31. PROVIDING AND CONSTRUCTING CONCRETE BLOCK MASONRY:

Concrete blocks (hollow or solid) shall generally conform to IS: 2185. Blocks shall be regular in size and shape and shall be of specified strength. Blocks shall be properly cured before they are brought to site. Half or three quarter size blocks are to be used wherever required to make up length of wall and broken blocks shall not be used. The texture of the blocks shall be such that plaster will adhere to it. The contractor shall supply samples for approval. Blocks supplied shall conform to approved samples.

Mortar

Mortar shall be similar to mortar in brickwork.

Workmanship

a) All brickwork shall be plumb, square and properly bonded. The joints shall be broken. The thickness of courses shall be uniform with courses horizontal. All connected work shall be carried out at nearly one level and no portion of the work shall be left more than one course lower than the adjacent work.

b) Blocks shall be laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6mm and not more than 8mm. The face joints shall be raked to a minimum depth of 10mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plaster or pointing. When plastering or pointing is not required, the joints shall be struck flush. For pointed masonry without plaster, smooth textured concrete block shall be used. The face of blocks work shall be kept clean at all times.

c) Where block are to be used for load bearing walls, the uppermost layer of block masonry supporting slab or other structured members, shall be solid or treated as directed by the Engineer in charge.

Precast concrete screen blocks of Jali work may be used for decorative purposes. The contractor shall furnish samples for approval.

32. PROVIDING AND CONSTRUCTING RANDOM RUBBLE MASONRY UNCOURSED IN FOUNDATION:

- a) Stones for this work shall be hard, durable rock, close or fine grained and uniform in colour free from veins, flaws and other defects and shall conform to IS:1597 (Part I). The stones shall be laid in mortar proportions specified for the particular item of work. Stones shall be got approved by the Engineer in charge before commencement of work.
- b) For all work below ground level, the masonry shall be random rubble uncoursed with ordinary quarry dressed stones or heating and faced with selected quarry dressed stones.
- c) For all work above ground level the masonry shall be random rubble faced with hammer dressed stones with squared quoins at joints and corners.
- d) No stones shall tail in to the wall, either with a point or to length less than 1½ times its height. The thickness of the joints shall not exceed 12 mm.
- e) Spauls and pinnings shall not be allowed to show on the face of the wall. Two bond stones each of minimum area of 500 sq.cm for every 1.0 sq.m. of each wall face shall be provided. These shall be through stones in walls 600mm thick and under, in walls thicker than 600 mm the length of bond stones shall be 2/3 times the thickness of wall. The stones for hearting of the wall shall not be less than 150mm in any direction. Chips and spauls shall be wedged into avoid thick mortar beds and joints. The wall faces, corners and joints or openings shall be truly vertical the quoins shall be of selected stones, neatly dressed with chinnel to form the required angle and laid header and stretcher alternatively.
- f) The exposed face of the work shall be carefully and neatly pointed with mortar in all joints on the other side the joints shall be neatly struck with trowel while the mortar is fresh.

Mortar

The mortar for the work shall be as specified in the respective item of work. Curing of masonry shall continue for a minimum of ten days.

33. PROVIDING AND CONSTRUCTING RANDOM RUBBLE MASONRY UNCOURSED IN SUPERSTRUCTURE:

The specification shall be as in Item 8.

F. EARTHWORK

Scope

This section covers the works specification of earthwork in excavation in all kinds of soils including murrum, hard murrum, soft rock (without blasting), hard rock (without blasting), rock (with blasting), filling excavated earth in plinths, sand filling in plinth, rubble soling, and brick on edge soling.

Applicable Codes

The following Indian Standard Codes, unless otherwise specified herein shall be applicable. In all cases, the latest revision of the codes shall be referred to.

- a) IS - 4081 Safety code for blasting and related drilling operations.
- b) IS - 1200 Method of measurement of building works.
- c) IS - 3764 Safety code for excavation work.
- d) IS - 3385 Code of practice for measurement of Civil Engineering works.
- e) IS - 2720 Part II Determination of moisture content.
Part VIII Determination of moisture content dry density relation using light compaction
Part XXVIII Determination of dry density of soils, in-place by the sand replacement method.
Part XXIX Determination of dry density of soils, in-place, by the core cutter method.

General

Contractor shall provide all tools, plants, instruments, qualified supervisory personnel, labour, materials, and temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein, for completion of the work.

Contractor shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for levelling, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 5m intervals or nearer as determined by Engineer in charge based on ground profile. These shall be checked by Engineer in charge and thereafter properly recorded.

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, slumps, bush, vegetations, rubbish slush etc. and other objectionable matter. If any roots or stumps of trees are found during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by Engineer in charge. Where earthfill is intended, the area shall be stripped of all loose/soft patches, top soil containing deleterious matter/materials before fill commences.

Relics, Objects of Antiquity, etc.

All gold, silver, oil minerals archaeological and other findings of importance, all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of Owner and Contractor shall duly preserve the same to the satisfaction of Owner/PKL and from time to time deliver the same to such person or persons as Owner/PKL may from time to time authorize or appoint to receive the same.

34. EARTH WORK IN EXCAVATION UPTO 1.5M FROM EXISTING GL:

A) Classification

Any earthwork will be classified under any of the following categories:

i. All kinds of soils

These shall include all kinds containing kankar, sand, salt, moorum and/or shingle, gravel, clay, loam peat, ash shells etc. which can generally be excavated by spade, pick-axe and shovel and which is not classified under soft and decomposed rock, and hard rock defined below. This shall also include embedded rock boulders not bigger than 1 metre in any dimension and not more than 200mm in any one of the other two dimensions.

ii. Soft Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite etc. which are to be excavated with or without blasting or could be excavated with picks, hammer, crow bars, wedges. This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not bigger than 1 metre in any dimension and not more than 500mm in any one of the other two dimensions Rubble masonry to be dismantled will also be measured under this item.

iii. Hard Rock

This shall include rock which cannot be easily excavated with pick-axes, hammer, crow bars and wedges but has to be either heated where blasting is prohibited or has to be blasted. They shall be stacked separately for measurement.

The earthwork in excavation shall be done as per the Architect and structural consultant's drawings upto required depths and levels and alignments in all sorts of soils. The depth of the foundation will be as per the Engineer's instructions. The lining work should be done by the Contractor. Roots or trees met with during the excavation shall be cut and smeared with coal tar. Excavated earth shall be stacked atleast 3m away from the trenches or as per the Engineer's instructions, so that it may not camage the sides of the excavated trenches. The sides of the excavated trenches shall be vertical and in straight line and bottom uniformly levelled watered, consolidated and ready for terminte treatment. The maximum load for stacking the earth shall be 100m, unless otherwise categorically specified in the item description.

In firm soil if the excavation is deeper than 2m the sides of the trenches shall be made bigger by allowing steps of 50cm on either side so as to keep the slope 0.25 to 1. In loose soft or slushy soil the width of the step shall be suitably increased or the sides sloped or shoring and strutting may be done as per the Engineer's instructions.

For excavation for drain work, the sides and the bottoms should be to the required slope, shape and gradient. The cutting shall be done from top to bottom. Under no circumstances shall undermining or under cutting be allowed. The final surface shall be neatly levelled and well compacted. The earth from the cutting shall be directly used for filling either in plinth or on grounds.

For excavation in trenches for pipes nothing extra shall be payable for the lift irrespective of the depth unless specifically mentioned otherwise.

If the trenches are made deeper than specified level due to oversight or negligence of the Contractor the extra depth shall be filled up by lean concrete of mix 1:5:10 (1 cement, 5 coarse sand and 10 coarse aggregate of nominal size 40mm) and if the trench is made wider than shown in the drawings the Contractor has to make good at his own cost. The foundation trenches shall be free from water and muck, while the foundation work is in progress.

The trenches which are ready for concreting shall be got approved by the Engineer in charge.

The excavated stacked earth shall be refilled in the trenches and sides of foundation in 150 mm layers and the balance surplus shall be first filled in layers in plinth and the remaining surplus shall be disposed off by uniform spreading within the site/outside the site as directed by the Engineer.

Adequate protective measures shall be taken by the Contractor to see that the excavation for the building foundation does not affect the adjoining structure's stability and safety. Contractor will be responsible if he has not taken precaution for the safety of the people, property or neighbor's property caused by his negligence during the constructional operations.

To the extent available, selected surplus from materials shall be used. Filling materials shall be free from clods, salts, sulphates, organic and other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150mm size, mixed with properly graded fine material consisting of earth to fill up the voids and the mixture used for filling.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc. shall be cleared of all debris and filled with earth in layers 15cm to 20cm, each layer being watered, rammed and properly consolidated before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Engineer in charge.

Lead

Lead for deposition/disposal of excavated material, shall be as specified in the respective item of work. If the lead is not specified in the respective item, a basic lead of 100 m shall be considered for quoting rates. Only leads beyond 100m shall be considered as extra lead and the Contractor shall be compensated for the same. For the purpose of measurement of lead the area to be excavated or filled or area on which excavated material is to be deposited/disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centerlines shall be taken as the lead which shall be measured, as far as practically possible, by the shortest straight line route on the plan and not the actual route taken by the Contractor. No extra compensation is admissible on the grounds that the lead including that for borrowed materials had to be transported over marshy or katcha land/route.

Back Filling

Back filling as per specification the side of foundations of columns, footings, structures, wall, tanks rafts, trenches etc. with excavated materials will not be paid for separately. Backfilling shall include stacking of excavated material as directed, excavation/stacking of selected stacked material, conveying it to the place of final back fill, compaction etc. as specified. As a rule material to be back filled shall be stacked temporarily within the basic lead of 100 metres unless otherwise specified in the item.

The excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes as directed by Engineer in charge within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as directed by Engineer in charge. As a rule, and material shall be laid along the entire of

the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Excavated soft rock or hard rock shall be stacked separately.

The balling out of water shall also be executed by the Contractor at his own cost.

35. EARTHWORK IN EXCAVATION FOR DEPTH EXCEEDING 1.50M BUT NOT EXCEEDING 3.0M:

The general specification shall be same as for the Item 1 given above.

36. EARTH WORK IN EXCAVATION FOR DEPTH EXCEEDING 3.0M BUT NOT EXCEEDING 4.5M:

The general specification shall be same as for the Item 1 given above.

37. EARTH WORK IN EXCAVATION IN ROCKS UPTO 1.50M FROM EGL:

A. Unless otherwise stated herein, IS 4081, safety code for blasting and related drilling operations shall be followed. After removal of over burden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by Engineer in charge. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions, shall be taken to preserve the rock below and beyond the lines specified for the excavating, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer in charge shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer in charge at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

B. Specific permission of Engineer in charge in charge will have to be taken by Contractor for blasting rock and he shall also obtain a valid blasting licence from the authorities concerned. if permission for blasting is refused by Engineer in charge, the rock shall be removed by wedging, pick barring, heating and quenching or other approved means. All loose/loosened rock in the sides shall be removed by barring wedging, etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

C) Contractor shall obtain necessary licensee for storage of explosives fuses and detonators issued to him from Owner's stores or from a supplier arranged by the Contractor, from the authorities dealing with explosives. The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities, for the explosives etc. as per rules and regulations of local, State and Central Govt. authorities and Statutory bodies. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done and surplus left after filling the holes shall be built as far as possible from the area to be blasted. Prior approval of the Engineer in charge shall be taken for the location proposed for the magazine.

D)

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

For blasting operations, the following points shall be otherwards:

Contractor shall employ a competent and experienced supervisor and licensed blaser in charge for each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer in charge and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200m radius from the firing point, at least 15 minutes before firing time by sounding warning siren. The areas shall be encircled by red flags. Clearance signal shall also be given sounding a distinguishing siren.

The blasting of rock near any existing buildings, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by MS plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Engineer in charge, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

The firing shall be supervised by a Supervisor and not more than six (6) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along with misfired hole (but not nearer than 600mm from it) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into plate required depth the balance of the hole shall be filed with stemming which may consist of sand or stone dust or similar inert material.

Contractor shall preferably detonate the explosives electrically.

The explosive shall be exploded by means of a primer which shall be fired by detonating a fuse instantaneous detonator (FID) or other approved cables. The detonators with FID shall be connected by special nippers.

In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatin with detonator and fuse wire may be used. Under water or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

Holes for charging explosive shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.

When excavations has almost reached the desired level, hand trimming shall have to redone for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75mm shall be filled up as instructed by Engineer in charge, with concrete of strength not less than M10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stepping in rock and excavation will be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of explosives, or any other Authority duly constituted under the State and/or Union Government.

The rate excavation shall include the following jobs:

Refilling of the trenches and consolidating and spreading as per the Engineer's directions.

Shorting and slutting as demanded by the site conditions and as instructed by the Engineer in charge.

38. EARTHWORK IN EXCAVATION IN ROCKS DEPTH EXCEEDING 1.50M BUT NOT EXCEEDING 3.0M:

The general specification is same as Item no. 4.

39. PROVIDING AND FILLING LOCAL SAND IN TRENCHES, PLINTH AND SURROUNDING AREAS:

At places backfilling shall be carried out with local sand if directed by Engineer in charge. The sand used shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to Contractor's account. The surface of the consolidated sand shall be dressed to require level or slope. Construction of floors or other structures on sand fill shall not be started until Engineer in charge has inspected and approved the fill.

