Technology Mission on Drinking Water in Villages & Related Water Management

WATER TECHNOLOGY LABORATORY

TECHNOLOGY MISSION ON DRINKING WATER IN VILLAGES AND RELATED WATER MANAGEMENT

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INTRODUCTION

There has been a growing concern to protect the environment and rural water supply and sanitation are one of the most recent strategies advocated for achieving development. As a step to this, Government of India has launched Technology Mission on Drinking Water in villages and Related Water Management. The primary objective of the Mission is to improve the performance and cost effectiveness of the on-going programmes in the field of rural drinking water supply so as to ensure the availability of an adequate quantity of drinking water of acceptable quality and to ensure availability of such water on long term basis.

NEERI has been closely associated in this task of national importance by assisting and guiding the executive agencies of State Public Health Engineering Department and local bodies by providing necessary technological support. Some of the important technologies for solving drinking water quality problems are (i) Defluoridation, (ii) Iron Removal, (iii) Pot Chlorination for Disinfection (iv) Slow Sand Filtration and (v) Guinea worm control.

Water Quality Assessment has been considered as an essential step in identifying exact nature of water quality problems. Various states have enacted acts for prevention, abatement and control of Water Pollution, by stipulating the maximum acceptable concentrations of specified impurities in drinking water. Such developments in the field of water quality presupposes need for systematic analysis of water. Various State Governments as well as Municipal Corporations, Municipalities and other, local bodies will be setting up laboratories for water analysis. As a forerunner for water quality assessment, it is of paramount importance to collect the samples in a methodical way and preserve them carefully for analysis. In addition other components of analytical systems such as requisite apparatus, instrumentation and laboratory facilities are to be provided adequately to attain required accuracy. Water requires a wide range of different types of analysis and is likely to involve extensive movement of samples between different parts of a laboratory. The design of laboratories for water analysis therefore need special consideration. Planning the spatial distribution of different analytical facilities within a laboratory on functional basis is quite necessary. Laboratories are to be established keeping in view therefore all these requirements.

Skilled manpower to carry out water analysis is yet another important factor. Information on type of personnel required would go a long way for setting up the laboratory. Laboratory with adequate facilities is essential for inspection and evaluation of the suitability of water supplies as well as for controlling the water treatment processes. Lack of information on equipment, chemicals and methods of water analysis are some of the constraints for assessing water quality. Since this basic information about infrastructural facility is necessary for carrying out water analysis for assessing the quality, it was thought desirable to bring out a publication to provide guidelines for setting up a small laboratory. It is hoped that it meets the desired purpose.

BUILDING & LAYOUT

The site plan, sections and elevations, ground floor plan of a typical Water Technology Mission Laboratory are shown in Drawing No.1 to 3. The land requirement considering the present need and future expansion programme is about 11,700 m^2. Initially, it has laboratories for chemical analysis (2 Nos) microbiology, biology, engineering, instrumentation and administrative blocks. The normal size of laboratory and of administrative rooms are about 56 m^2 and 27 m^2 respectively. The total covered area is about 920 m^2. The facilities of cold room and BOD room have also been provided.

The furniture layout with respect to laboratory tables, racks, almirahs, fume chambers and sink are given in Drawing No.4. The details of drawings of furniture are given in Drawing No.5. Figure 1 to 8 shows the various laboratories of a typical water technology laboratory.

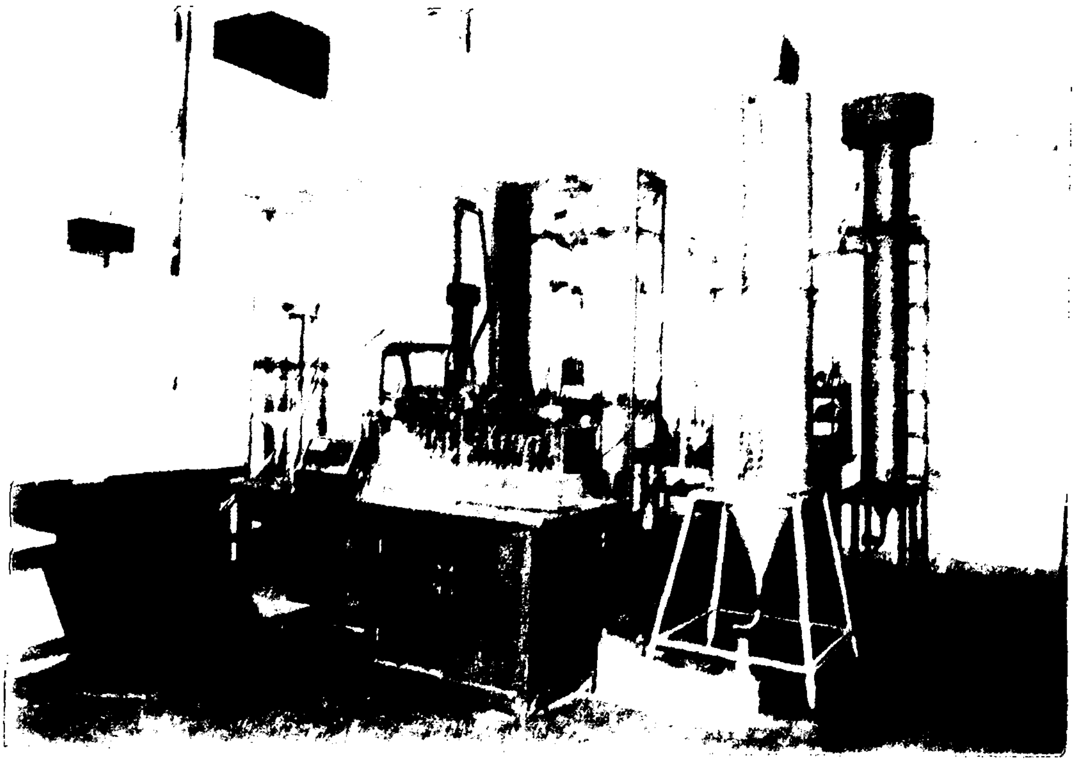
SAMPLE COLLECTION AND PRESERVATION

INTRODUCTION

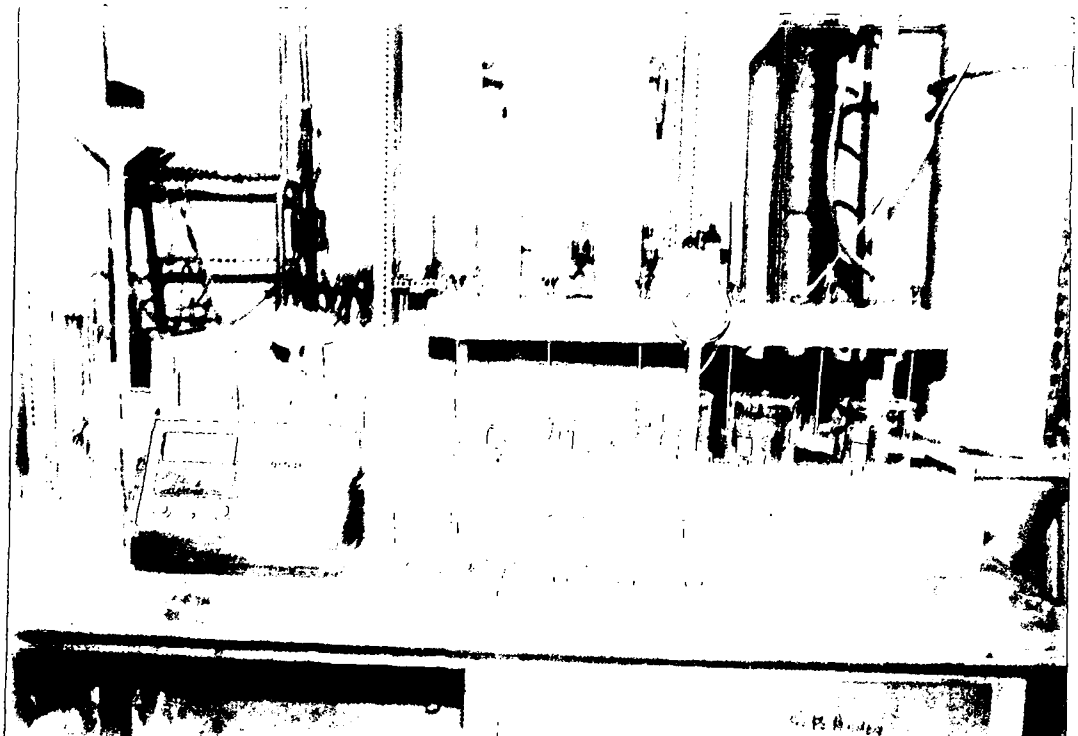
The collection of water samples may seem a relatively simple task. However, to obtain representative water sample and to preserve their integrity until they are analysed in the laboratory requires a series of steps, procedures and practices. If the liquid is of relatively uniform composition in both time and space then any sample should suffice and there is no problem. Howerver, if its composition varies with time or is not uniform at place where it is decided to take the sample then no single sample will be truly representative. In such cases a decision has to be taken of either (i) taking and analysing a number of samples or (ii) taking a number of sub-samples, combining them suitably to form one composite sample and analysing that.

The objective of the sampling is to collect a portion of material small enough in volume to be conveniently transported to and handled in the laboratory while still accurately representing the material being sampled. This implies, firstly, that the relative portions of the concentrations of all pertinent components must be the same in the sample as in the material being sampled and secondly, that the sample must be handled in such a way that no significant changes in composition occur before the tests are performed. The analysis is generally intended to reveal the composition of the waters at the time or over the period of sampling. Consequently, errors are introduced if changes take place between taking of the sample and analysis being carried out. There is infact a strong likelihood that such changes will occur in most of the waters. The arrangements should be such that these are prevented or at least minimised.

Water is a dynamic system. During sampling the water is removed from its natural environment. Due to this change the chemical composition of water may not remain same but may tend to adjust itself according to its