40. PROVIDING AND LAYING RUBBLE SOLING:

Rubble used for packing under floors, foundations etc. shall be hard, durable rock, free from veins, flaws and other defects. The size of the rubble shall be 100mm - 150mm unless otherwise specified and the quality shall be got approved by the Engineer in charge. Rubble shall be laid closely in position on the sub-grade. All interstices between the stones shall be wedged in with smaller stones of suitable size well driven to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of rubble stone and shall not lag behind.

Small interstices shall be filled with murrum, well watered and rammed.

41. BRICK SOLING:

Bricks shall be laid on edge or flat as per the item specification. The bricks shall be placed as close as possible. Broken bricks shall not be used except for closing the line. Bricks should not show any efflorescence on drying.

The sling pattern shall be as specified in the item specification, it can be plain, diagonal or herring-bone. Suitable slope shall be maintained as specified by the Engineer in charge.

The joints shall be filled with earth or sand as specified. If it is to be filled with cement mortar, the proportion of the mortar shall be as specified in the item specification.

42. PROVIDING AND LAYING DRY STONE PITCHING:

Stone subject to marked deterioration by water or weather will not be accepted. The stone shall be hard, durable and fairly regular in shape and its thickness in any one direction shall not be less than the thickness of the pitching as specified in the Schedule of Quantities.

Before laying the pitching the sides of the sloped surface shall be trimmed to the required slope and profiles. The depressions shall be thoroughly filled and compacted. It shall commence from the bottom. The stones shall be placed normal to the slope and the largest dimension is perpendicular to the face of the slope unless such dimension is more than the thickness of the pitching. The largest stones shall be placed at the bottom. The joints between the stones shall be filled with good earth. The earth shall be approved by the Engineer in charge before filling.

43. PROVIDING AND LAYING DRY STONE PITCHING WITH CEMENT POINTING:

The general specification shall be same as the Item no. 1 but for the joints between the stones shall be filled with cement mortar of proportion as specified in the item description in the Bill of Quantities.

44. PROVIDING AND FILLING DRY BRICKBAT AT ALL LEVELS:

The brickbats shall be of 40-65mm (average) thickness in size. The brickbats shall be clean and mortar free. They should be washed off dust before it is filled. They shall be filled in places as directed by the Engineer in charge.

BILL OF QUANTITIES**Reed Beds**

It. No	Item	Unit	Quantity	Unit rate	Amount (Rs)
1.	Earthwork excavation in ordinary soil upto a depth of 1.50m from GL including removal of surplus earth, de-watering, shoring if required, cost of all tools and plants, labor etc. complete.	m ³	534		
2.	Providing plain cement concrete M10 using 40mm graded hard blue granite stone as coarse, aggregate, good clean river sand as fine aggregate including cost of all shuttering, materials, labor etc. complete.	m ³	31.20		
3.	Providing random rubble masonry in CM 1:6, including cost of all materials, labor, bond stones, etc. complete.	m ³	150		
4.	Plastering 15mm thick with C.M. 1:4, one coat including cost of all materials and labor etc. complete a) Over RR masonry b) Over water proofing layer	m ² m ²	282 282		
5.	Providing and applying 2 part, cement based water proofing course over plastered /concrete surfaces, from standard firms like M/s. Fosroc, M/s. Roffe, Dr. Sika, or equivalent including providing guarantee for 10 years	m ²	282		
6.	Supplying and laying good clean river sand including cost of material and labor.	m ³	294		
7.	a. Supplying and laying as per instructions and specifications, well washed pebbles of size 5-10mm procured from river beds, with a uniformity coefficient 1.3 to 1.5, including cost of all labor, materials etc. complete. b. Supplying and laying as per instructions and specifications, well washed pebbles of size 60 - 100 mm procured from river beds, with a uniformity coefficient 1.3 to 1.5, including cost of all labor, materials etc. complete.	m ³ m ³	500 31.20		
8.	Providing and laying 0.60mm thick jute felt reinforced PVC sheets having a minimum width of 1.9mm and joined together with HDPE slit tape fabric with an overlap of a minimum 100 mm including cost of all materials and labor etc. complete. (Only flat area as laid will be measured)	m ²	918		
9.	Providing and placing in position stainless steel wiremesh 2mm thick, 40 mm mesh size box type frame work, of size 0.50 X 0.8m and length 13 m, with 20mm X 20mm stainless angle at all corners and welded on all four sides (except the ends). All stainless steel materials shall conform to AISI 304, including cost of all materials, labor for fabrication and erection etc. complete.	No	6		

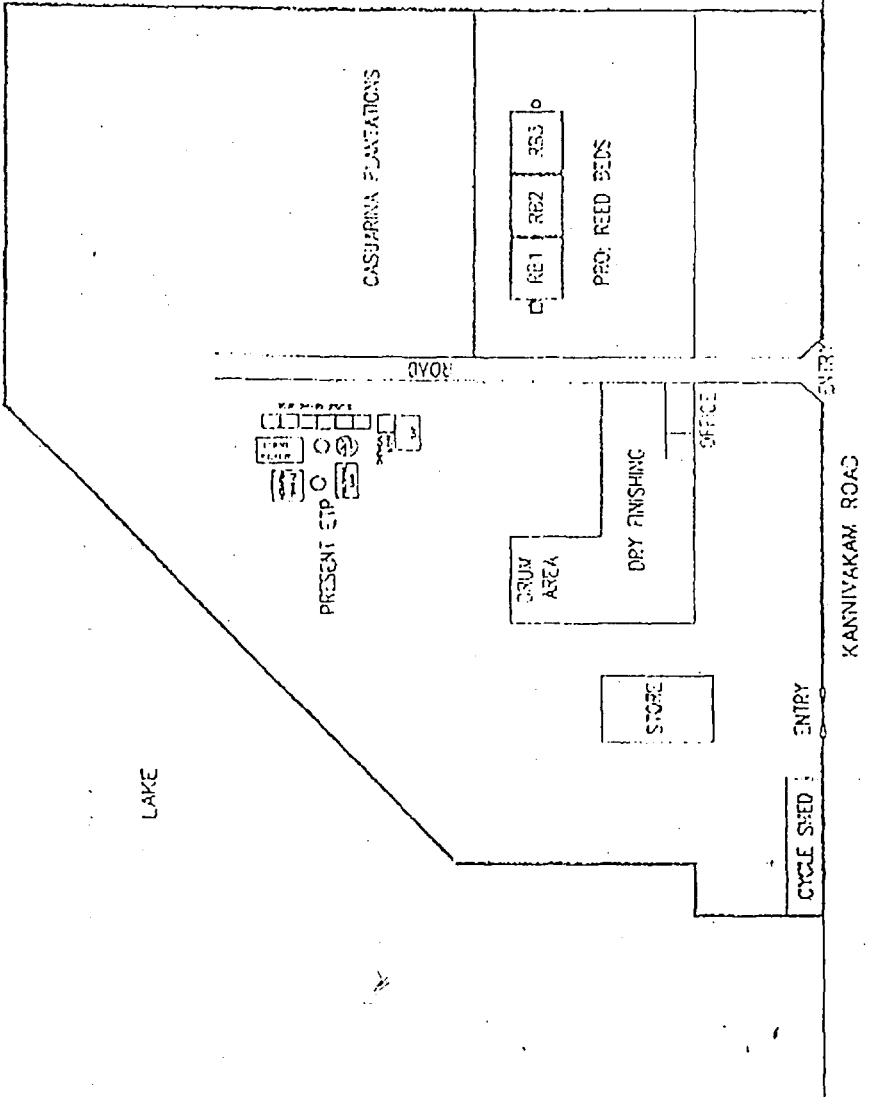
Sump

Item No.	Item	Unit	Quantity	Unit rate	Amount (Rs)
1.	Earth work excavation in ordinary soil including removal of surplus earth, dewatering, shoring if required, cost of all tools and plants, labor etc. complete. a) up to a depth of 1.50m b) Beyond 1.50m	m ³ m ³	9.00 6.00		
2.	Providing plain cement concrete M10 using 40 mm graded hard blue granite stone as coarse aggregate, good clean river sand as fine aggregate including cost of all shuttering, materials, labor etc. complete	m ³	1.30		
3.	Providing reinforced cement concrete of M20 proportion, using 20 mm graded stones as coarse aggregate including cost of providing and removing all shuttering, cost of all materials, tools and plants, labor etc. complete.	m ³	3.2		
4.	Providing steel reinforcements for RCC work, bent or the required shape, and tied with 18G black annealed binding wire including cost of all labor, materials etc. complete	kg	269		

ANNEX II

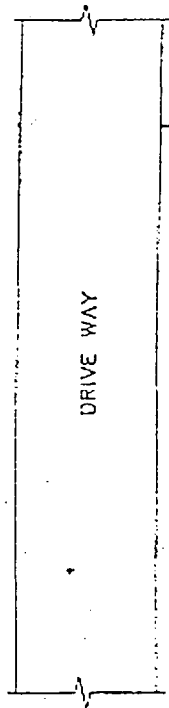
DRAWINGS

58/101 TO 58/106 & 58/201



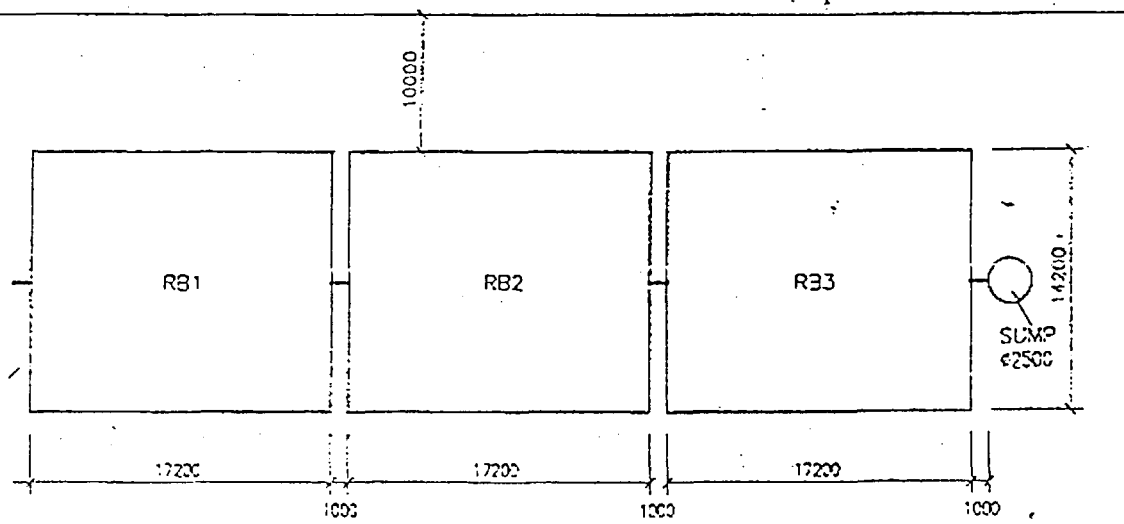
PROJECT	UNIDO SPONSORED PDU-97/305P
TITLE	GENERAL LAYOUT FOR P.K.L. KANNIVAKAM
CONSULTANTS	THE SOLUTIONS CENTRE, XLIV/1566 COCHIN - 682 017, INDIA.
SCALE	1:200
DRAWING No.	58/101

PRESENT
ETP



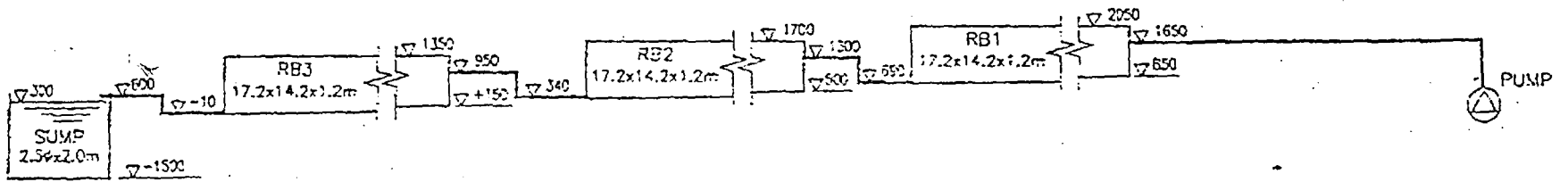
CASUARINA PLANTATION

FENCING



ALL DIMENSIONS ARE IN mm.