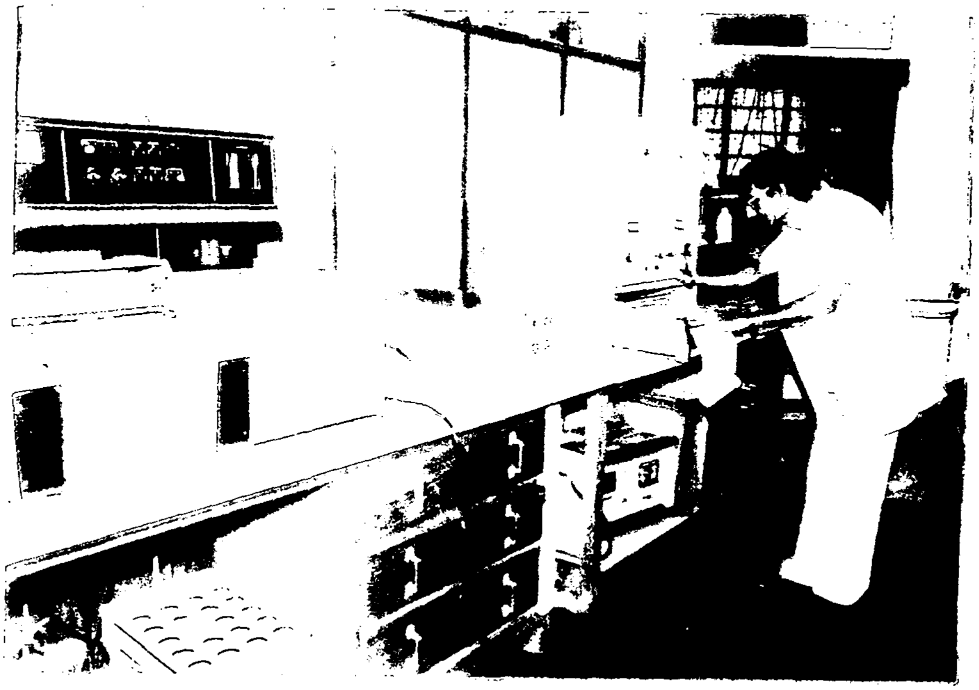


Settling Column and Tubular Filters

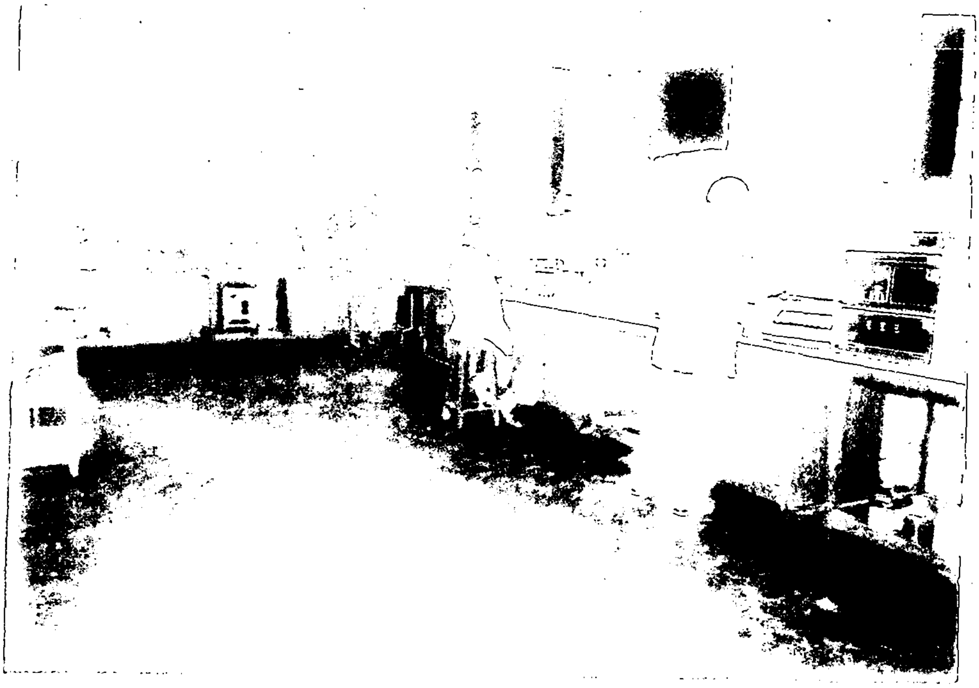


Jar Test Apparatus and Turbidimeter

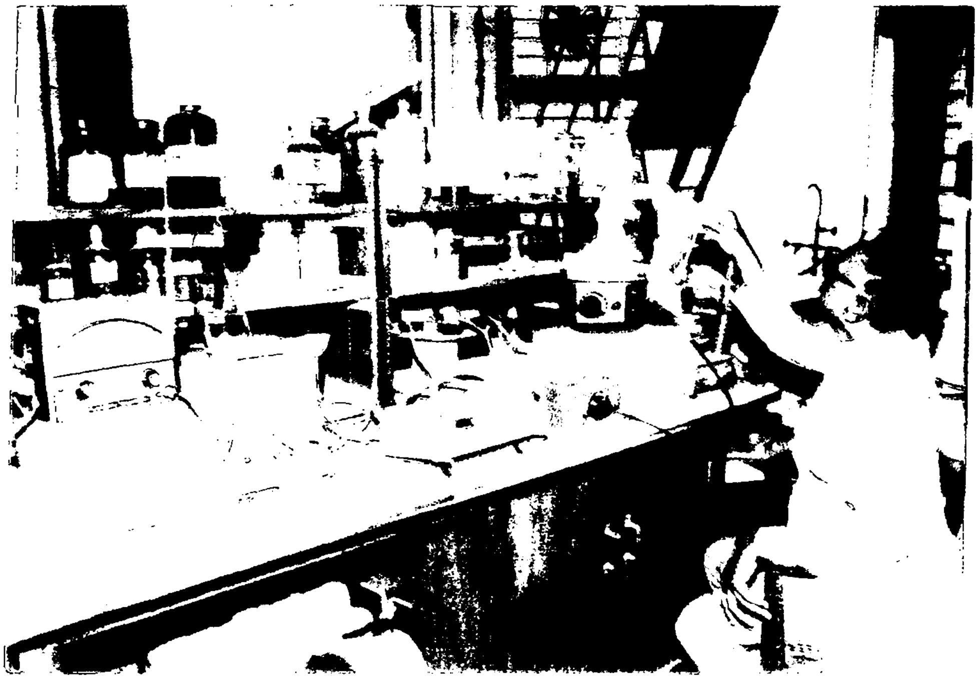
SOPHISTICATED ANALYTICAL INSTRUMENTS



A Total Organic Carbon Analyzers

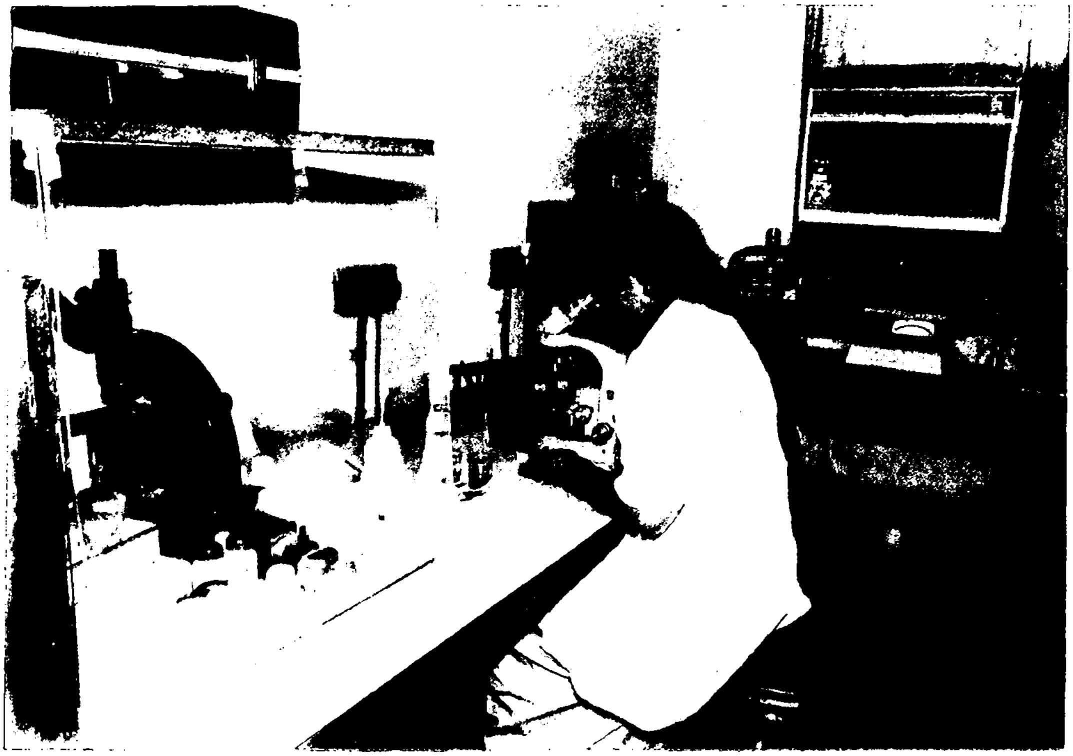


Gas Chromatographs, High Pressure Liquid Chromatograph
and Ion Chromatograph



Fluoride Distillation and Estimation

Separation of Pesticides Extract



Microscopic Studies of Organisms

View of Library

ew environment. Constituents of the water sample may interect with the surface wall of the container and consequently their concentration may be altered. This is particularly true when samples contain metals. Cases of adsorption of metals on the container surfaces as well as leaching of metals into water samples, have been observed. These considerations, therefore, are to be taken into account while undertaking sampling programme.

PLANNING OF SAMPLING

The monitoring of water quality to give reliable and usable data requires that analytical and other resources are employed to the best advantage. The first step in the planning of water monitoring is to decide what data is needed and how it is useful. The type of investigation, purpose of study and anticipated variations are other points to be considered. The first stage of planning of the sampling programme is the selection of the most suitable site to provide the required data.

SITE SELECTION

The objectives of water quality monitoring system are (1) to assess the impact of activities by man upon the quality of water and its suitability to required uses, (2) to determine the quality of water in its natural state which might be available to meet the future needs and (3) to keep under observations the sources and path way of specified hazardous substances. The first objective is met by establishment of impact stations, the second by base line stations and third by either impact or base line stations depending upon whether the hazardous substance is of artificial or natural origin.

The selection of sampling site is decided by the various uses of the water and by their location, relative magnitude and importance. The chances of accidental pollution are also an important factor and should be considered. The location of a river use down stream of a large urban of industrial area, imposes greater risk and requires more supervision than similar uses located upstreams.

SITE LOCATION FOR RIVER

The sampling sites of a river passing through a major city are given below :

Select Site

1. Immediately down stream of an international boundary.
2. At a place of abstraction for public supply of larger town.
3. In an important fishing, recreation and amenity zone.
4. At a place of abstration for large scale agricultural irrigation.
5. At a fresh water tidal limit of major river.
6. At a place of abstraction for large industrial supply.
7. Down stream of industrial effluent discharges and important tributary influencing main river.
8. Base line station where it is available in natural state.

Site Location for Lake :

A partially enclosed body of fresh water surrounded by land is called lake. Only four sampling sites are normally sufficient for monitoring.

Select Site

1. At a place where principle feeder tributary meets the lake.
2. At a central place of the lake. The sample from this site gives the general water quality of the lake.
3. At a place wherefrom water is pumped for water supply for major city.
4. At a place wherefrom water is discharged from the lake.

Site Location for ground waters

For the selection of sites for underground water, it will be necessary to obtain hydrological information. The first step will be choice of acquifer and its relative importance will be assessed from its total yield, the population served, its value to industry and agriculture and the magnitude of threats to its water quality. The assembled information about the acquifer should describe its hydrological characteristics regarding the location, depth and area of the aquifer and its geological and mineralogical characteristics. Water levels, hydraulic gradients, transmissivity and velocity and direction of water movements should also be known. Background information will be needed on existing and potential influence on water quality.

The larger and more uniform the acquifer the more representative will be the sample from a single location. The choice of station will usually be restricted to existing abstraction points or springs. It may, be decided to insure the cost of drilling new boreholes to provide information on the quality of water of a potential new source.

It is unlikely that ground water containing any of the specified dangerous substances will be withdrawn for use. Where wastes containing any of these substances have been used for recharge or where the natural geochemistry suggests their possible presence the water should be examined for these substances.

TYPE OF SAMPLES

1. **Grab or Catch samples** : A sample collected at a particular time and place can represent only the composition of the source at that time and place. However, when a source is known to be fairly constant in composition over a considerable period of time or over a substantial distances in all direction, then the sample may be said to represent a larger time period or larger volume or both, than the specific

point at which it was collected. In such circumstances same source may be quite will represented by single grab samples collected at suitable intervals can be of great value in documenting the extent, frequency and duration of these variations. In case the composition of a source varies in space rather than in time, a set of samples collected from appropriate locations with less emphasis on timing may provide the most useful information.

2. **Composite Samples** : The term composite refers to a mixture of grab samples collected at the same sampling point at different times. Sometime the term time composite is used when it is necessary to distinguish this type of sample from others. Time composite samples are most useful for observing average concentrations, as an alternative to the separate analysis of a large number of samples, followed by computation of average and total results. A composite sample of 24 hr. period is considered standard for most determinations. Composite samples can not be used for determinations of components or characteristics subject to significant and unavoidable changes on storage.

3. **Integrated samples** : Mixture of grab samples collected from different points simultaneously or as nearly as possible is called integrated sample. Such samples are useful for river or stream that varies in composition across its width and depth. The need for integrated samples may also exist if combined treatement is proposed for several separate waste water stream. The preparation of integrated samples require special equipment to collect samples from a known depth, without contamination by overlying water. Prior knowledge about volume, movement and composition of the various parts of the water sampled is also required.

SAMPLING FREQUENCY

The quality of water in various water bodies is subjected to change.

Water samples could be collected at intervals so that no change in quality could pass unnoticed. While there may be some relationship between the rate of change of different determinants other alter independently. The larger the number of samples from which the mean is derived, the narrower will be the limits of the probable difference between observed and the true values. However, the sampling schedule is a compromise between accuracy and the funds and personnel available for the work.

NUMBER OF SAMPLES

Number of samples and how oftem should samples be collected, are calculated by statistical considerations.

The confidence level of an arithmatic mean of normal distributed value is the percentage of occasions (p%) on which the true mean may be expected to lie with a given range of values. This range is known as the confidence interval and is bounded by the confidence limits. A 95% confidence limit of ± 10 implies that on 95 occasions out of 100 the observed mean will not differ from the true mean by more than 10.

Mathematically

$$P\% = X \pm L$$

$$\text{and } L = \frac{kS}{\sqrt{N}}$$

Where X = mean concentration
N = Number of normally distributed samples
S = Standard deviations
K = A factor depending on P

Values of K may be obtained from Table 1.

Table 1 : Values of K for given confidence levels

Confidence level of	99	98	95	90	80	68	50
K	2.58	2.33	1.96	1.64	1.28	1.00	0.67

There is general agreement that when the number of samples that can be handled is strictly limited it is preferable to reduce the number of sampling site rather than to curtail the frequency of sampling. It is advisable to obtain reliable results from one station than dubious data from two. The following frequencies of sampling may be adopted provisionally.

a) Weekly samples for one year.
b) Daily samples for days consecutively (4 times/year)
c) Round the hour sampling for 24 hours.
d) 4-hourly samples for 7 days - and 4 times/year.

The parameters may be limited during these samplings but should be pertinant to the source/sampling station.

The analytical data collected as per the above procedure will help to have proper emphasis on parameters of relative importance; their ranges, interferences, and frequencies of their occurence. This is applicable to rivers, lakes and industrial effluent outfall also.

SAMPLING FACILITIES

There are many sampling facilities, however, their availability depends on local circumstances. They have their own merits and demerits, depending on sampling site. Some of the sampling facilities commonly used are bankside, boats, bridges, cable ways and helicopter.

SAMPLING CONTAINERS, WASHING & PREPARATION

It is advantageous to measure the quantity of water in situ by means of sensors which is lowered into position rather than by withdrawing samples. However, it is not always possible. Water samples are, therefore, collected in suitable containers. A sample container must satisfy the following requirements.

1. It could easily be freed from contamination.
2. It should not change the relevant water characteristics on contact.
3. It should have adequate capacity for storing the samples.
4. It should be resistant to impact and to internal pressure which is increasing by expansion of water or by release of dissolved gases at elevated temperature on storage.

The samples bottle may be made of either glass or plastic usually polyethylene. It must be capable of being tightly sealed either by stopper or cap. The bottles should be soaked with 10% HCL for 24 hours and then thoroughly cleaned and rinsed with distilled water. The specific situation will determine the use of borosilicate glass bottles or polyethylene bottles. Rinse with chromic acid solution followed by tap water and distilled water and then invert them to dry. For metals analysis, rinse the bottles with 20 per cent nitric acid followed by distilled water and for phosphorus analysis, rinse the bottles with 50% hydrochloric acid followed by distilled water.

GENERAL PROCEDURE FOR SAMPLING AND PRESERVATION OF SAMPLES

The determinants for water quality monitoring may be classified as (1) conservative which does not change with time (2) Non-conservative which changes with time but can be stabilised for atleast 24 hours by appropriate treatment and (3) Non- conservative which changes rapidly with time and cannot be stabilised. The first two groups can be measured by taking representative samples for subsequent analysis in a laboratory. The third group including temperature, pH and dissolved oxygen, need to be measured in the field immediately after sampling.

The sampling may be carried out either manually or automatically using appropriate samplers. The simplest manual sampling is carried out by a plastic bucket or stainless steel jar fastened by a rope. However, this method has got a drawback that the sample is taken from the surface and undue proportion of floating matters is also collected. An alternative is to immerse the sample bottle directly in the water. Sample from various depths may be collected by using any of the sampler described elsewhere. A wide range of indigenous automatic sampling equipment are also available for taking sample mechanically at fixed intervals or continuously. Any sampling techniques may be used, however, adaption of a particular technique depends upon what is being analysed and what constituents are to be determined.

SAMPLE COLLECTION

Wherever possible the container should be rinsed out two or three times with the sample to be examined before being finally filled. If this cannot be done the container should be drained. The stopper should not be laid down, but kept in hand before it is reinserted. Unless it is absolutely unavoidable, no funnel or jug should be used in filling the container, and the container should be so held that the water does not come in contact with hand before entering.

In taking a sample from a tap or pump, the nozzle should be examined to see that it appears clean. If not, it should be cleaned and water should be allowed to run to waste before filling the bottles, unless it is desired to ascertain whether the water is affected by standing in the main or pump pipe. If such is the case it is better to take the sample first in the early morning before anyone has drawn for other purposes.

In taking samples from spring and rivulets, it is often necessary to make excavation sufficiently large to hold hand and bottle and allow sufficient time for all matter disturbed to be washed away before taking the samples. Where the sample must be taken by immersing the bottle, as in ponds, reserviors, lakes, rivers and many wells, it is generally quite satisfactory if any container is weighted sunk rapidly to the required depth.

Complete information on the source and conditions under which the sample was collected has to be provided. Attach a record tag to the sample by noting sample number, source of sample analysis required, temperature at which sample collected of person taking the sample. The tag should be signed, time recorded and dated by the person taking the sample.

Field analysis :

A number of parameters including pH, alkalinity, conductivity, dissolved oxygen, ammonia, carbondioxide, temperature, turbidity and residual chlorine should be measured at the sampling site immediately after collection of sample.

PRESERVATION & HANDLING :

Between the time that a sample is collected in the field and until it is actually analysed in the laboratory, physical changes and chemical and biochemical reactions, may take place in the sample container which will affect the intrinsic quality of the sample. It is necessary, therefore, to preserve the samples before shipping to prevent or minimize their changes. This is done by various procedure such as keeping the samples in the dark, adding chemical preservatives, lowering the temperature to retard reactions by freezing or by a combination of these methods.

The physico chemical determinands of interest are :

Nutrient Group : Kjeldahl-N, ammonia-N, nitrate-N, nitrite-N, ortho and total phosphate,

Metal Group : Arsenic, chromium, mercury, sodium, copper, iron, zinc, manganese calcium, magnesium, potassium, aluminium, cadmium, barium, and lead

Dissolved gaseous Group	:	Dissolved oxygen and carbon dioxide; free or combined residual chlorine unionised, hydrogen sulphide
Physical & Mineral Group	:	Temperature, specific conductance, Turbidity, pH, acidity, alkalinity, chlorides, sulfide, sulphate, silica, cyanide, total solid, suspended solid, and dissolved solids.
Organic Group	:	TOC, COD, BOD, Oil & Grease, phenol, organochlorine compounds, poly cyclic aromatic hydrocarbon, PCBs and chlorophenoxy.

Nutrient Group :

Collect two samples 5 litre and 0.5 litre in separate containers. Use HCl rinsed borosilicate glass bottle (dark coloured bottle should be avoided) or polyethelene container for the 5 litre sample. Add in the first sample 40 mg/l $HgCl_2$ as preservative for surface and mildly polluted waters. Refrigerate sample at 4°C (If refrigeration facilities are not available, store in ice box containing salt-ice mixture). It should be ensured that solid ice always remains.

SAMPLE REQUIREMENTS & MODE OF PRESERVATIONS :

A. **Metals :-**

Determinand - (total)	Sample ml	Container	Preservative	Max. holding time
Arsenic	250	HNO_3 rinsed bsgb or pec.	2 ml of 6 N HNO_3 to pH below 2	6 months
Calcium Sodium Potassium	500	- do -	4 ml of 6 N HNO_3 to pH below 2	- do -

Determinand - (total)	Sample ml	Container	Preservative	Max. holding time
Chromium (VI)	200	- do -	Refrigeration at 4°C	24 hours*
Mercury	250	- do -	2 ml/L 20% (W/V) $K_2Cr_2O_7$ solution (prepared in 1+1 HNO_3)	1 months**
Boron	100	HNO_3 rinsed pec only	Refrigeration at 4°C.	6 months
Trace metals	2000	HNO_3 rinsed bsgb or pec	16 ml of 6 N HNO_3 to pH below 2	6 months

bsgb : borosilicate glass bottle; pec; polyethylene container;
* = preferably immediately. Use unscratched container.
** = Use mercury free reagents.

Dissolved determinands :-

Filter rapidly the sample through Whatman No.42/ (membrane filter of 0.45 micron porosity and add HNO_3 to pH below 2. Analyses the filtrate within six months.

General preservation for all metals groups :

Take one 200 ml sample into a HNO_3 rinsed pec. Analyse for chromium (VI) immediately. Take a second 100 ml sample in pec for boron. A third 2500 ml sample can be acidified to pH2 with HNO_3 and refrigerated at 4°C for analysis within six months. A fourth sample is collected for Hg and preserved as recommended.

B. **Basic & Optional Determinands :**

Determinand	Recommended container	Sample Volume ml.	Preservative	Max. holding time.
Acidity	Bsgb, Pec.	100	Refrigeration at 4°C	24 hrs.
Alkalinity	- do -	200	- do -	24 hrs.
B.O.D.	- do -	1000	- do -	4 hrs.
Carbondioxide	- do -	100	analyse immediately	-
Carbon Total Organic	Glass brown pec.	100	Refrigerate or add HCl to pH 2	4 hrs.
Chlorine residual	Bsgb, Pec.	500	Analyse immediately	-
C.O.D.	- do -	100	Analyse as soon as possible, refrigeration at 4°C or add H_2SO_4 to pH_2.	24 hrs.
Cyanide	- do -	500	Add NaoH to pH 12 refrigerate	24 hrs.
Colour	- do -	500	Refrigeration at 4°C	24 hrs.
Fluoride	Pec. only	200	- do-	7 days

Determinand	Recommended container	Sample Volume	Preservative	Max. holding time.
Phosphate	Glass rinsed with 1+1 HNO_3	100	Refrigeration at 4°C add 40mg H_gCl_2/l	24 hrs.
Residues	Bsgb pec.	500	Refrigeration at 4°C	7 days
Silica	Pec.	200	- do -	7 days
Sp. Conductance	pec. only	200	- do -	24* hrs.
Sulphate	Bsgb, pec.	200	- do -	7 days
Sulphide	- do -	1000	2 ml of 1-N Zinc acetate & Refrigerate	7 days
Sulphite **	- do -	500	Refrigeration at 4°C.	24 hrs.
Taste	Glass	500	Analyse as soon as possible; refrigerate	24 hrs.
Temperature	--	--	Analyse immediately	--
Turbidity	Bsgb, Pec.	100	Refrigeration at 4°C.	24 hrs.

* Preferably immediately.

** Collect full sample bottle & cap immediately to reduce contact with atmospheric oxygen.

Determinand	Recommended container	Sample Volume	Preservative	Max. holding time.
Grease & Oil	Glass wide mouth	1000	Refrigeration at 4°C. Add 5 ml 1+1 H_2SO_4/1(H_2SO_4 to pH_2)	24 hrs.
Iodine	Bsgb, Pec	500	Analyse immediately	-
Nitrogen Ammonia	- do -	500	Analyse as soon as possible. Add 2 ml 40% H_2SO_4.	24 hrs.
Nitrate	- do -	100	Analyse as soon as possible, add 2 ml 40% H_2SO_4.	24 hrs.
Nitrite	- do -	100	Analyse as soon as possible, add 40 mg $HgCl_2$/1 and refrigerate.	24 hrs.
Odour	Glass	500	Analyse as soon as possible,refrigerate	24 hrs.
Dissolved Oxygen	Glass, BOD bottle	300	Analyse immediately or fix on site.	6 hrs.
pH	Bsgb, Pec	100	Refrigeration at 4°C	6* hrs.
Phenolics	Bsgb,	1000	Add H_3PO_4 to pH 4.0 and 1 gm $CuSO_4$/1 refrigerate.	24 hrs.

GENERAL PRESERVATION FOR PHYSICAL & MINERAL GROUP :

Collect 4 l. sample pec. bsgb and then immediately seperate the aliquot for phenolic, cyanide and sulphite and add the appropriate chemical preservative.

C. Organic determinands :-

Determinands	Sample volume ml	Recommended container	Preservative	Max. holding time
Polycyclic Aromatic Hydrocarbans	1000	bsgb	refrigerated at 4°C as soon as possible	14 days
Chlorinated hydrocarbons	2000	- do -	- do -	- do -
Polychloro-biphenyls	1000	- do -	- do -	- do -
Chlororphenoxys	1000	- do -	- do -	7 days.