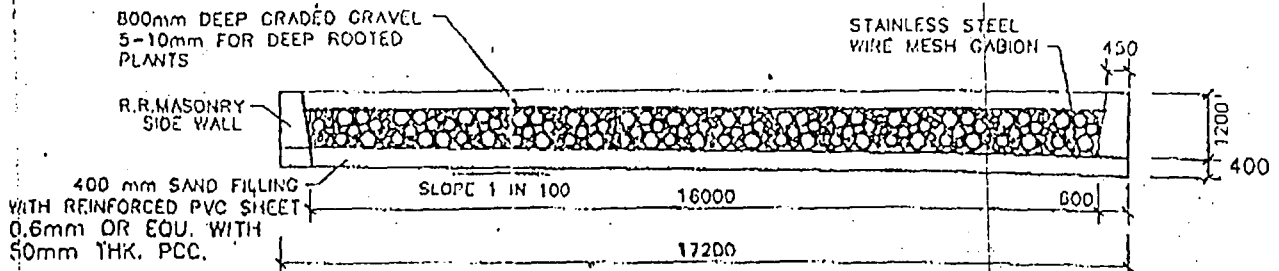
PROJECT	UNIDO SPONSORED PDU-97/305P
TITLE	LAYOUT FOR PKL, KANNIYAKAM
CONSULTANTS	THE SOLUTIONS CENTRE, XLIV/1566 COCHIN - 682 017, INDIA.
SCALE	1 : 400
ORG.No.	58/102



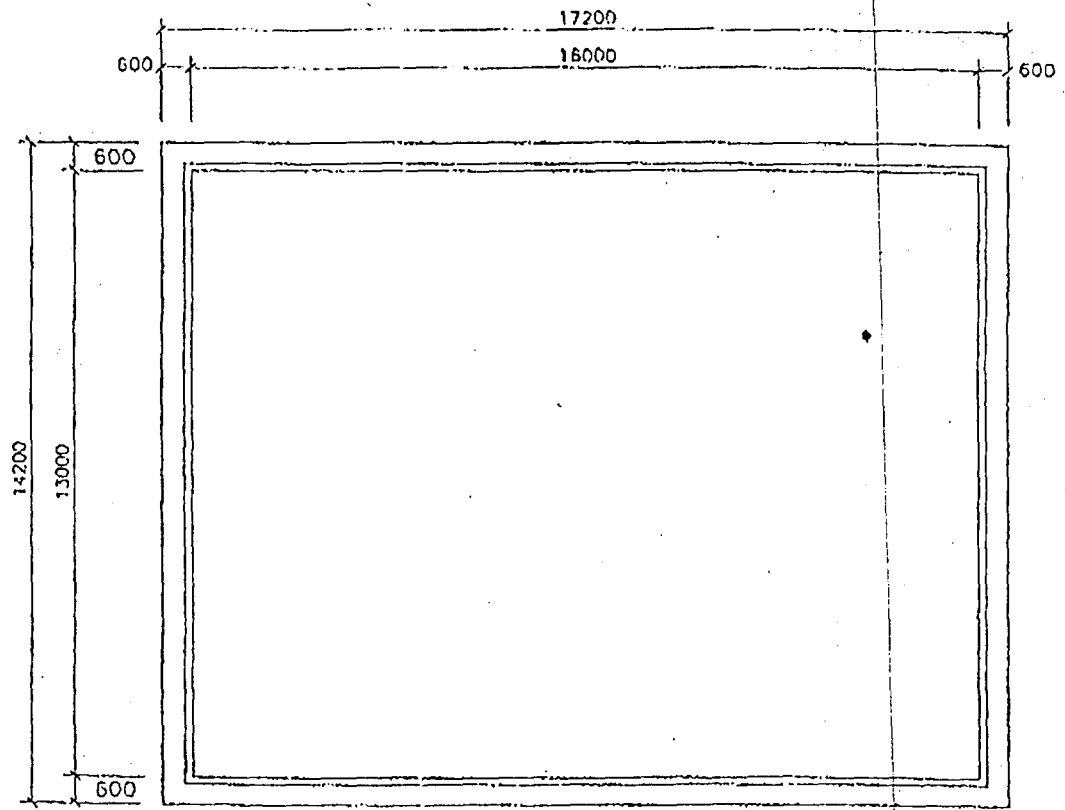
DATUM = MFL OF LAKE = 0
 AV.GL = 850

ALL DIMENSIONS / LEVELS ARE IN mm.
 SIZES OF UNITS IN m.

PROJECT	UNIDO SPONSORED PDU-97/305P
TITLE	FLOW DIAGRAM FOR PKL, KANNIVAKAM
CONSULTANTS	THE SOLUTIONS CENTRE, XLIV/1566 COCHIN - 682 017, INDIA
SCALE	
DRG.No.	58/103



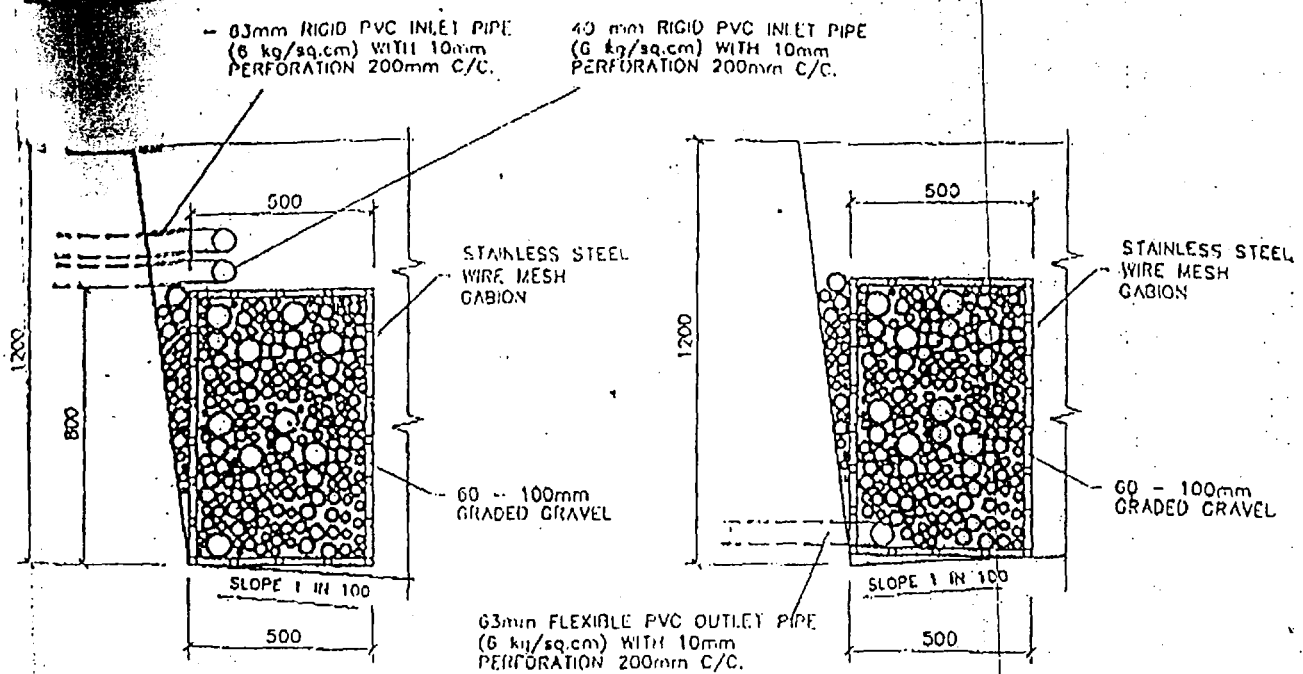
ELEVATION



PLAN

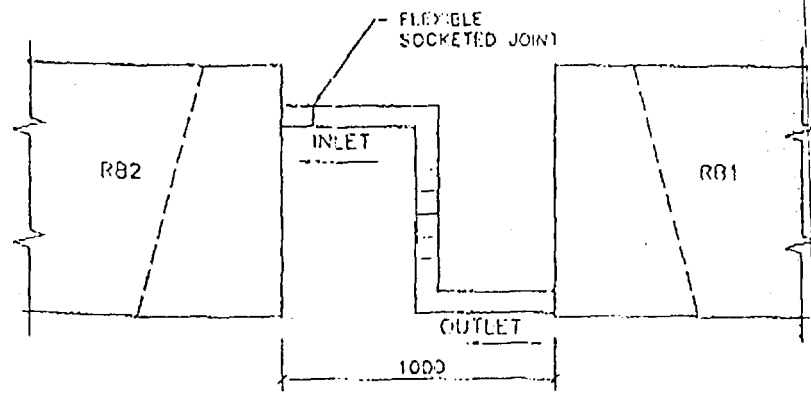
ALL DIMENSIONS ARE IN mm.

PROJECT	UNIDO SPONSORED PDU-97/305P
TITLE	DETAILS OF TYP. RB FOR PK1, KANNIVAKAM
CONSULTANTS	THE SOLUTIONS CENTRE, XLIV/1566 COCHIN - 682 017, INDIA.
SCALE	1 : 150
DRG.No.	58/104A