SAMPLING & PRESERVATION OF SAMPLES OF ORGANIC GROUPS :

Ideally, analysis of the sample for organic groups should be conducted within a matter of hours from the time of sampling. However, this is frequently impractical in terms of distance from the sampling site to laboratory, and/or the laboratory workload. Samples being examined solely for organo-chlorine residues may be held up to a week under refrigeration at 2 to 4°C. Those intended for organo-phosphorous or carbamate analysis should be forzen immediately after sampling. These samples may be stored for the maximum period of four days. Samples for PCB's, PAH's and chlorophenoxys should also be stored below 4°C. Water samples should be collected and stored in all glass system. Glass containers must be scrupulously cleaned and rinsed with some of the solvents to be used for subsequent pesticides extraction. All bottle cap should be teflon or aluminium foiled lined to prevent contamination of the samples with the trace quantities fo impurities which may be present in laminated paper liners.

SAMPLING FOR BACTERIOLOGICAL ANALYSIS

1) Sampling bottles

Sterilized glass bottles provided with ground glass stopper having an overlapping rim should be used. The stopper and the neck of the bottle should be protected by brown paper.

2) Dechlorination of samples

Sodium thiosulphate should be added to the clean, dry sampling bottles before sterilization in an amount to provide an approximate concentration of 100 mg per litre in the sample. This can be done by adding 0.2 ml of 10 per cent thiosulphate solution to an 250 ml capacity bottle. The bottle is then stoppered and sterilized by either dry heat at 180°C for 1 hr. or steam sterilization at 2.7 kg/cm^2.pressure for 15 min.

3) Sampling procedures

The sample should be representative of the water to be tested and they should be collected with utmost care to assure that no contamination occurs at the time of collection or prior to examination. The sample bottle should not be opened till the time of filling. The stopper should be removed with care to eliminate soiling. During sampling, the stopper and the neck of the bottle should not be handed and they should be protected from contamination. The bottle should be held near the base, filled without rinsing, and the stopper replaced immediately. Then the brown paper wrapping should be tied to protect the samples from contamination.

a. **Sampling from taps** : The tap should be opened fully and the water allowed to run to waste for two to three minutes or for a sufficient time to permit clearing of the service line. The flow from the tap should then be restricted to permit filling the bottle without splashing. Leaking taps, which allow water, to flow over the outer surface of the bottle, must be avoided as sampling points. It should be ascertained whether the tap from where the sample is collected is supplying water from a service pipe directly connected with the main or with a cistern or a storage tank.

b. **Sampling direct from a source** : When the sample is to be collected directly from a stream, river, lake, reservoir, spring, or a shallow well, it should be representative of the water that will be taken for supply to the consumers. Hence a sample should not be taken from a point which is too near the bank or too far from the point of draw-off, or at a depth above or below the point of draw-off. Areas of relative stagnation in a stream should be avoided.

Samples from a river, stream, lake or a reservior can often be taken by holding the bottle in the hand near its base and plunging its neck downward, below the surface. The bottle should then be turned until the neck points slightly upwards, the mouth being directed against the current. If no current exists, as in a reservoir, a current should be artificially created by pushing the bottle horizontally forward in a direction away from the hand. If it is not possible to collect samples in this way, a weight may be attached to the base of the bottle which can then be lowered into the water. In any case, damage to the bank must be guarded against, otherwise fouling of the water can occur. Special apparatus which permits mechanical removal of the stopper of the bottle below the surface is required to collect samples from the depths of a lake or a reservoir. If the sample is to be taken from a well, fitted with a handpump, water should be pumped to waste for four to five minutes before the sample is collected. If the well is fitted with a mechanical pump, the sample should be collected from a tap on the discharge. If there is no pumping machinery the sample can be collected directly from the well by means of sterilized bottles fitted with a weight at the base. In this case, care should be taken to avoid contamination of the sample by any surface scum. Where it is not possive to collect the sample directly into the bottle as for example where there is a high bank the sample may be obtained by means of a suitable metal jug. The jug is sterilized by pouring into it a teaspoonful of methlated spirit and tilting the jug in such a way that the spirit comes in contact with the entire inner surface of the jug and igniting. The jug should be lowered into the required depth and then drawn up and down two or three times before it is brought to the surface. It should be rinsed out at least twice before the sample is taken. Should the jug come in contact with the bottom or skid along the surface so that it may have collected the surface film, the sample should be discarded, the jug resterilized and another sample drawn. The water from the jug should be poured into the bottle and the glass stopper of the bottle be replaced, care being taken to avoid the cover being caught between the stopper and the neck of the bottle.

4) Size of the sample.

The volume of the sample should be sufficient for carrying out all the tests required, and in no case, it should be less than 250 ml.

5) Preservation and Storage

Water samples should be examined immediately after collection. However, this is seldom practical and hence it is recommended that the samples should be preferably analysed within one hour after collection, and in no case this time should exceed 24 hours. After collection the samples should be carried in an ice box. Care must be taken to avoide the entry of water from the ice box into the sample bottle.

GUIDELINES FOR METHODS OF ANALYSIS

The list of common physical, chemical and bacteriological parameters and headings of their methods of analysis are given in Table 1. The procedures are described in detail in another publication entitled "Laboratory Manual on Water Analysis" published by NEERI, Nagpur under Technology Mission on Drinking Water in Villages and related Water Management. (A Technology Information Package).

Table 1. **PHYSICAL PARAMETERS**

S.No.	Parameter	Method of Analysis
1.	pH	Electrod Method
2.	Turbidity	Nephelometric Method
3.	Conductivity	Conductivity meter
4.	Dissolved Solids	Evaporation Method
	CHEMICAL PARAMETERS	
5.	Alkalinity	Potentiometric Titration Method
6.	Acidity	- do - - do -
7.	Hardness	EDTA Titrimetric Method
8.	Calcium	- do -
9.	Magnesium	- do -
10.	Sodium	Flame Photometric Method
11.	Potassium	- do - - do -
12.	Ammonia	Kjeldahl/Nesslerization Method
13.	Iron	Phenanthroline Method
14.	Manganese	Persulphate/Periodate Method
15.	Chlorides	Silver nitrate/Titrimetric Method
16.	Sulphate	Turbidimetric/Gravimetric Method
17.	Fluorides	SPADNS/Ion Selective Method
18.	Nitrates	UV Spectrophotometric Method Chromotropic Acid Method

S.No.	Parameter	Method of Analysis
19.	Phosphates	Stannous Chloride Method
20.	Silica	Heteropoly Blue Method
21.	Dissolved Oxygen	Azide Modification Method
22.	COD	Dichromate Method
23.	BOD	Dilution Method
24.	Total/Faecal Coliforms	Multiple-Tube Fermentation Technique/Membrane Filter Test.

RECORDING AND REPORTING OF DATA

The Water Technology Laboratory shall keep records of submitted samples and completed analysis in a manner that provides for the data retrievability, the sample preservation and the persons responsible for the sampling and analysis. All laboratory data sheets shall be dated and signed by the analysts and the Head of the Laboratory or his designee.

Electrical conductivity, pH, temperature, and turbidity should be recorded in units specified for the respective tests and the results of other chemical examinations shall be expressed in terms of substances or ions actually determined and reported as miligram per liter, which may be considered for all practical purposes as equivalent to parts per million (ppm).

A commonly used and functional method of recording laboratory data is a note book specifically printed for this purpose. The pages are serially numbered in pairs with a carbon between the pages to provide a matching serial numbered copy of the data. These books are permanenly bound but the duplicate page is perforated for easy removal. The duplicate page may then be filed in a system wherefrom it may be readily retrieved. The pages of the note book are generally lined in a grid pattern with provision for such information as project identification, date, reference to the analytical procedure, the observations, sample calculations as mg/L and signature of the analyst.

ANALYTICAL QUALITY CONTROL (AQC)

The basic objective of a water analysis laboratory is to produce accurate data describing the physical-chemical characteristics of water samples under study. Quality assuracne is the total program for assuring the reliability of analytical data. Items discussed in this document (sampling and sample preservation; parameters and analytical methodology; apparatus; laboratory space and services; data handling and reporting) can all be considered as contributing to the overall programme of quality assurance. Another essential component of a quality assurance programme is analytical quality control which refers to the routine application of procedures for controlling the measurement process.

It is true that some error is inherent in all analytical results, the key idea of analytical quality control is to assure that error does not exceed tolerable value. In this decision, practical and economic factors must also be considered. Many laboratories are not convinced of the necessity for analytical quality control. They consider that faithful application of standard methods is all that is needed to assure the accuracy of results. Unfortunately, inter-laboratory studies do not provide evidence for such optimism. In these studies, portions of the same sample are distributed to each of a number of laboratories without disclosing the true concentrations of the determinands of interest. Each laboratory then analyses its sample and reports the results to a Central Laboratory for processing. Number of such studies have been performed in recent years and provide valuable evidence on analytical errors. The difference between the smallest and largest results reported is usually 50-100% of the true value, and values of several hundred per cent are by no means infrequent.

Internal and External Quality Control :

Internal quality control or statistical quality control is the most important component of any laboratory quality control programme.

Experience indicates that 10-20% of the resources of a laboratory should be devoted to such work. Several approaches to internal quality control have been described.

In general, all of these schemes are based on the establishment of control tests and control charts for precision and accuracy. Recovery tests on spiked samples are also used to evaluate the accuracy of analyses.

External quality control is best applied after incorporating internal quality control practices in the laboratory, and consists in the periodic analysis of reference samples. These reference samples may not be different from the control samples which the laboratory has been preparing for its own use, with the exception that the amount of each substance present is unknown to the analysts. A check by one laboratory of the proficiency or ability of another laboratory to obtain acceptable results (i.e. an external quality control programme) is basically a check on whether the laboratory being tested has an acceptable interanl quality control programme.

When a group of laboratories has to achieve comparability of results from different laboratories by controlling the accuracy of each, the approach outlined in Figure 9 is recommended. Laboratories concerned with their own accuracy are recommended to carry out all possible stages mentioned in the suggested scheme.

Preparation of Control Samples :

One of the most important factors in analytical quality control (AQC) is the availability of an adequate and reliable supply of stable known control solutions which are prepared by taking required quantity of salt. From the stock solution, working standards are prepared just before use by diluting known quantity to 1 litre by double distilled water. All salts must be nitrates because sulphates and chlorides would precipitate barium and silver respectively. The five synthetic concentrated samples have been recommended for AQC and the details are given in Annexure A.

STAFF

No matter how well equipped a laboratory might be, the analytical results are not obtained automatically. It is necessary that the laboratory be staffed with professional and technical personnel capable of carrying out the required analyses.

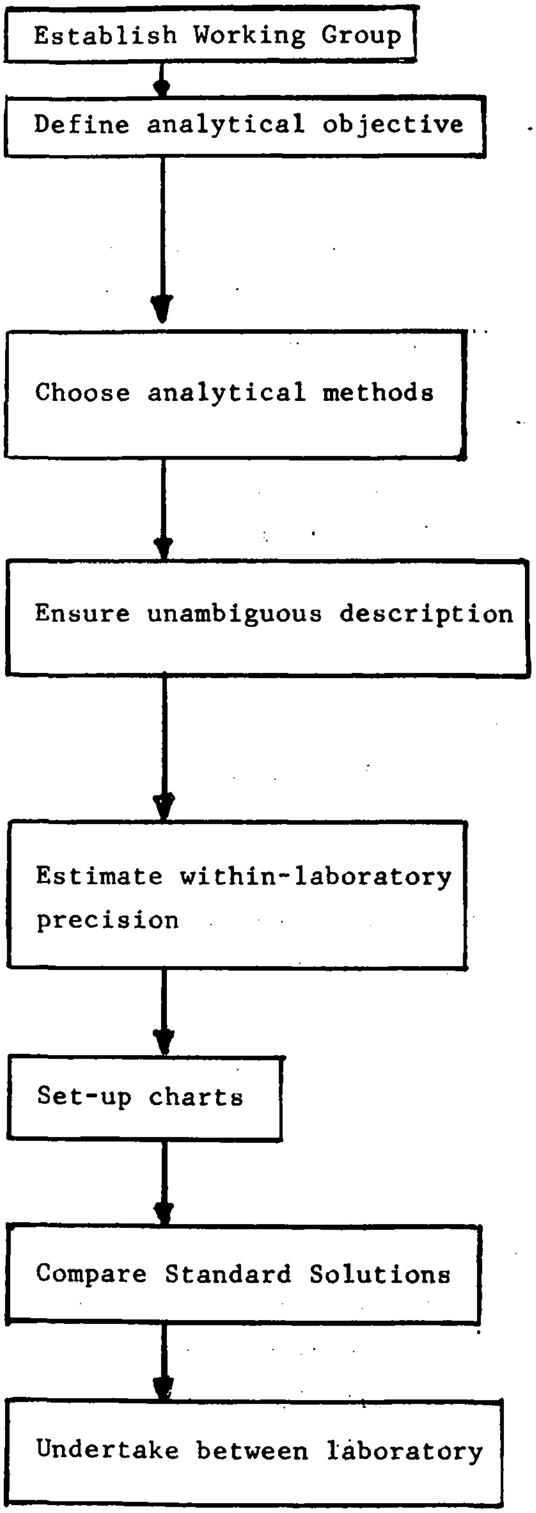
The Chief Chemist should have a post-graduate degree in Chemistry from a recognized University, as well as some advanced studies or equivalent experience in the laboratory.