INLET DETAILS

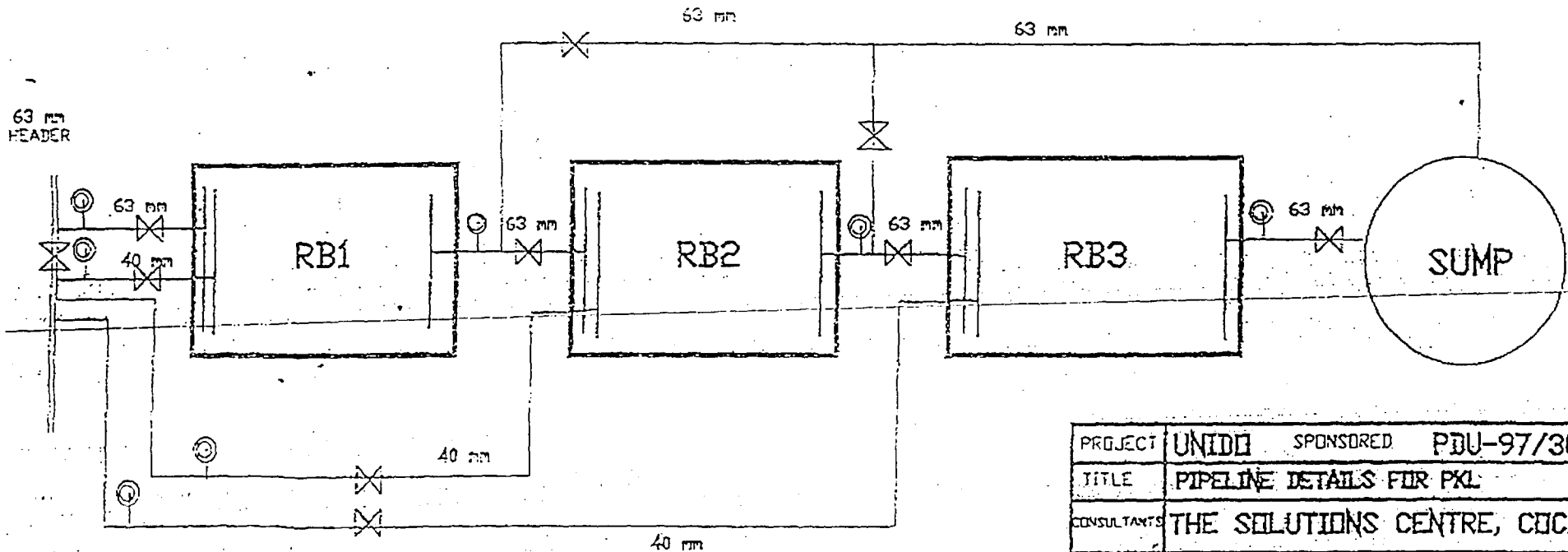
OUTLET DETAILS



TYPICAL PIPE CONNECTION BETWEEN REED BEDS

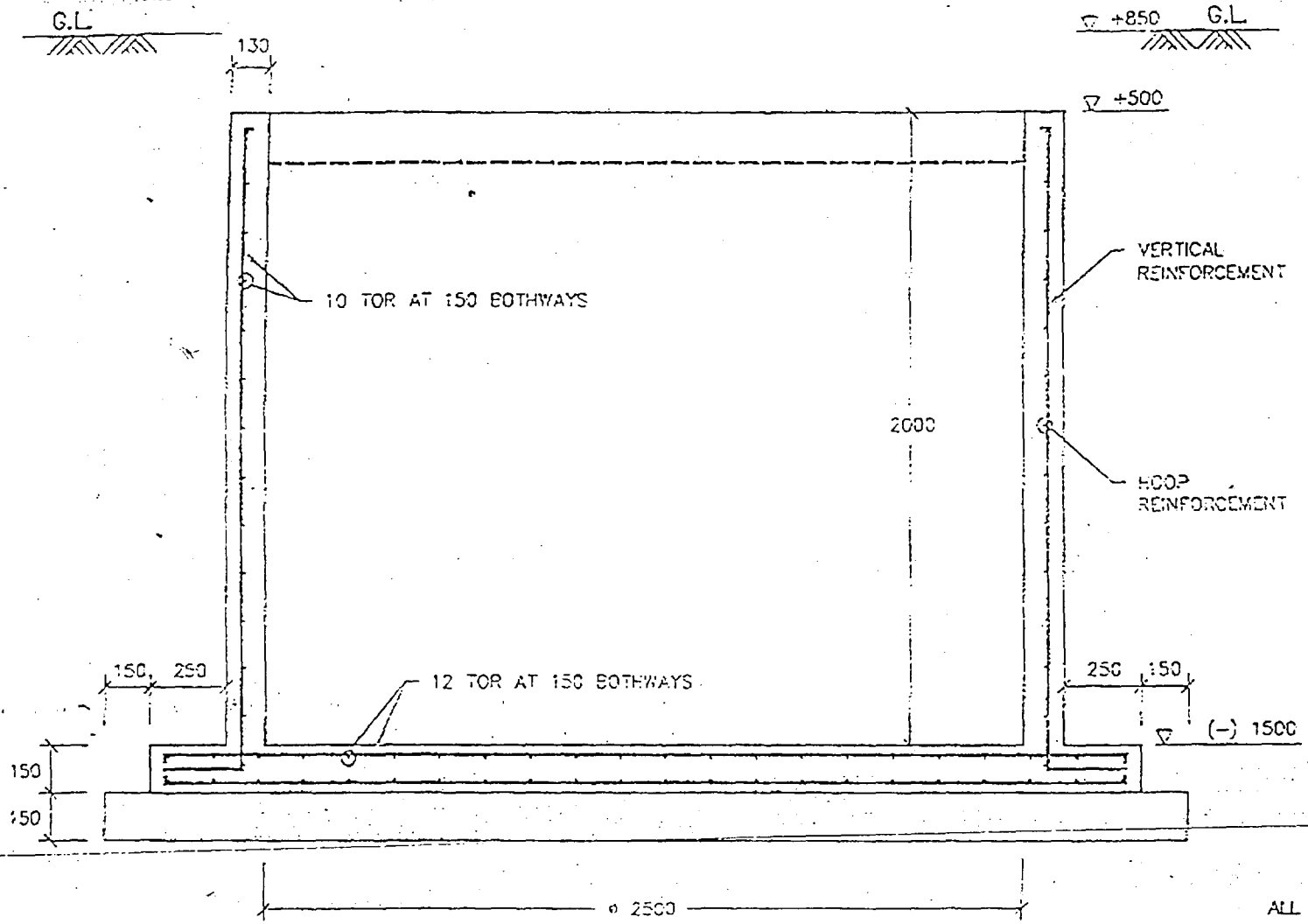
ALL DIMENSIONS ARE IN mm.

PROJECT	UNIDO SPONSORED. PDU-97/305P
TITLE	DETAILS OF TYP. RB FOR PKL, KANNIVAKAM
CONSULTANTS	THE SOLUTIONS CENTRE, XLIV/1566 COCHIN - 682 017, INDIA.
SCALE	
DWG.No.	58/104B



—X— VALVE ⊙ FLOW METER

PROJECT	UNIDE	SPONSORED	PDU-97/305P
TITLE	PIPELINE DETAILS FOR PKL		
CONSULTANTS	THE SOLUTIONS CENTRE, COCHIN		
SCALE	N.T.S.		
DRG.No.	58/105		

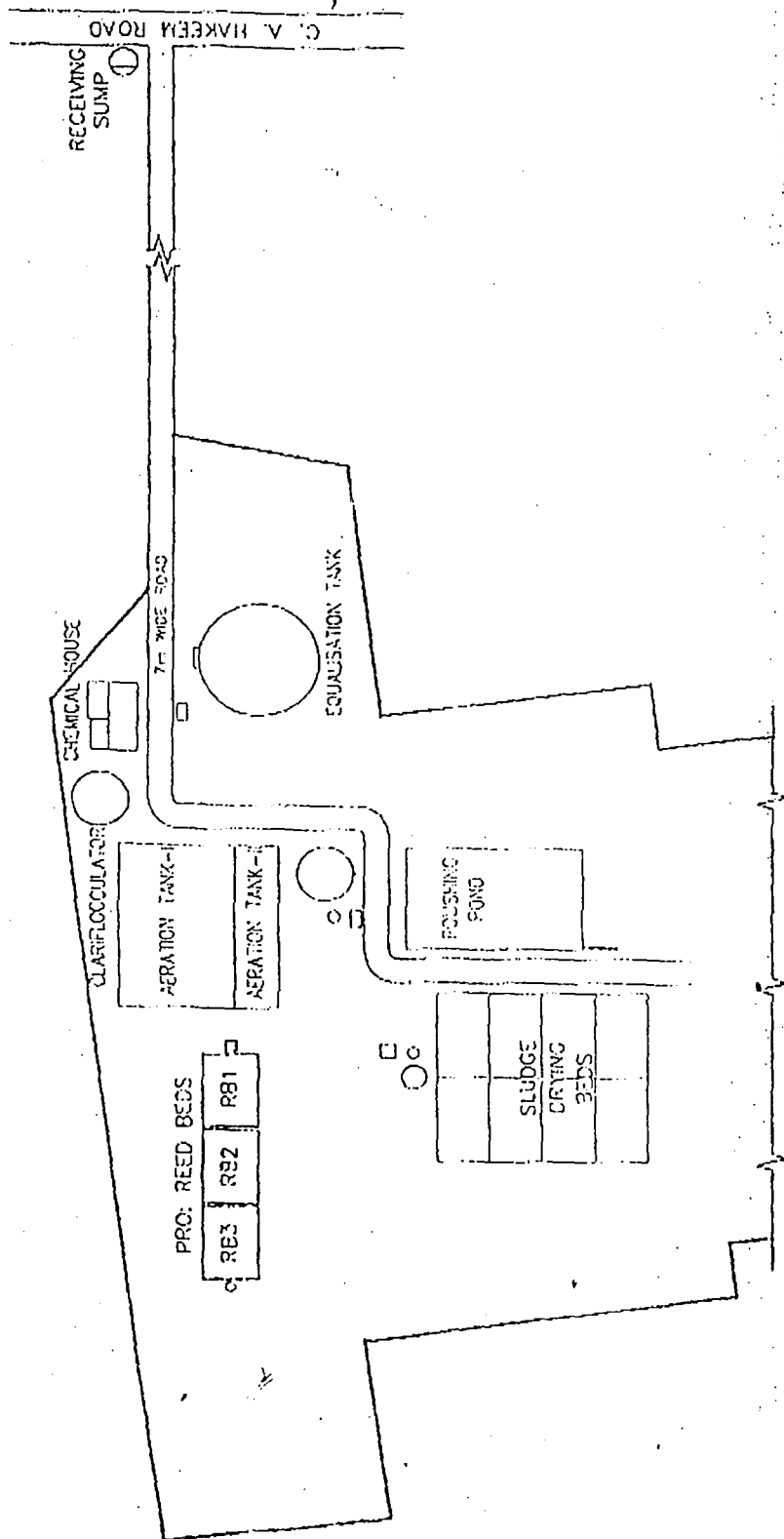


ALL DIMENSIONS ARE IN mm.

CIRCULAR SUMP TANK

PROJECT	UNIDO SPONSORED PDU-97/305P
TITLE	STRUCTURAL DETAILS FOR PKL, KANNIYAKAM
CONSULTANTS	THE SOLUTIONS CENTRE, XLIV/1566 COCHIN - 682 017, INDIA.
SCALE	1 : 25
DWG.No.	58/106

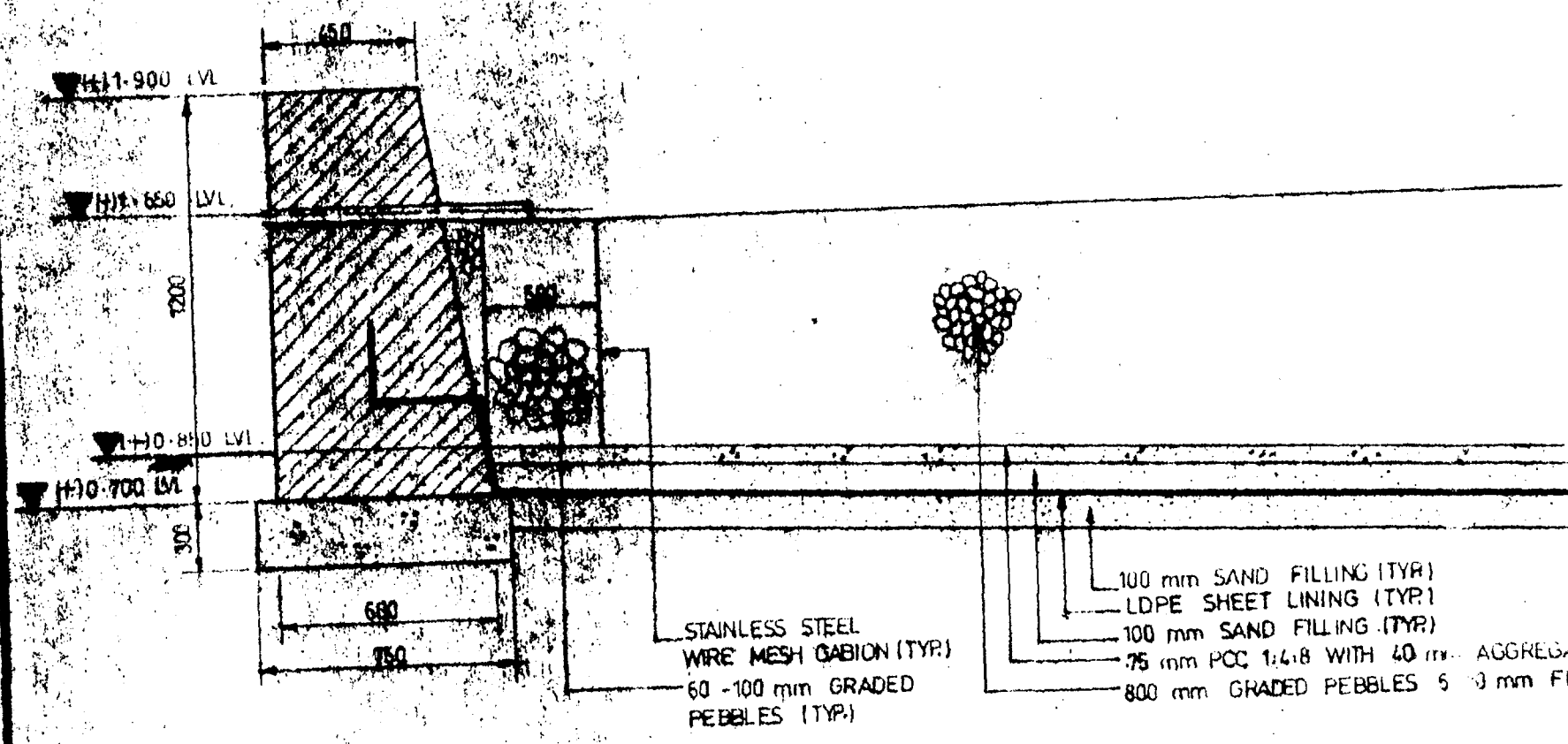
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100



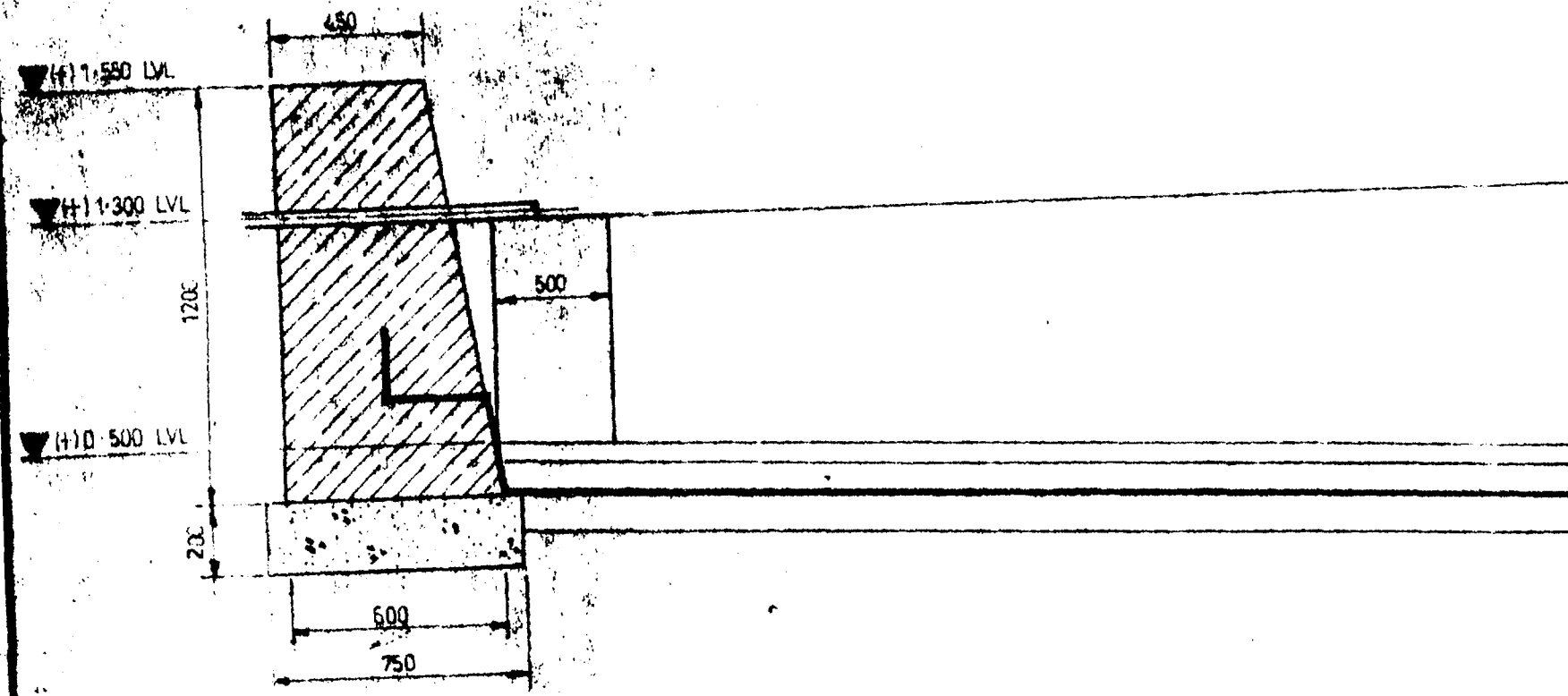
ALL DIMENSIONS / LEVELS /
 SIZES OF UNITS ARE IN M.