The number of assistant chemists required by the laboratory will depend on work load, particularly the types of measurements and frequency of determination. Adequate secretarial support should be available for reporting results, filing reports, etc.

Table 2 indicates the skills and time required for standard analytical operations, as recommended by the U.S Environmental Protection Agency. Also listed in this Table are estimates for the number of determinations that an analyst should be able to perform on a routine basis.

It is recommended that a complete and unambiguous written description of all the anlytical methods are made available to the analysts. If the analyst is to continue to grow professionally and to give faithful service, it is considered essential that each analyst be provided with the opportunity to occasionally attend technical seminars and university or government sponsored training courses on water analysis. All laboratory personnel should be provided with means for obtaining access to the scientific literature.

FIGURE 9 : **Flow Chart for AQC Scheme**



To ensure proper co-ordination.

To define accuracy required, i.e. to choose numerical values for the maximum tolerable bias and standard deviation and for the required limit of detection.

To choose analytical methods with satisfactory small sources of bias and capable of adequate precision and limit of detection.

To ensure that the chosen method is of method completely and unambiguously specified and that as far as possible it will be followed exactly by all laboratories.

To estimate the standard deviation of analytical results and, if necessary, improve the precision until the target value is achieved.

To establish a control chart and regularly analyse control solutions to ensure that precision remains adquate.

To ensure that the standard solutions used by all laboratories are in satisfactory agreement.

To estimate the bias of each laboratory and if necessary improve and if necessary improve until the target value is achieved. The test should be regularly repeated.

SOLUTION 'A' **ANNEXURE I**

Metal	Salt*	Stock solutions g/L	mL/+ stock/L concentrate	mg/L+ concentrate	mg/L diluted 5 mL/L.
Zinc	Zn metal in HNO_3	1.0000	10	10	0.05
Cadmium	$Cd(NO_3)_2.4H_2O$	2.7442	4	4	0.02
Lead	$Pb(NO_3)_2$	1.5984	10	10	0.05
Iron	$Fe(NO_3)_3.9H_2O$	7.2359	30	30	0.15
Manganese	Mn metal in HNO_3	1.0000	20	20	0.10
Chromium	$K_2Cr_2O_7$	2.8281	10	10	0.05
Silver	$AgNO_3$	1.5748	10	10	0.05
Copper	Cu metal in HNO_3	1.0000	5	5	0.025
Cobalt	$Co(NO_3)_2.6H_2O$	4.9383	8	8	0.04
Barium	$Ba(NO_3)_2$	1.9029	30	30	0.15
Mercury	$Hg(NO_3)_2$	1.6184	1.0	1.0	0.005

* All salts must be nitrates because sulfates will precipitate the barium and chloride will precipitate the silver.

\+ If necessary, add HNO_3 untill the pH of the concentrate is about 2, before making up to a final volume of one litre.

The salts listed in solution 'A' have been recommended in the preparation of calibration curves for metal analysis in the atomic absorption spectrophotometer.

SOLUTION 'B'

Dry KH_2PO_4 in a desicator, weigh 54.436 gm, and add to this salt in a 1 L volumetric flask, 180.2 mL of 1.00 N NaOH. Make this solution up to volume (1,000 mL) with distilled water. When diluted 5 mL to 1,000 mL with distilled water this will produce:

Total dissolved solids	293 mg/L
Conductivity	303 S/cm
pH	6.87

SOLUTION 'C'

Anion	Salt	Stock solution* g/L	mL stock/L concentrate	mg/L in concentrate	mg/L diluted 5 mL/L
NO_3	KNO_3	8.1525	Undiluted	5,000.0	25.0
SO_4	Na_2SO_4	5.9144	Undiluted	4,000.0	20.0
Cl	KCl	23.1335	Undiluted	11,000.0	55.0
F	NaF	2.2104	240	240.0	1.2

* Preserve with 1 mL/L of a 27.1 gm/L solution of $HgCl_2$.

SOLUTION 'D'

Standardize a solution of sodium or potassium cyanide containing approximately 2.0 mg CN/mL by titrating with standard silver nitrate that has been standardized the same day with standard chloride solution. If this stock standard solution is found to contain, for example, 1.89 mg CN/mL, take 42.3 mL of this solution, make to about 3.5 L, adjust to pH 11.5 with NaOH and dilute to 4,000 mL. This concentrate contains 20.0 mg CN/L, and is quite stable. Dilute 5 mL to 1,000 mL just before use to obtain 0.10 mg CN/L.

SOLUTION 'E'

Metal	Salt	Stock solution g/L	mL stock/L concentrate	mg/L concentrate	mg/L diluted 5 mL/L
Arsenic	$Na_2H\ AsO_4.7H_2O$	4.1653	8.0	8.0	0.04
Selenium	SeO_2	1.4052	1.0	1.0	0.005

Table 2 : **Skill - Time Rating of Standard Analytical Operations**

Measurement	Skill Required (Simple Instrumental)	No./Day*
pH	1	100-125
Conductivity	1	100-125
Turbidity (HACH 2100)	1	75-100
color	1	60-75
DO (Probe)	1, 2	100-125
Fluoride (Probe)	1, 2	100-125
	(Simple Volumetric)	

Measurement	Skill Required	No./Day*
	(Simple Instrumental)	
Alkalinity (Potentiometric)	1	50-75
Acidity (Potentiometric)	1	50-75
Chloride	1	100-125
Hardness	1	100-125
DO (Winkler)	1, 2	75-100
	(Simple Gravimetric)	
Solids, Suspended	1, 2	20-25
Solids, Dissolved	1, 2	20-25
Solids, Total	1, 2	25-30
Solids, Volatile	1, 2	25-30
	(Sample Colorimetric)	
Measurement	Skill Required	No./Day*
	(Simple Instrumental)	
Nitrite N (Manual)	2	75-100
Nitrate N (Manual)	2	40-50
Sulfate (Turbidimetric)	2	100-125
Silica	2	100-125
Arsenic	2, 3	20-30
	(Complex, Volumetric or Colorimetric)	
BOD	2, 3	30-40+
COD	2, 3	25-30
TKN	2, 3	25-30
Phosphorus, Total	2, 3	50-60
Phenol (Dist'n only)	2, 3	20-30
Oil & Grease (Soxhlet)	2, 3	15-20
Fluoride (Dist'n)	2, 3	25-30
Cyanide	2, 3	10-15
	(Special Instrumental)	
Metals by AA (No preliminary treatment)	2, 3	150

Measurement	Skill Required (Simple Instrumental)	No./Day*
Metal by AA (With preliminary treatment)	2, 3	60-80
Pesticides by GC (Without clean up)	3, 4	3-5
Pesticides by GC (With clean up)	3, 4	2-4

* The no. of analyses per day assumes that 10-15% of the analyst's time is devoted to AQC.

\+ depends on type of sample

Sill required :

1. analyst with minimum training.
2. analyst with special training or professional with minimum training.
3. experienced analyst, professional.
4. experienced analyst, professional with advanced studies.

EQUIPMENT

The performance and capabilities of Water Technology Laboratory depend heavily upon instrumentation, equipment, staff and other facilities. Analytical instruments and equipment are mostly in the development stage with manufacturers continuously striving for miniaturization, better durability and sensitivity and improved automation. Consequently, the selection and purchase of analytical equipment and instruments is a tedious process. Table 3 lists the equipment and instrument most commonly used for water and wastewater analysis. These represent basic equipment and instruments used and need careful consideration before purchase. This list may require additions or deductions subject to the need of the laboratory and availability of funds.

Table 3: **LIST OF EQUIPMENT/INSTRUMENTS FOR WATER TECHNOLOGY LABORATORIES**

1. Analytical Weighing Balance
2. Atomic Absorption Spectrophotometer
3. Autoclave
4. Bacteriological Incubator (Thermostatically controlled)
5. Balance, Stainless-steel Pans Capacity : 2 Kgs.
6. BOD Incubator
7. Centrifuge
8. Chloroscope
9. Comparator (Lovibond with standard discs)
10. Conductivity Meter
11. Colony Counter
12. Dissolved Oxygen Meter
13. DREL/5 Hach Portable Environmental Lab Kit
14. Electronic Weighing Balance (Mettler)
15. Flame Photometer, Digital
16. Gas Chromatograph
17. Gas Cylinders with Burners
18. Heating Mantles

19. Hot Air Oven
20. Hot Plates
21. Hot Plates with magnetic stirrer
22. Ion Selective Electrodes
23. Jar Test Machine
24. Kjeldahl Nitrogen Assembly
25. Membrane Filter Assembly
26. Mercury Analyzer
27. Millipore Portable Water Laboratory (Membrane Filter Test Kit)
28. Microscope Optical and dissecting Occular stage micrometer and Camera Lucida
29. Muffle Furnace
30. Polarograph
31. Refrigerator
32. Rotary Shaker
33. Sieves shaker with standard sieves
34 Specific Ion Meter + Reference Electrode
35. Sepctrophotometer (Bausch & Lomb Spectronic 21)
36. Soxhlet Apparatus
37. Thermometers 0 to 100°C
38. Thermometers 0 to 250°C
39. Total Carbon Analyser
40. Vaccum Pumps
41. Voltage Stabilizer
42. Water Bath (Six openings)
43. Water Bath Thermostatically controlled.

CHEMICALS

Chemicals generally required for the estimation of common parameters in Water Technology Laboratory are given in Table 4. The quantity of different items required for a laboratory has not been included as this will depend on the nature and volume of work to be handled. Chemical reagents, solvents and gases are available in a wide variety of grades of purity ranging from commercial grade to various 'Ultra pure' grades. The purity of these chemicals required in Water Technology Laboratory varies with the type of analysis. The parameter being measured and the sensitivity and specificity of the detection system are important factors in determining the purity or reagents required. For most of the analysis, analytical reagent grade is satisfactory. However, for trace inorganic and organic analysis frequently require special 'Ultra pure' reagents, solvents and gases. In methods of estimation where purity of reagents is not specified, it is intended that analytical reagent grade is used. Reagents of lesser purity than that specified by the method should not be used.

Table - 4 **LIST OF CHEMICALS**

1. Aluminium potassium sulphate
2. Acetic acid, glacial
3. Ammonium acetate
4. Ammonium perpurate (Murexide)
5. Ammonium solution - Sp.gr. 0.89 (30%)
6. Ammonium chloride
7. Tri-ammonium citrate
8. Ammonium persulphate
9. Di-ammonium hydrogen phosphate
10. Ammonium molybdate
11. Amino-2-naphthol-4-sulphonic acid
12. Acetone
13. Agar-Agar

14. Aluminium ammonium sulphate
15. Aluminium hydroxide
16. Ammonium oxalate
17. Boric acid, anhydrous
18. Boric acid, hydrous
19. Barium chloride
20. Buffer tablets : pH 4.0
21. Buffer tablets : pH 7.0
22. Buffer tablets : pH 9.2
23. Beef extract
24. Bile salt
25. Brilliant green
26. Bromocresol purpule
27. Chloramine-T
28. Chloroform
29. Cobaltous chloride
30. Calcium carbonate
31. Calcium chloride (fused)
32. Carbon tetrachloride
33. Citric acid
34. Copper sulphate
35. Crystal violet
36. Diethyl ether
37. Dithizone
38. Diphenyl carbazide
39. EDTA (disodium salt)
40. Ethyl alcohol
41. Eriochrome Black T-dye powder
42. Eosin
43. Ethyl violet
44. Ferrous ammonium sulphate
45. Ferric chloride, anhydrous
46. Ferrous sulphate
47. Formaldehyde solution 37-41% W/V

48. Ferric ammonium sulphate
49. Glycerol
50. Glucose
51. Grease, white for burette cocks, etc.
52. Hydrochloric acid
53. Hydrogen peroxide solution 30% W/V, 100 volumes
54. Hydroxylamine hydrochloride
55. Hydrazine sulphate
56. Hexamethylene tetramine (Hexamine)
57. Ion exchange resin - Polystyrene quarternary anion exchange resin - Deacedite DD-1P or its equivalent
58. Ion Exchange Resin - Polystyrene cation exchange resin - Zcokarb 225 or its equivalent
59. Iodine
60. Laboratory chemicals first-aid chart
61. Laboratory chemicals spillages chart
62. Lactose
63. Methyl red indicator powder
64. Methyl orange indicator powder
65. Methyl alcohol (Acetone free)
66. Mercuric nitrate
67. Mercuric sulphate
68. Mercuric iodide
69. Manganese sulphate
70. Methyl blue dye powder
71. Nitric acid (69.5-73%) Sp.gr. 1.41-1.42
72. Naphthylamine
73. Oxalic acid
74. Orthotolidine dihydrochloride
75. Phenolphthalein indicator powder
76. Potassium hydrogen phthalate
77. Potassium iodide
78. Phenol red indicator powder
79. Potassium cyanide

80. Potassium chromate
81. Potassium dichromate
82. Potassium sodium tartarate
83. Potassium hydroxide
84. Pyridine
85. Phthalic anhydride
86. Peptone
87. Potassium hydrogen bi-iodate
88. Potassium chloroplatinate
89. 1-10, Phenanthroline hydrate
90. Orthophosphoric acid (Manganese free) 88-93%
91. Potassium dihydrogen phosphate
92. Phenol
93. Potassium nitrate
94. Di-potassium hydrogen phosphate
95. Perchloric acid 69-71% $HClO_4$
96. Petroleum ether 30-60°C
97. Potassium ferro cyanide
98. Potassium iodate
99. Paraffin Wax (melting point 58-60°C)
100. Sodium hydroxide flakes
101. Sulphuric acid, 98% (Sp.gr. 1.835)
102. Sulphuric acid, fuming (Oleum) about 20% SO_3
103. Sodium carbonate, anhydrous
104. Sodium thiosulphate
105. Sodium chloride
106. Sodium acetate, trihydrate
107. Stannous chloride dihydrate, arsenic free
108. Silver nitrate
109. Starch, soluble
110. Sodium sulphite, anhydrous
111. Sodium azide
112. Sodium citrate (tri)
113. Sodium fluoride, anhydrous

114. SPADNS dye; sodium 2-parasulphophenylaza 1-8-dihydroxy-3-6-naphthaline disulphonate
115. Sodium fluoride
116. Sodium sulphate, anhydrous
117. Silver sulphate
118. Sulphanilic acid
119. Sodium nitrate
120. Di-sodium hydrogen phosphate
121. Stannous chloride
122. Sodium borate decahydrate (borax)
123. Sodium sulphide, $Na_2S.9H_2O$
124. Sodium aluminate
125. Sodium oxalate
126. Safranine
127. Sodium arsenite
128. Sodium dihydrogen phosphate
129. Tartaric acid dextro-rotatory
130. Toluene
131. Teepol
132. Vim or its equivalent for cleaning laboratory sinks
133. Zinc acetate
134. Zinc sulphate

GLASSWARE & MISCELLANEOUS

Laboratory glasswares are used for storage of reagents and measurement of solution, volume and confinement of reactions. A good quality glassware should be used in the laboratory engaged in Water Technology. There are many grades and types of glasswares ranging from student grade to other possessing specific properties such as resistance to thermal shock, low baron content and super strength. Borosilicate glass bottles with ground glass stoppers are recommended for most standard solutions and solvents. Plastic containers are also used but they should not be used to store reagents required for organic analysis. Photo sensitive reagents are stored in brown coloured bottles. Glass stoppered resistant glass bottles are necessary for collecting samples. All volumetric glassware should be accurately calibrated. The list of common glassware and miscellaneous items required for Water Technology Laboratory is given in Table 5.

Table 5 : **LIST OF GLASSWARE AND OTHER CONSUMABLES FOR WATER LABORATORIES**

Sl. No.	Item	Capacity
1.	Beakers	50 ml
		100 ml
		250 ml
		1000 ml
2.	Beaker covers	75 mm dia.
3.	Bottles (Aspirator)	1000 ml
4.	Bottles (Winchester)	2500 ml
5.	Bottles, glass stoppered wide mouth	250 ml
		500 ml
		1000 ml
6.	Bottles, glass stoppered narrow mouth	125 ml
		250 ml
		500 ml
		1000 ml

Sl. No.	Item	Capacity
7.	Bottles, glass stoppered narrow mouth, brown glass	125 ml 250 ml 500 ml 1000 ml
8.	B.O.D. bottles	300 ml
9.	Buchners funnels	15 cm dia. 9 cm dia.
10.	Burettes	25 ml 50 ml
11.	Centrifuge tubes	Plain Graduated
12.	Crucibles silica	46 mm
13.	Crucibles, gooch holders	
14.	Dessicators, 300 mm dia. with cover ground to fit the porcelain plate with holes for crucibles	40-50 mm dia.
15.	Dessicators, Vaccum of strong white glass 300 mm dia. with Stop cock, hook and rubber cork	
16.	Durham tubes	5 x 30 mm
17.	Dropping bottles	100 ml
18.	Erlenmeyer flasks	50 ml 100 ml 250 ml 500 ml 1000 ml
19.	Evaporating dishes	75 mm 90 mm
20.	Filter paper 9 cm & 12 cm packages of different Whatman No.5	

Sl. No.	Item	Capacity
21.	Funnels	90 mm
		65 mm
22.	Flasks, glass supported	250 ml
23.	Flasks, flat bottom boiling	500 ml
		1000 ml
24.	Flat bottom COD flasks with condensors	250 ml
		500 ml
25.	Flask, suction	500 ml
		1000 ml
26.	Glass tubings assorted sizes	
27.	Imhoff cones	1000 ml
28.	Kjeldhal flasks	100 ml
		250 ml
29.	Mortars, porcelain unglazed inside complete with pestle	150 mm External dia.
30.	Mortars, Heavy glass, bottom ground inside complete with pestle	100 mm External dia.
31.	Mortars heavy iron complete	150 mm External dia. & 150 mm depth with iron pestle
32.	Measuring cylinders	25 ml
		50 ml
		100 ml
		250 ml
		500 ml
		1000 ml
33.	Measuring cylinders stoppered	50 ml
		100 ml
		250 ml
34.	Nessler tubes	100 ml

Sl. No.	Item	Capacity
35.	Nitrogen distillation assembly	
36.	Petri dishes	60 mm x 15 mm
		100 mm x 17 mm
37.	Pipettes bulbs	5 ml
		10 ml
		20 ml
		25 ml
		50 ml
		100 ml
38.	Pipettes, graduated	1 ml
		2 ml
		5 ml
		10 ml
		20 ml
39.	Polythene bottles with double stopper	100 ml
		500 ml
		1000 ml
40.	Polythene cans	1 lit.
		2.5 lit.
		5.0 lit.
41.	Polythene carbuoys	20 lit.
42.	Porcelain dishes	150 ml
43.	Quickfit standard ground joints, pyrex glass equipment, each cone and socket should be complete with apprx. 150 mm of tubig size number of the joint; B-10	
	B-24	
	B-40	

44. Quickfit general utility set consisting of the following Pyrex glass or its equivalent.

Flask 100 cc. RB B 245
Flask 500 cc. RB B 24 U
Flask 1000 cc. RB B 24 U
Reduction adapter DA 23
Multiple adapter MA 4/23
Still head SH 6/22
Thermometer pocket SH 4 A
Splash head SH 7/02
Liebig condenser C 1/22
Receiver adapter, long RA 1/12 with hook
Vacuum receiver adapter RA 3/23
Stirrer, link type ST/1/1
Stirrer, guide ST/2/2
Stirrer, glass fitting ST/4/2 brass
Cone with stem, strait MF 15/15
Cone with stem, bent MF/15/2B
Adapter with side tube MF 18/3
Dropping funnel D 2/22

45. Quickfit condenser Pyrex glass or its equivalent with B-24 cone and socket

Description	Overall mm.
Liebig (thin wall)	500
Internal coil	300
Double surface	400
Allihn's bulb type	250

46. Rubber tubings assorted sizes

47.	Separating funnels	100 ml 250 ml 500 ml 1000 ml
48.	Silica glass crucibles	25 ml
49.	Sintered glass crucibles	25 ml

50.	Test tubes assorted sizes	
51.	Test tubes without rim	75 x 10 mm
		150 x 12 mm
		150 x 15 mm
		150 x 18 mm
		150 x 25 mm
52.	Tiles white glazed for comparing colour	250 mm. sq.
53.	Volumetric flasks - capacity	25 ml
		50 ml
		100 ml
		250 ml
		500 ml
		1000 ml
54.	Wash Bottles	500 ml
		1000 ml
55.	Watch glasses assorted sizes	
56.	Weighting bottles	
56.	Water suction pumps.	

MISCELLANEOUS

Titrations

1. Glass rods
2. Glazed tiles
3. Burette stand
4. Bossheads & clamps
5. Pipette stand
6. Spatula
7. Weighing bottles

Digestion/Heating

1. Tripod stand
2. Wire gauze with asbestos center
3. Glass beads
4. Porcelain triangle
5. Asbestos sheet

Colorimetric estimations

1. Nessler tube stand
2. Tissue paper
3. Wash bottle

General

1. Craft paper
2. Glass marking pencils
3. Non absorbent cotton
4. Twine balls
5. Lysol/Dettol
6. Nichrome wire

7. Spirit lamp
8. Wooden racks
9. Pipette case cylinderical of copper or stainless steel
10. Clamps, burette
11. Clamps, condensor
12. Clamps, holder
13. Clamps, pinch
14. Corks assorted sizes
15. Cork borers
16. Glass tubes
17. Iron Stands
18. Rings iron 12 cm.
19. Rings iron 9 cm.
20. Rubber Stoppers
21. Tongs.

STANDARD REFERENCE BOOKS & JOURNALS

A good information system with a library back up is a must for Water Technology Laboratory as it helps for the comprehensive planning and successful execution of R & D Projects. A list of important books and journals which are frequently referred to in day-to-day work are given below.

BOOKS :

1. American Public Health Association Standard Methods for the Examination of water and wastewater. 16th ed. Washington, DC, APHA, 1985.

2. American Water Works Association
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   Package Sequential Solids Contact Clarifiers for Low Cost Drinking Water Production in Rural Areas from Surface Sources. Paper presented at the All India Seminar on low cost and package Water Treatment Plants for Drinking Water in Rual Areas, Nagpur. Jan. 8-9, 1977.

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3. Journal American Water Works Association.
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BUYER'S GUIDE

The names and addresses of some suppliers of different equipment, chemicals, and glassware, are given below. This list is only indicative and should not be taken as recommendations for any particular firm. The purchaser is free to contact any supplier to suit his local conditions and requirements.

ADDRESSES OF FORMS FOR PROCURING EQUIPMENT, GLASSWARE AND CHEMICALS

1. Pharma Trust
   114, Keshav Baug, Princess Street
   BOMBAY - 400 002.

2. Laboratory Furnishers
   Prakash Mansion, Opposite Dadar Fire Brigade
   186/C, Dr. Ambedkar Road, Dadar,
   BOMBAY - 400 014

3. Scientific Instrument Co. Ltd.
   Dr. D.N. Road, 240 Navasari Building
   BOMBAY - 400 001.

4. The Scientific Instruments Company
   II, Esplanade (East)
   CALCUTTA - 700 069.

5. Toshniwal Instruments
   8, Mohata Bhavan, Dr. E.Moses Road, Worli
   BOMBAY - 400 018.

6. Associated Instruments Manufacturers(I) P.Ltd.
   India House, Fort Street
   PO Box No.119
   BOMBAY - 400 001.

7. Scientific Products
   54, Podar Chambers, Parsee Bazar, Fort
   BOMBAY - 400 019.

8. Tempo Industrial Corporation
   B-9, Hans Bhavan, Bahadur Shah Zafar Marg
   NEW DELHI - 110001.

9. Systronics Ltd.
   Telerad Premises, Chandivili
   Off Saki Vihar Road,
   BOMBAY - 400 072

10. Technical and Scientific Sales
    12/273 Bhan Duji Road Extension
    Near Sion Hospital (West)
    BOMBAY - 400 002.