PROJECT	UNIDO SPONSORED PDU-97/305P
TITLE	GENERAL LAYOUT FOR VISHTEC CETP
CONSULTANTS	THE SOLUTIONS CENTRE, XLIV/1566 COCHIN - 682 017, INDIA
SCALE	1:200
DWG. No.	58/201

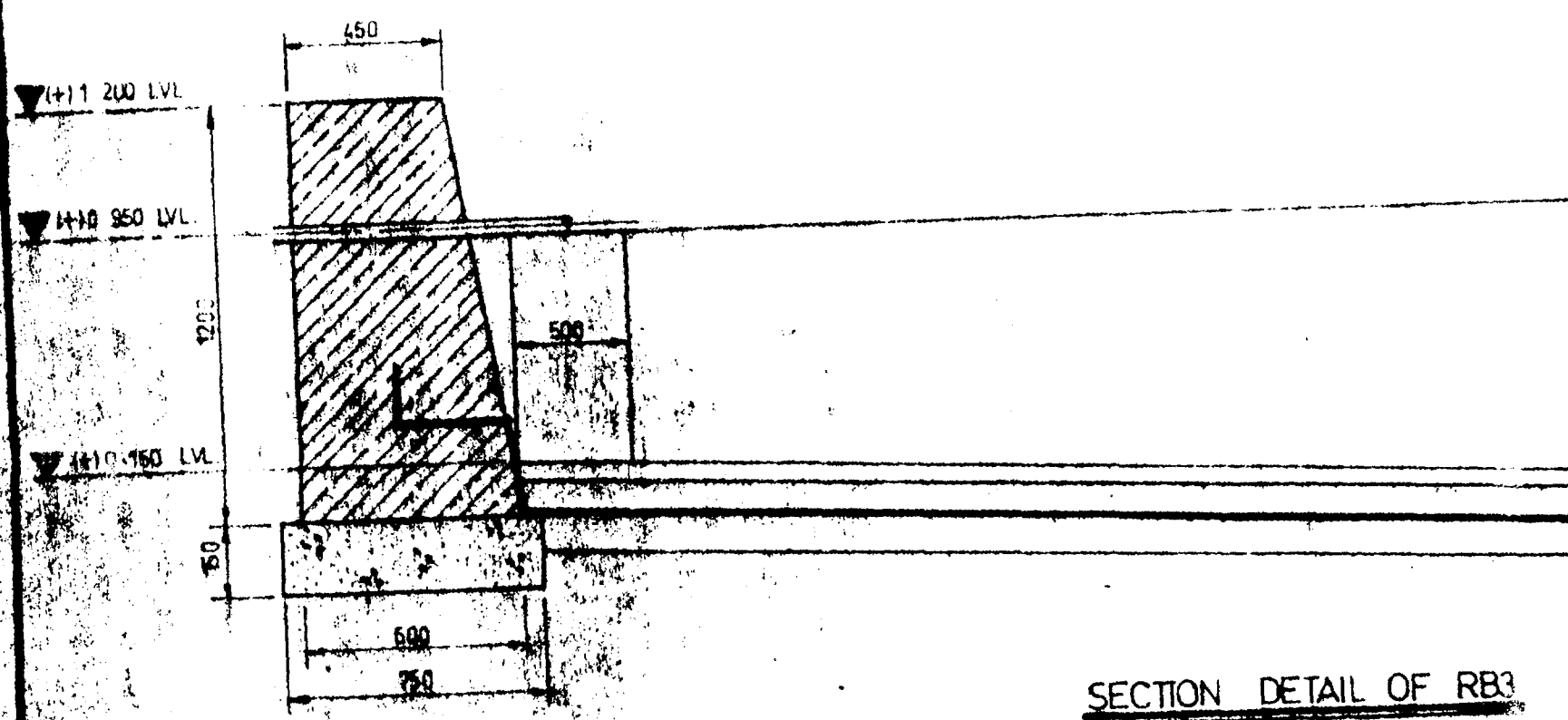
A SECTION 1



SECTION DETAIL OF RB1

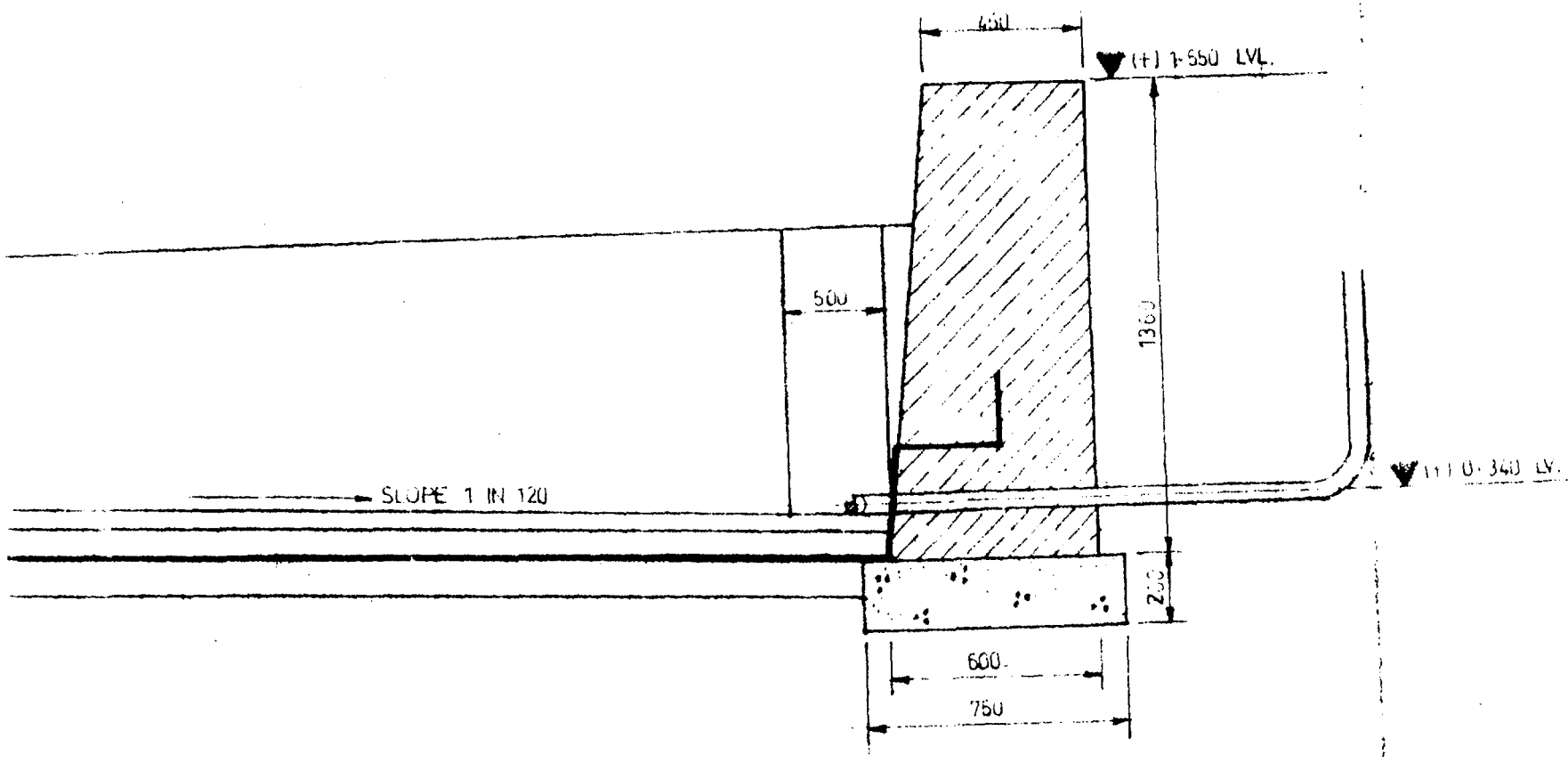
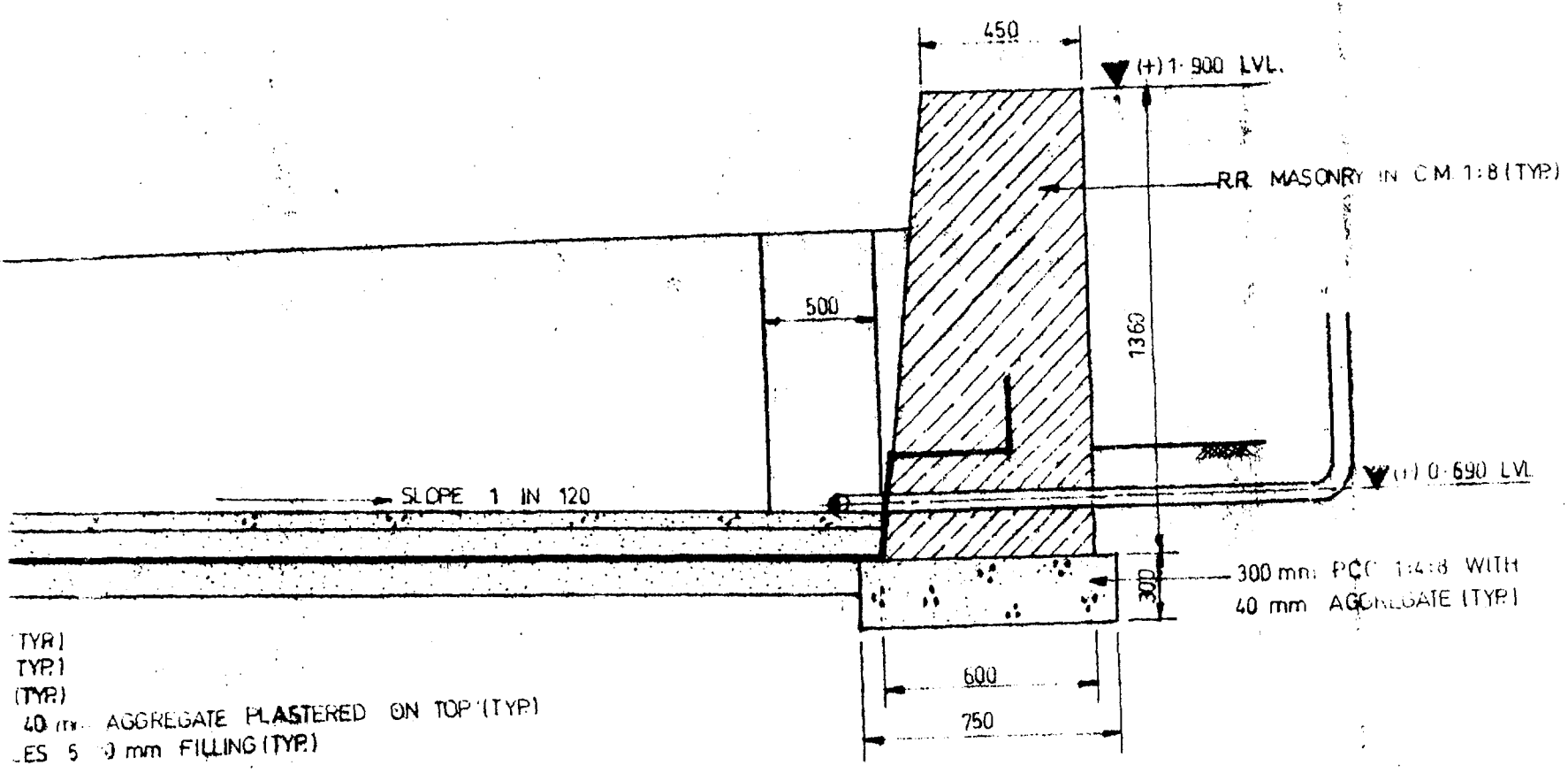