11. Elico Pvt. Ltd.
    B-17, Sanatnagar Industrial Estate
    HYDERABAD - 500 018.

12. Kusum Engineering Co. Pvt. Ltd.
    25, Swallow Lane
    CALCUTTA - 700 001.

13. The General Engg. and Scientific Works
    Industrial Estate
    BEHRAMPUR (ORISSA)

14. Annapurna Metal Works
    3, Ashu Biswas Road,
    CALCUTTA - 700 025.

15. Laboratory Furnishers
Dhum Mansion, 106 C. Vincent Road, Dadar,
BOMBAY - 400 014.

16. Andhra Scientific Co.Ltd.
Cantonment Road, PO Box No.26
MASULIPATNAM (AP)

17. Scientific Products
54, Podar Chambers, Parsee Bazar St., Fort
BOMBAY - 400 001.

18. Bird & Co. Pvt. Ltd.
1, India Exchange Place
CALCUTTA - 700 001.

19. Blur Star Limited
Kasturi Building
J. Tata Road
BOMBAY - 400 020.

20. Delux Enterprises
A-25, Okhla Industrial Area, Phase-I
NEW DELHI - 110 020.

21. Hindustan Trading Corporation
Kirpa Nagar, Chandigarh Road
AMBALA CITY.

22. Devson Enterprises
F-2, Textile Colony, Industrial Area
LUDHIANA.

23. Rajsons
5 Triloknath Road, Near G.P.O.
Post Box No.7, Hazaratganj
LUCKNOW - 226 001 (UP).

24. Amalgamated (Scientific) Suppliers
96, Raja Ram Mohan Sarani (Amherst Street)
CALCUTTA - 700 009.

25. Associated Chemiglass Enterprises
864, Poonamali High Road
MADRAS - 600 010.

26. Associated Chemiglass Enterprises
37, Seshadri Road
Near City Railway Station
BANGALORE - 560 009.

27. K.B.J. & Co.
4-4-316. Bank Street
HYDERABAD - 500 001.

28. Srikant Agency
XL/2396, Lissy Hospital Road
Ernakulam North PO.
COCHIN - 682 018.

29. Kaydee Enterprises
41, Parimal Society, Paldi
AHMEDABAD - 380 006.

30. Ajay Scientific Co.
2-A, Govind Building, Ground floor
140 Princess Street
BOMBAY - 400 002.

31. Associated Trading Co.
2-A, Govind Building, Ground floor
140, Princess Street
BOMBAY - 400 002.

32. Indequip Scientific Enterprise
10/12, Jamboolwadi, 2nd floor
Kalbadevi Road
BOMBAY - 400 002.

33. Karwa Udyam Pedhi
1180 Raviwar Peth
POONA - 411 002.

34. Western Scientific Corp.
25, Popatwadi, Kalbadevi Road
BOMBAY - 400 002.

35. Advance Scientific Industries
5/5759, Dev Nagar
Near Khalsa School, Desh Bandhu Gupta Road
NEW DELHI 110 005.

36. Gyan Scientific Traders
5, Ashok Nagar
Gautam Budh Marg
LUCKNOW - 226 019.

37. Gyan Scientific Agencies
C21/86B, Mahamandal Nagar, Lahurabir
VARANASI - 221 002.

38. International Traders
Plot No.7, Basti Harphool Singh
Sadar Thana Road
DELHI - 110 006.

39. The Central Scientific Supplies Co.Ltd.
Hakim Mansions
29, Stringers Street
MADRAS - 600 108.

40. The Central Scientific Supplies Co.Ltd.
5-4-449, Station Road, Nampalli
HYDERABAD - 500 001.

41. B. Babulal & Co.
Inside Devkaran Mansion Compound
PO Box No.2409, Princess Street
BOMBAY - 400 002.

42. Chemicals Corporation
Mangaldas Building No.2, Room No.96
Mangaldas Road
BOMBAY - 400 002.

43. Standard Scientific Co.
Kanti Niwas, Indora
NAGPUR 440 017.

44. Upper India Scientific Co.
Residency Road, Sadar,
NAGPUR 440 001.

45. Central Scientific Co.
Vijay Niwas
Opp. Tarun Bharat, Ramdas Peth
NAGPUR - 440 010.

46. Equipment & Chemicals Corporation
8595 Ratan Nagar, New Rohtak Road
Near Jain Service Centre
NEW DELHI - 110005.

47. Northern Laboratory Implements
1018, Gali Shakti Mandir
Tiraha Darya Ganj
NEW DELHI - 110 002.

48. Scientific Industries
4A/25, Rajinder Nagar, PO Box No.2825
NEW DELHI - 110 060.

49. Oswal Scientific Stores
SCO 4, Sector 16D
CHANDIGARH - 160 016.

50. Laboratory Instruments & Chemicals
Cross Road No.5, Grain Market
AMBALA CANTT - 133 001.

51. Scientific & Industrial Enterprises
B-45, Nehru Ground
FARIDABAD - 121 001.

52. Lab Chemicals & Glasswares Co.
Post Box No.14
Unit IV, Market Shop No.W/4
BHUBANESHWAR - 751 001.

53. Central Scientific Supplies Co.Ltd.
29, Stringers Street
MADRAS - 600 018.

54. Paramount Chemicals
15. Nyniappa Naick Street
MADRAS - 600 003.

55. Precision Scientific Company
3, Baker Street
MADRAS - 600 001.

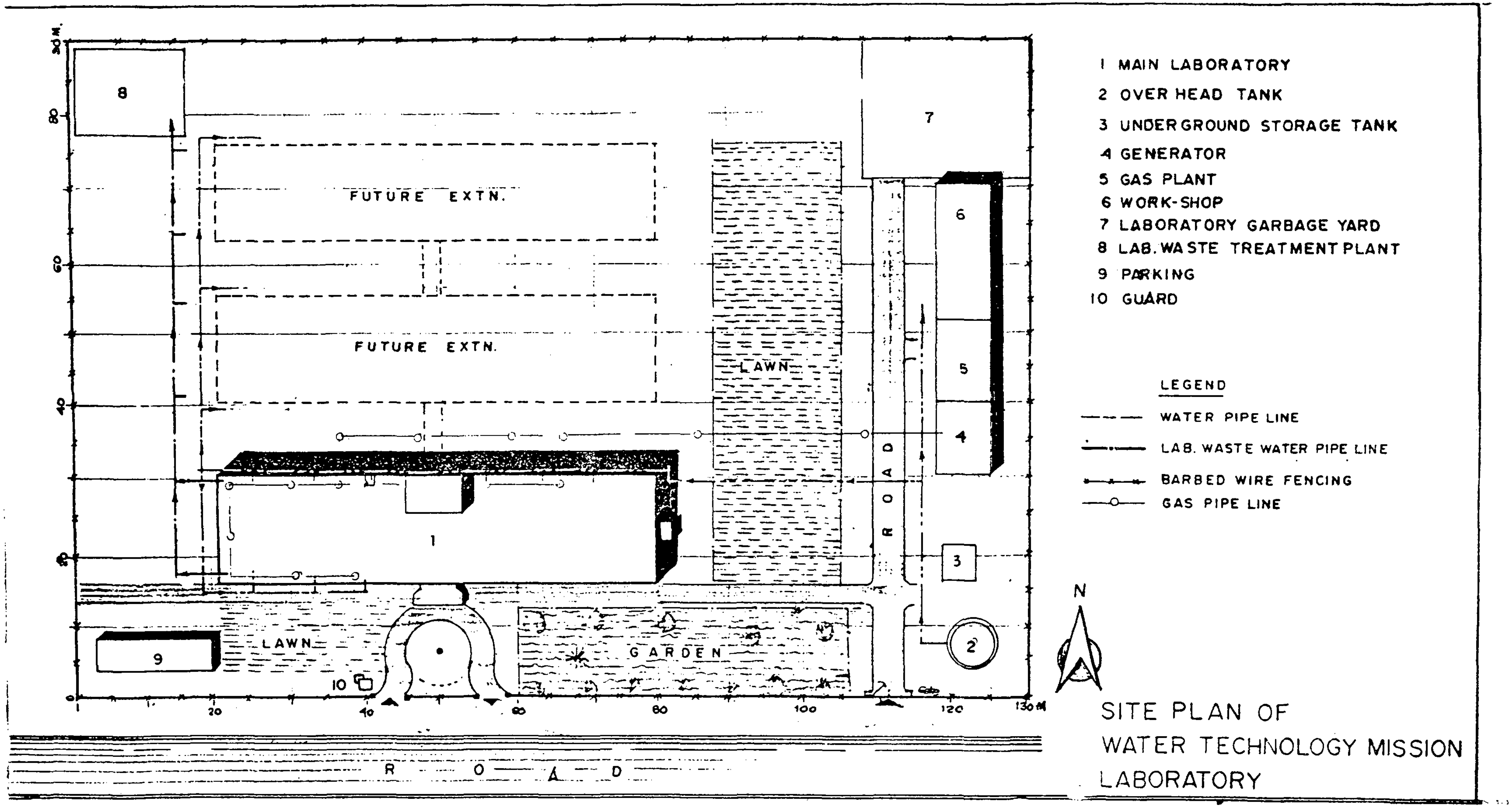
56. Scientific Syndicate
13, R.B.V.R. Shopping Complex
Tilak Road
HYDERABAD - 500 001.

57. Scientific Equipments & Chemicals Co.
38/250-B, Vasudev Building
T.D. Road, Convent Road Junction
Ernakulam College P.O.
COCHIN - 682 035.

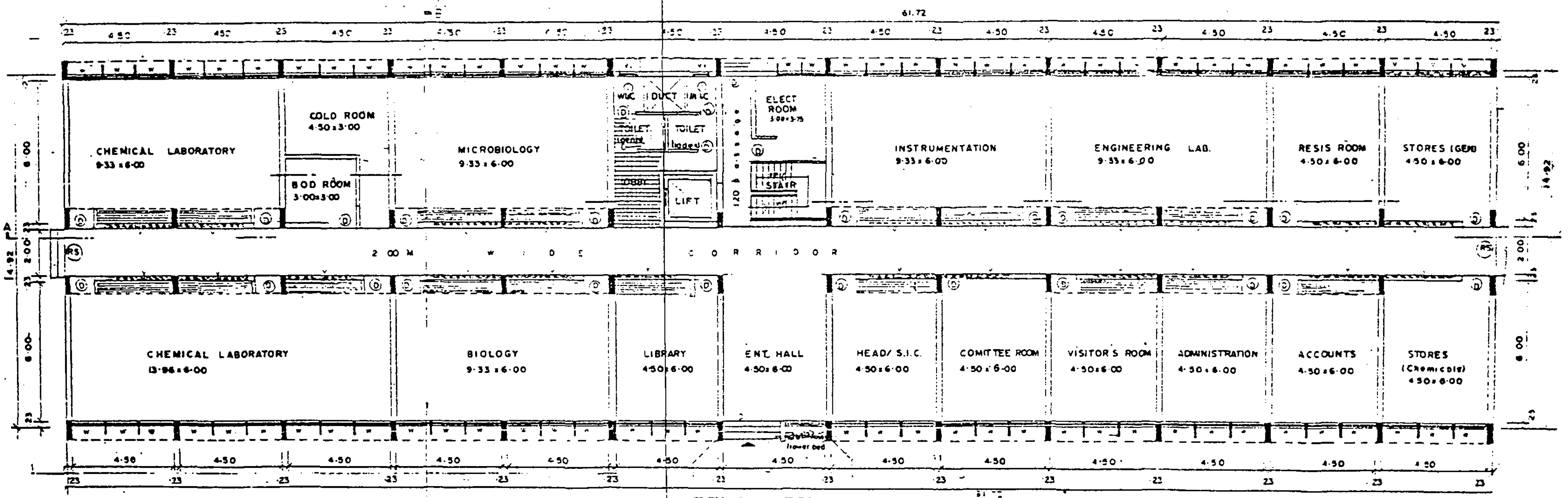
58. Central Scientific Supplies Co.Ltd.
20/A, Sir Sringeri Mutt Building Complex
K.V. Temple Street, Sultanpet
BANGALORE - 560 053.