SECTION DETAIL OF RB2

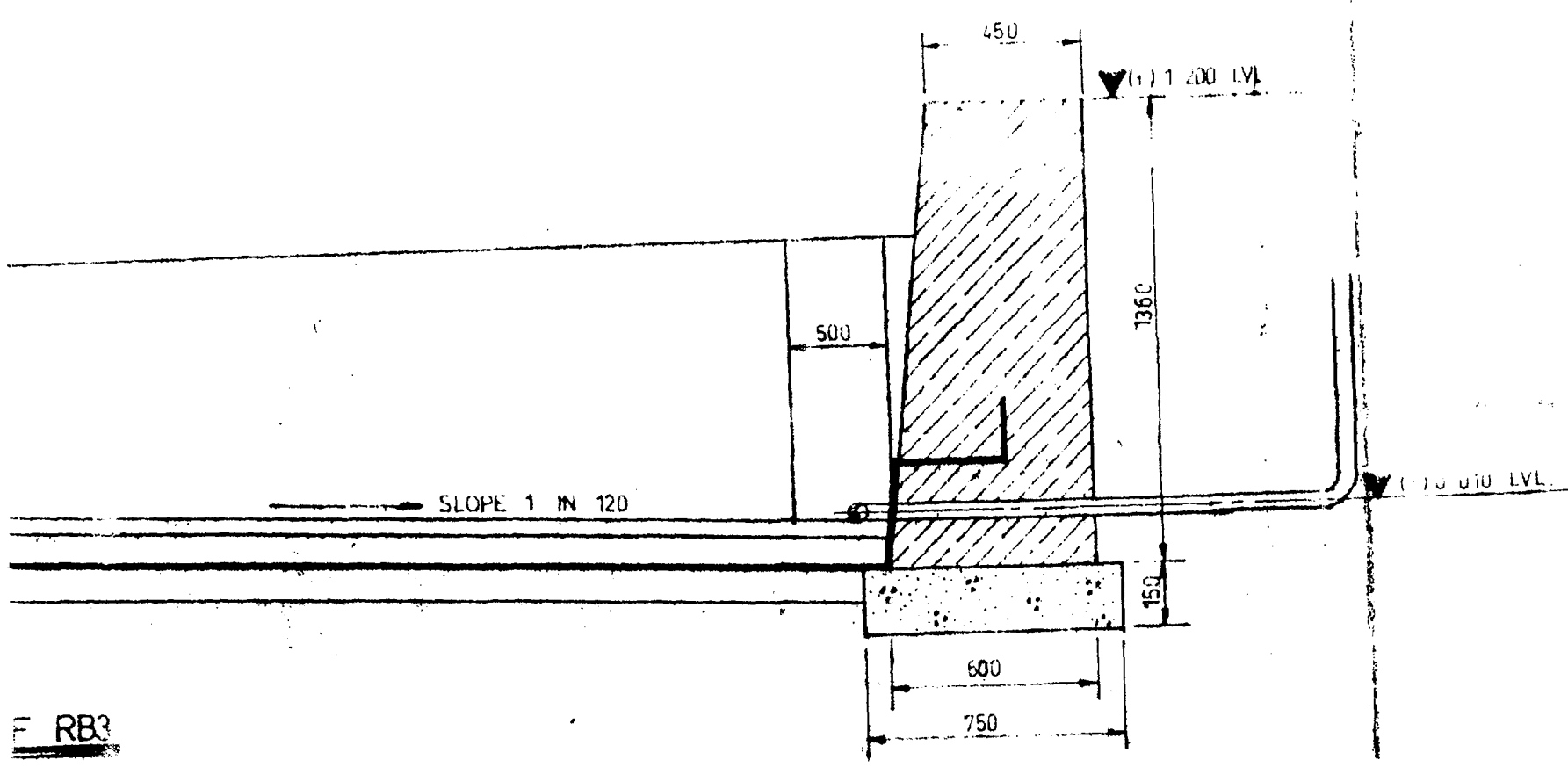


SECTION DETAIL OF RB3

(A) SECTION (2)



RB2



RB3

(A) SECTION (3)

NOTES

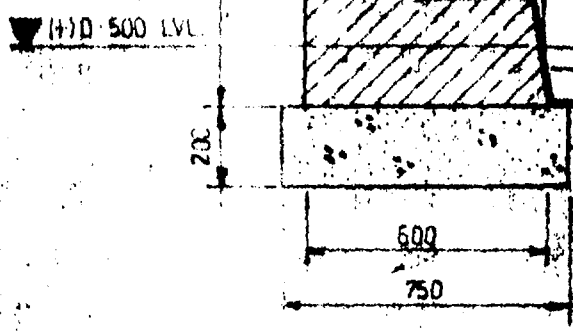
1. ALL DIMENSIONS ARE IN MM & ALL LEVELS ARE IN METERS.
2. CONCRETE GRADE M20
3. STEEL GRADE S. 415.
4. THIS DRG. SHOULD BE READ IN CONJUNCTION WITH DRG. NO. UN/7AM/037/001 (SHEET 1 OF 2)

UNIDO

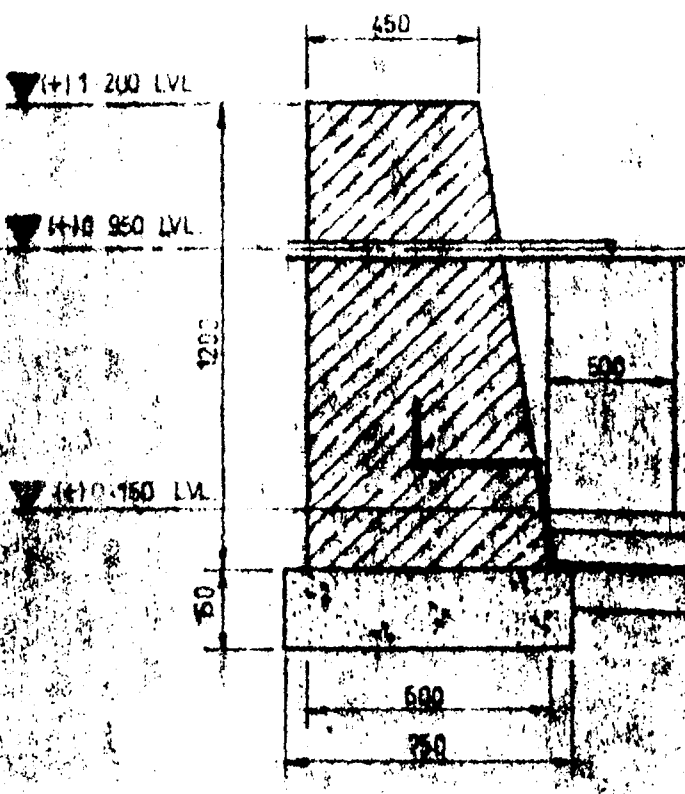
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