59. Laboratory Supplies Co.
9, Sri Krishna Buildings
Avenue Road
BANGALORE - 560 002.

60. Chemicals & Instruments Corpn.
55, Ezra Street (3rd Floor)
CALCUTTA - 700 001.



SITE PLAN OF
WATER TECHNOLOGY MISSION
LABORATORY



SCHEDULE OF OPENINGS

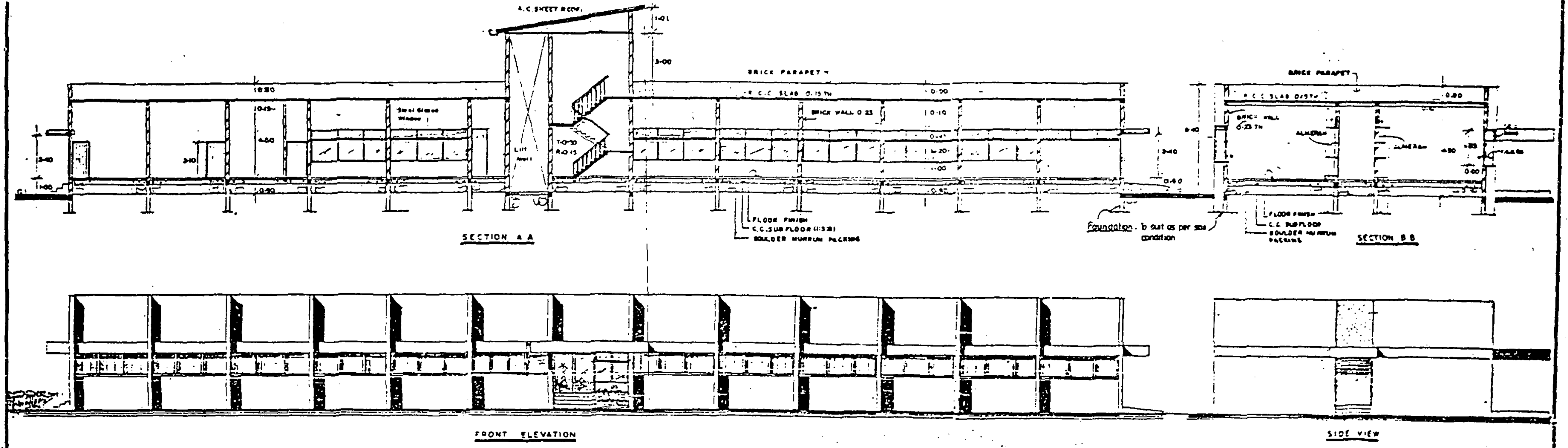
D	DOOR	0.90 x 2.10	T W Fully panelled
D1	—⌒—	0.75 x 2.10	——⌒——
D2	—⌒—	2.40 x 2.40	M.S. Full glazed
RS		2.40 x 2.40	Rolling Shutter
W	WINDOW	1.50 x 1.70	M.S. Fully glazed.
V	VENT.	1.50 x 0.50	——"——
V1	— —	0.50 x 0.60	——"——

GROUND FLOOR PLAN

Scale: N.T.S.

All dimensions in Metres.

GROUND FLOOR PLAN



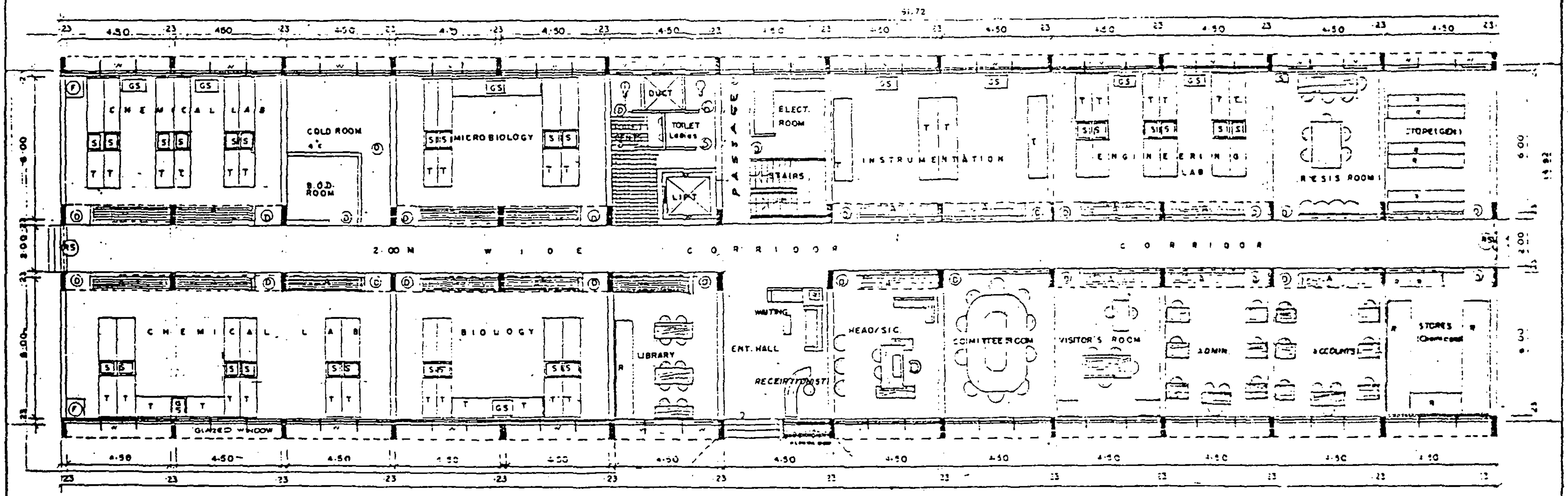
SECTION A A

SECTION B B

FRONT ELEVATION

SIDE VIEW

SECTIONS AND ELEVATIONS

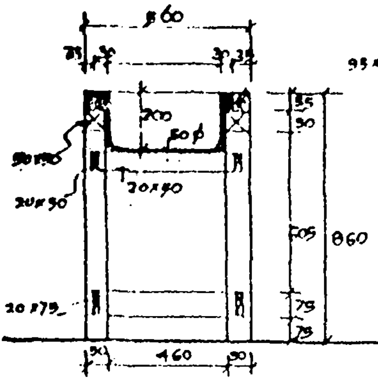


LEGEND: T – LABORATORY TABLE
R – RACKS
A – ALMERH
S – SINK
GS – SINK WITH DRAINGE BOARD
F – FUME CHAMBER
D – DOOR
W – GLAZED WINDOW
V – VENTILATOR
RS – ROLLING SHUTTER

GROUND FLOOR PLAN

Scale – N.T.S.
All dimension in Metre

FURNITURE LAYOUT
(GROUND FLOOR PLAN)



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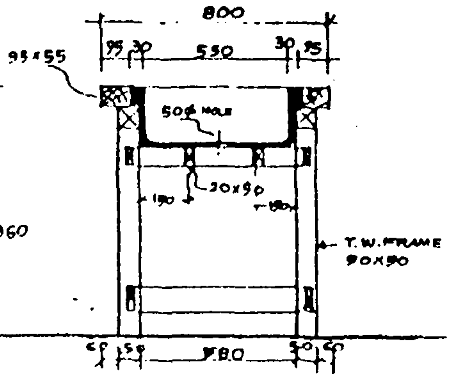
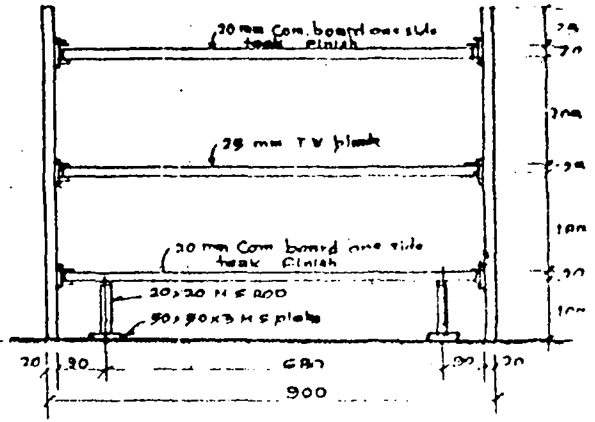
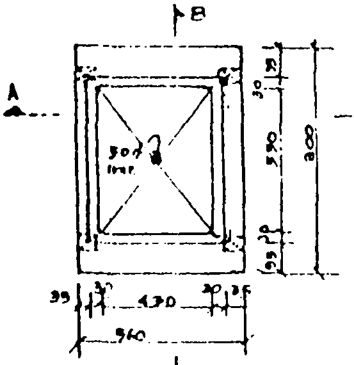


SECT. B B

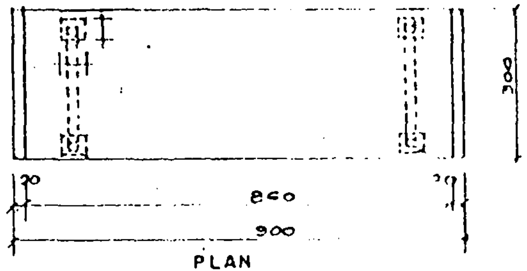


FRONT ELEVATION



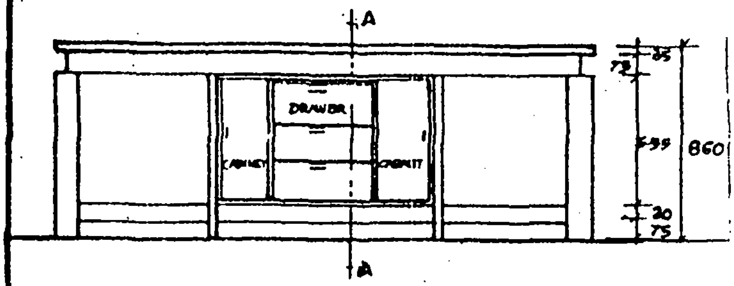
PLAN

LAB TABLE SINK

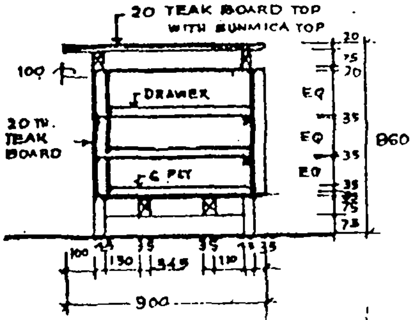


PLAN

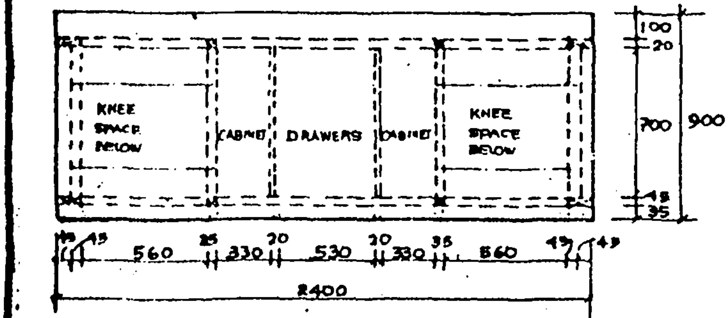
CHEMCAL RACK



FRONT ELEVATION



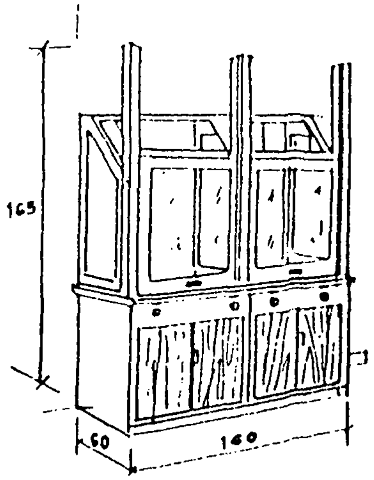
SECTION A A



PLAN

LABORATORY TABLE

LABORATORY FURNITURE



LAB. FUME CUPBOARD