REGIONAL PROGRAMME FOR POLLUTION CONTROL
IN THE TANNING INDUSTRY IN SOUTH-EAST ASIA

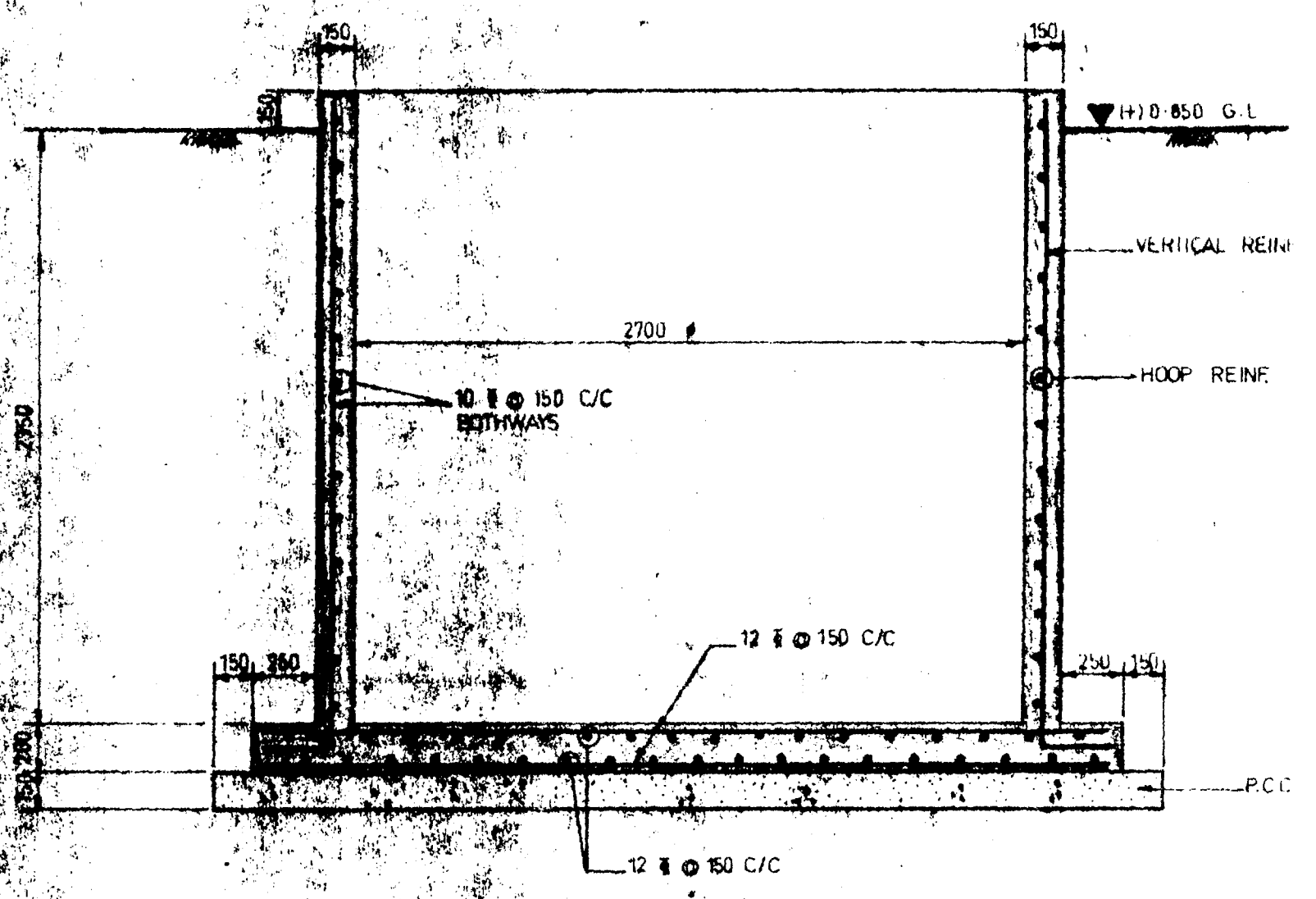
TNPCB BLDG., 1 FLOOR, 100, ANNA SALAI, GUINER, CHENNAI - 600 032, INDIA



SECTION DETAIL OF RB2

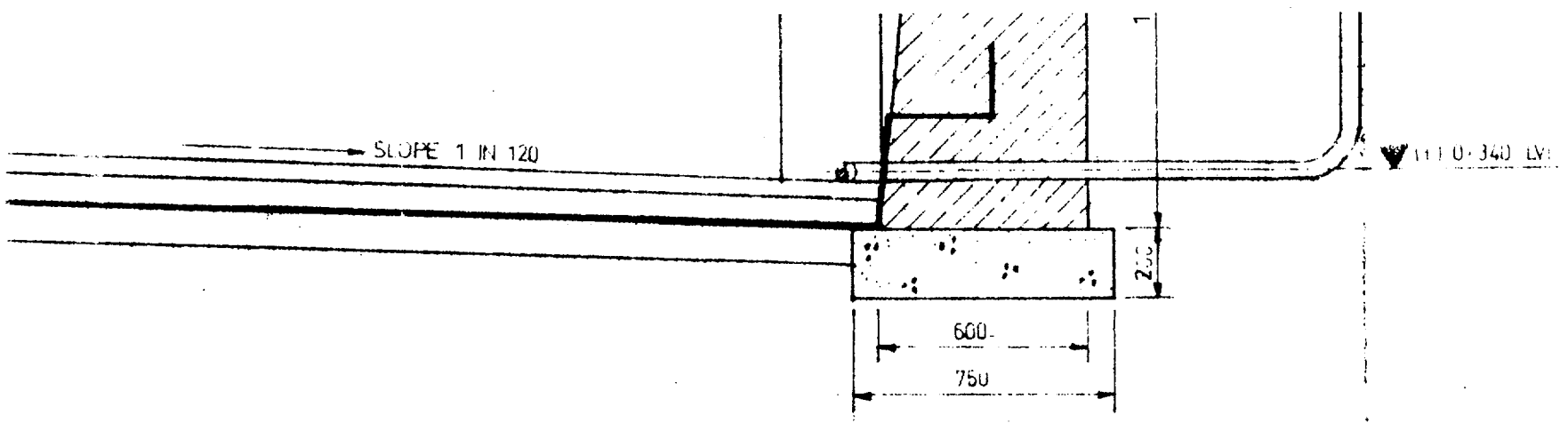


SECTION DETAIL OF RB3

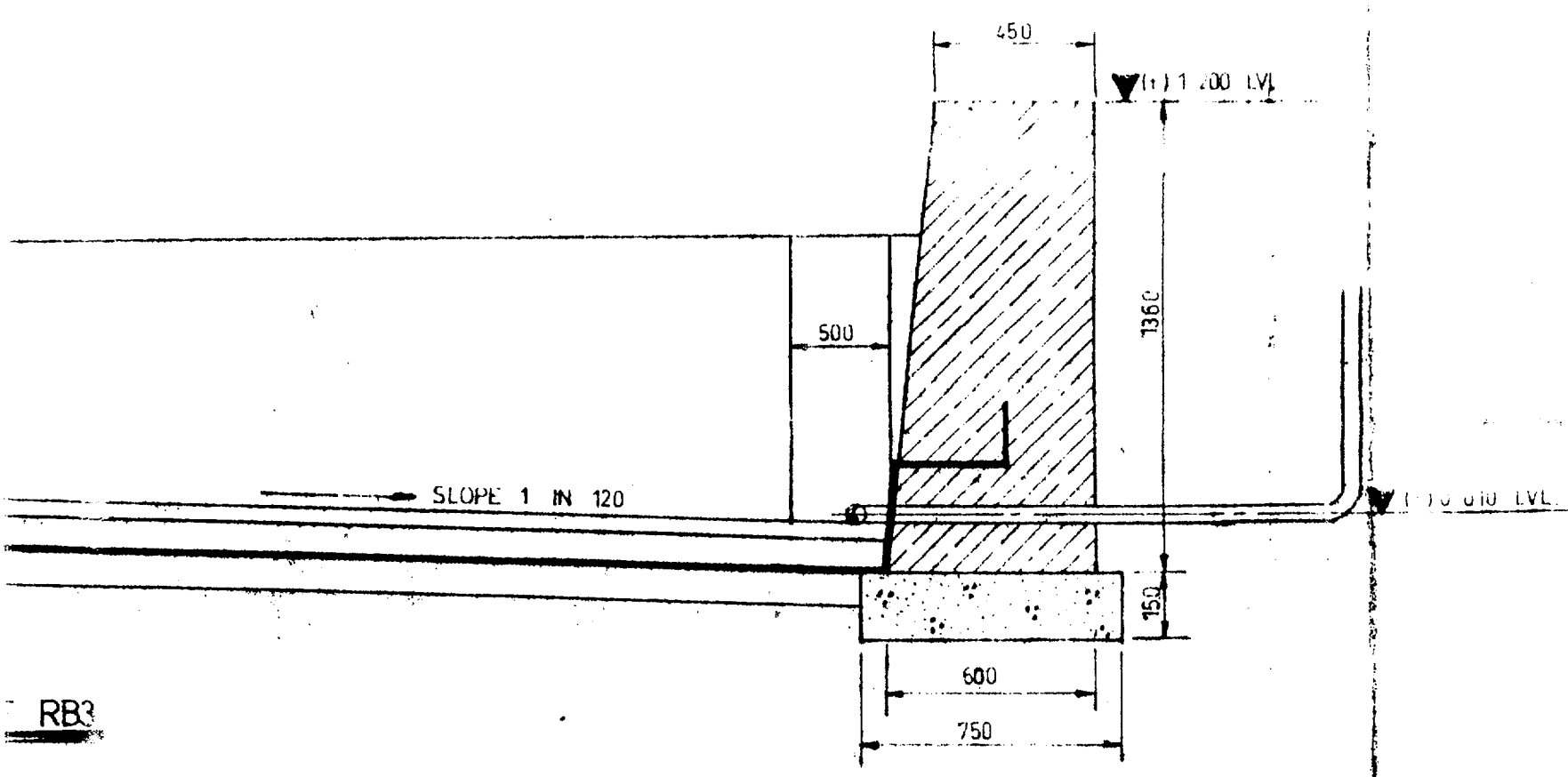


SECTION DETAIL OF SUMP

(A) SECTION 4



RB2



RB3

S.L

REIN

EINF

P.C.C

(A) section (5)

UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

REGIONAL PROGRAMME FOR POLLUTION CONTROL
IN THE TANNING INDUSTRY IN SOUTH-EAST ASIA

TNPCB BLDG., 1 FLOOR, 100, ANNA SALAI, CHENNAI - 600 032, INDIA

PROJECT

REED BEDS FOR PRESIDENCY KID LEATHERS
ETP AT KANNIVAKAM

TITLE

SECTION DETAILS OF REED BEDS &
SUMP

DRN : B. MANJULA

SCALE : 1:20

DATE : 12-8-98

CHK

APPD :

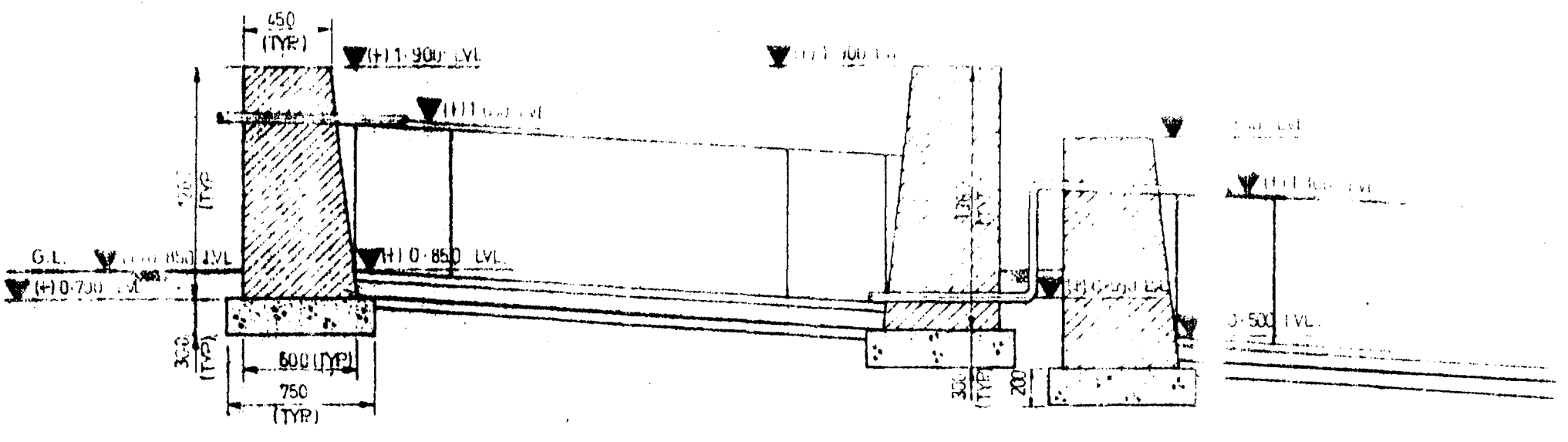
REV

DRG. NO : UNO / TAM / 037 / 001

SHEET 1 OF 1

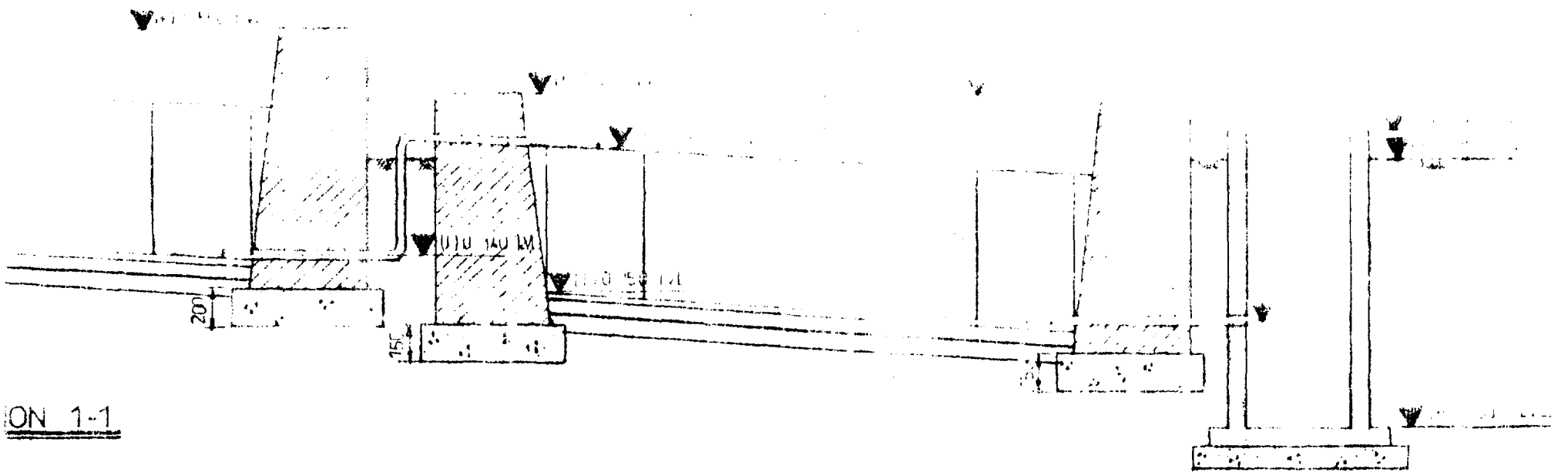
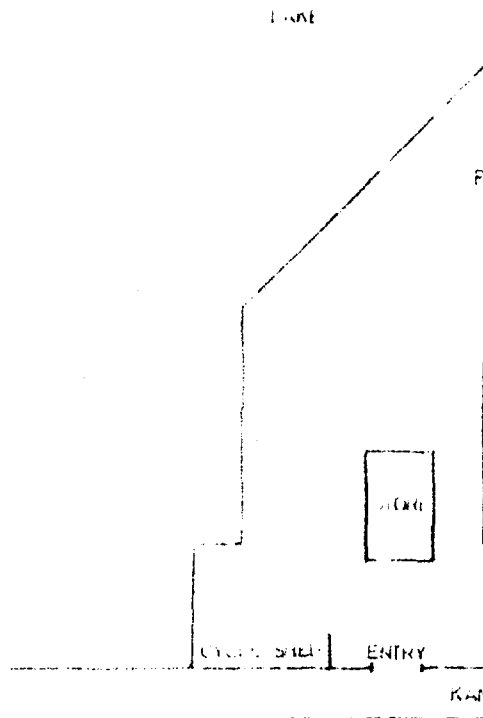
(A) SECTION (6)

Ⓑ SECTION ①



SECTION 1-

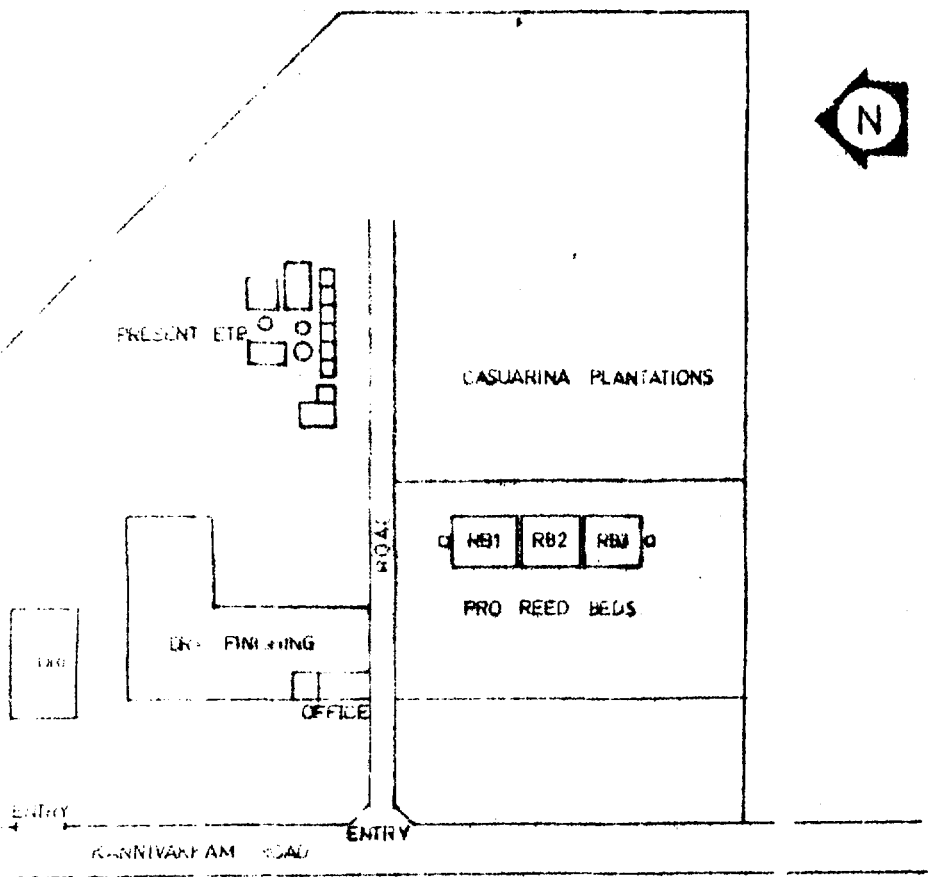
ⓑ SECTION 2



SECTION 1-1

450 1500 16300 450 1000 350 100 150

(B) SECTION (3)



KEY PLAN

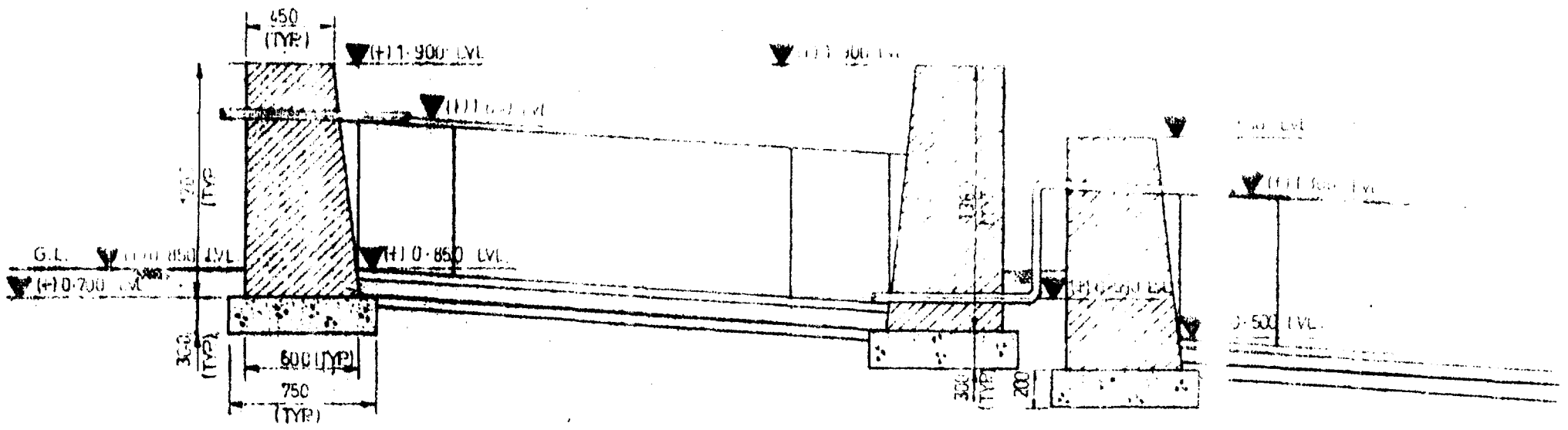
NOTES

1. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METERS.
2. THIS DRS SHOULD BE READ IN CONJUNCTION WITH DRG NO. UN/TA/17/001 (SHEET 2 OF 2)
3. FOR SYSTEM SIMILAR DRG. REF. DRG. NO. 187/001

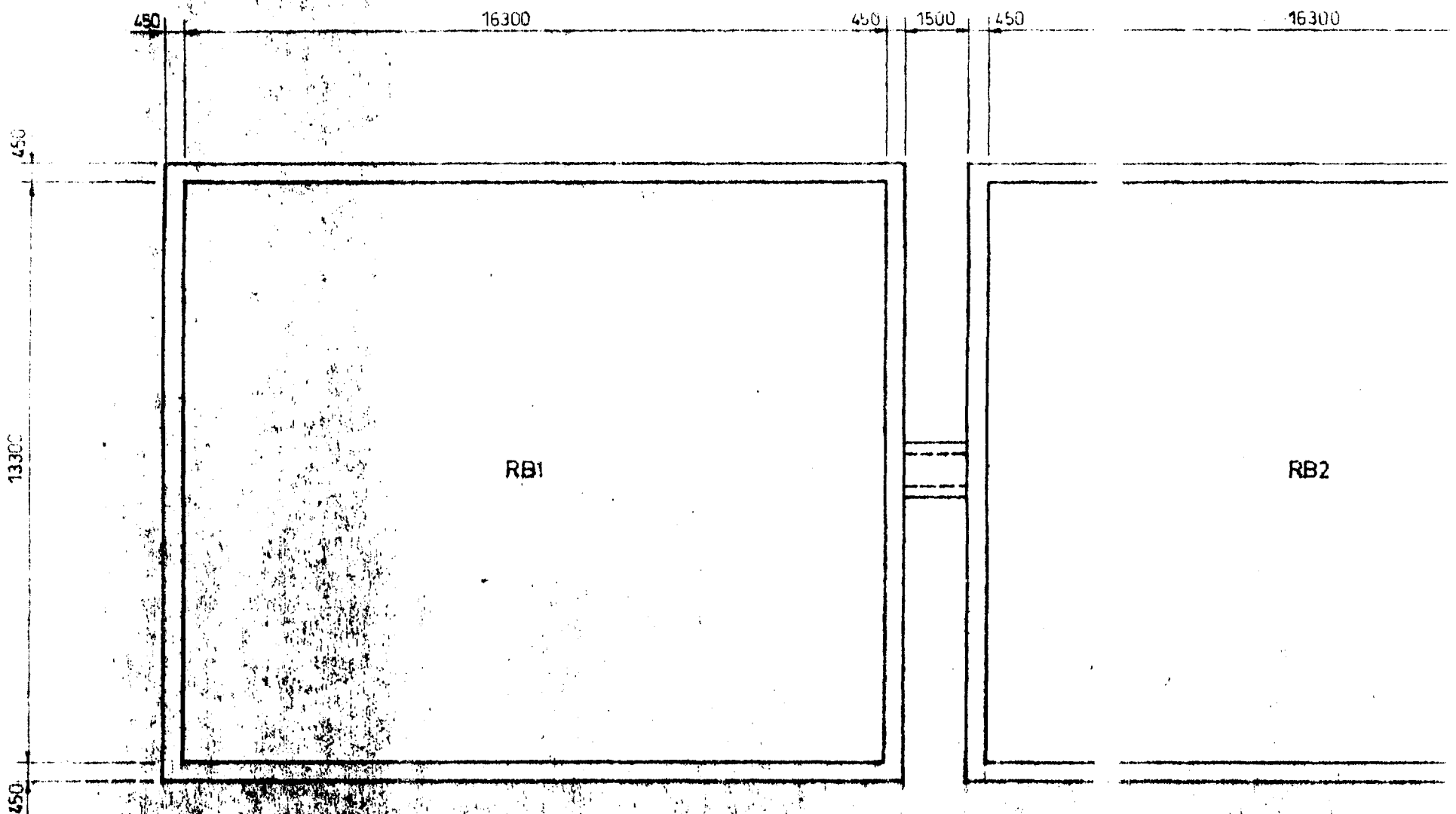
UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

REGIONAL PROGRAMME FOR POLLUTION CONTROL
IN THE TANNING INDUSTRY IN SOUTH-EAST ASIA

TNPCC BLDG., 1 FLOOR, 100, ANNA SALAI, GUNDOY, CHENNAI - 600 002

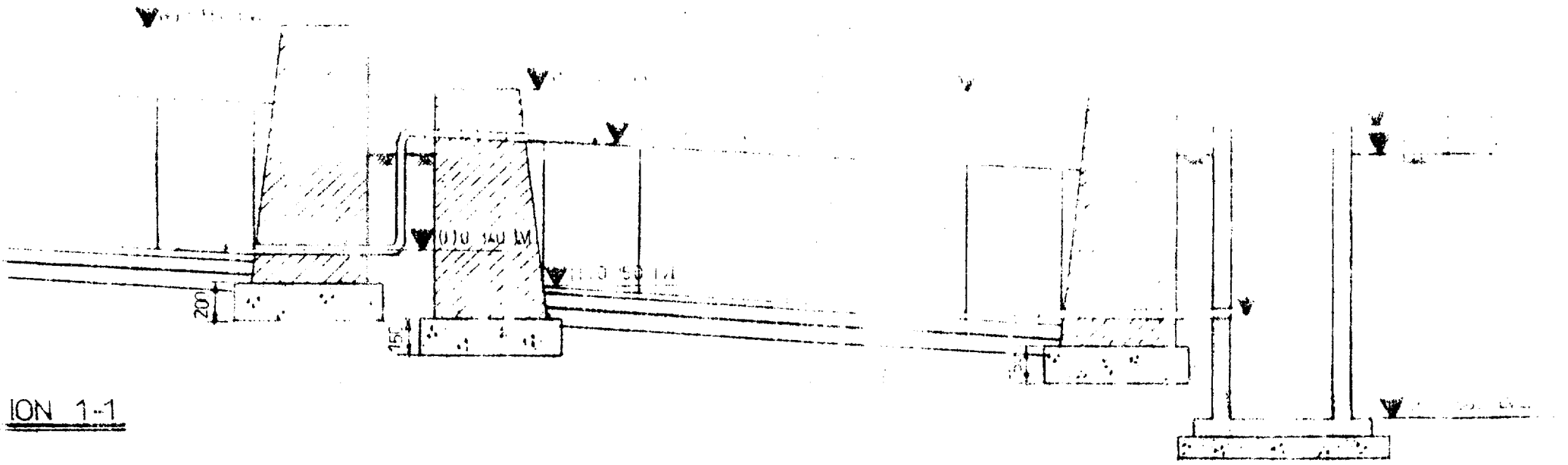


SECTION 1-

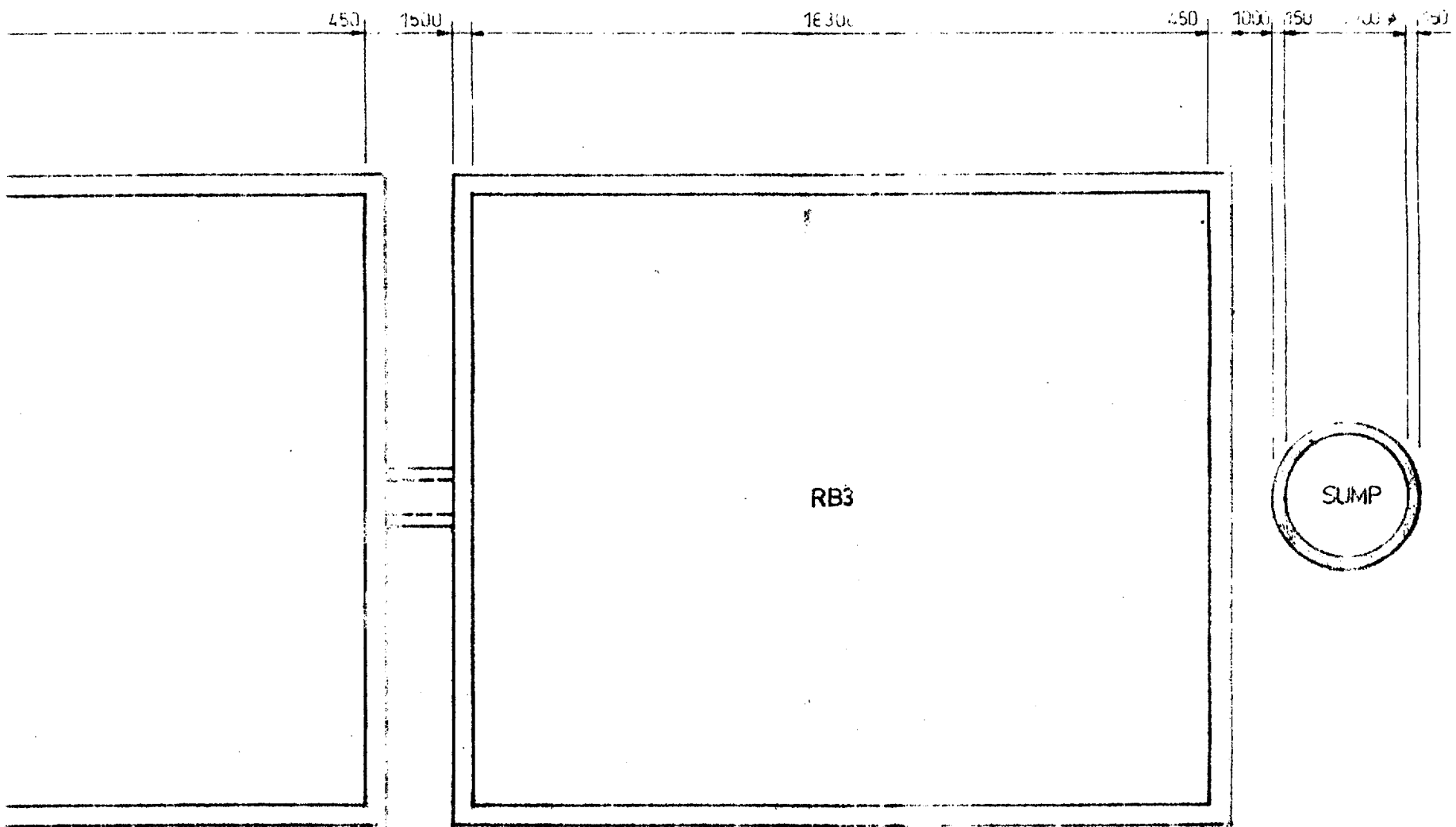


PLAN

ⓑ SECTION 4



ION 1-1



PLAN

(B) SECTION (J)

UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

REGIONAL PROGRAMME FOR POLLUTION CONTROL
IN THE TANNING INDUSTRY IN SOUTH-EAST ASIA

TNPCC BLDG., 1 FLOOR, 100, ANNA SALAI, GUNDOY, CHENNAI - 600 002

PROJECT

REED BEDS FOR PRESIDENCY KID LEATHERS
ETP AT KANNIVAKAM

TITLE

GENERAL ARRANGEMENT OF REED
BEDS AND SUMP

DRN : S. MANJ.R.

DATE : 12-8-98

APPD.

DRG. NO : UM/TAM/037/00

(B) section (6)