Government of India & Government of The Netherlands

Technical Assistance
HYDROLOGY PROJECT

DHV CONSULTANTS & DELFT HYDRAULICS with HALCROW, TAHAL, CES, ORG & JPS

SURFACE WATER MONITORING

PROCEDURES FOR OPERATION AND MAINTENANCE NORMS

FEBRUARY 2001

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SURFACE WATER MONITORING

MAINTENANCE NORMS

FEBRUARY 2001

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1 General

Maintenance norms for the following classes of stations/laboratories are discussed:

– Meteorological stations
– Gauge Discharge (GD) stations
– Water Quality laboratories levels I, II and II+

Meteorological stations

There are various types of meteorological monitoring stations in the HP Network. The first type consists of the meteorological stations, spread over various states of the peninsular India, is predominantly the rainfall monitoring stations using SRG or SRG/ARG instruments. These are inspected and are being reactivated as part of HP, by rectifying deficiencies wherever feasible. Other type constitutes a few climate stations in each state.

The meteorological station types in the reactivated variety are:

1. SRG (Standard Rain Gauge) stations
2. ARG (Autographic Rain Gauge) stations
3. HP-FCS (HP- Full Climate Stations)

The maintenance costs of the above types comprise the following components:

1. Maintenance of civil works
2. Cost of consumable items
3. Charges of staff

GD Stations

There are different types of GD Stations for measurement of water levels and velocity. The commonly considered types under the Hydrology Project are:

1. GD Stations (Wading) or wading at low flows and is for part-time
2. GD Stations (Bridge or Cableways) at higher flows
3. GD Stations (Boat outfit) at higher flows
4. GD Stations having sediment laboratory

The maintenance costs for the above types of GD Stations comprise the following components:

1. Maintenance cost of civil works
2. Maintenance cost of equipment
3. Cost of consumables
4. Payments to staff
5. Miscellaneous expenditure

Water Quality Analysis Laboratories

The following types of laboratories exist:

1. Level I Laboratory
2. Level II laboratory
3. Level II+ laboratory

The maintenance costs for the different types of laboratories comprise the following components:

1. Cost of chemicals and glassware
2. Maintenance of equipment
3. Maintenance of building

Note: Norms for various types of sites have been worked out further, as also for sediment and water quality sampling and analysis. Following these norms, staff costs are assuming quite a substantial amount. If same staff can be deployed for doing a set of tasks or on roving basis, the costs have to be adjusted in budgets.

2 Maintenance norms for the Standard Rain Gauge (SRG) Stations

Maintenance costs are required for civil works, consumable items and charges to staff. The details of costs under these headings are worked out as given below.

PART – A

Maintenance of Civil Works

1. Barbed wire fencing usually sags during a span of two-three years. Hence, it is necessary to tighten it.
2. Angle iron posts are rusted or damaged with time generally two to three posts are damaged every year, which are to be replaced.
3. While tightening the barbed wire, damaged barbed wire is replaced by a new one. For this purpose barbed wire 'U' nails are required. Some quantities of barbed wire and 'U' nails are required almost every year.
4. Painting to angle iron posts is necessary to protect against rusting.
5. Jungle clearance, repairing approach roads, etc.

PART – B

Consumable items

Stationery is required to keep record of the data at every rain gauge station:

- 200 pages register, with hard cover building - 1 no./station
- Forms for data recording on monthly basis - 15 nos/station
- Postal charges to despatch data forms to SDDPC - monthly

PART – C

Payment to rain gauge reader

Payment to rain gauge reader deployed on SRG stand alone sites is recommended @ Rs. 500/- p.m.

Conclusion

Considering all the above points, the estimated expenditure for the maintenance of Standard Rain Gauge Station per year works out to be approximately Rs.5,750/- as detailed below:

Maintenance Cost

Standard Rain Gauge Station

Item No.	Item	Qtty.	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Maintenance of Civil Works				
1.	Tightening of barbed wire fencing	Job/year			
2.	Replacing twisted/ broken angle iron posts, Lump Sum (LS).	Job/year			
3.	Providing 'U' nails & barbed wire etc. LS	6 kgs			
4.	Jungle clearance, repairing approaches, painting to angle posts as necessary, LS	Job/year			
	Total for Civil Work maintenance				**1,000**
	Part B: Cost of Consumable Items (Stationery)				
5.	Measuring Jar	1			
6.	200 pages card board bound register	1			
7.	Data recording forms	15			
8.	Postage	L S			
	Total for Consumable Items				**500**
	Part C: Charges of Staff (One Raingauge Reader)				
11.	Rainy seasons	5	500	Per month	2,500
12.	Off-season	7	250	Per month	1,750
	Total Charges of Staff				**4,250**
	Grand Total				**5,750**

N.B.:

a) The HP Monitoring Network covers Peninsular India. Hence, providing uniform cost throughout the country may not be appropriate. Costs are recommended amounts, and may be adjusted according to local conditions.

b) The cost on account of deployment of staff is the main component of the running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

3 Maintenance norms for the Autographic Rain Gauge (ARG) Stations

Maintenance costs are required for civil works, equipment, consumable items and payments to staff. The details of costs under these headings are worked out and given below:

PART – A

Maintenance of Civil Works

1. Barbed wire fencing usually sags during a span of two-three years. Hence, it is necessary to tighten it.
2. Angle iron posts are rusted or damaged with time generally two to three posts are damaged every year, which are to be replaced.
3. While tightening the barbed wire, damaged barbed wire is replaced by a new one. For this purpose barbed wire 'U' nails are required. Some quantities of barbed wire and 'U' nails are required almost every year.
4. Painting to angle iron posts is necessary to protect against rusting.
5. Jungle clearance, repairing approach roads, etc.

PART – B

Maintenance of Equipment

The autographic-raingauge (ARG) is to be set ready for observation before the arrival of the monsoon for recording the rainfall. For replacement of the defective parts of the instrument, suggested spares are to be kept at the divisional level so that repairs are attended to speedily and the period of data loss is totally reduced.

PART – C

Cost of consumable items

a) For the ARG instrument working on quartz clock, 1.5 volts batteries are required after every 15 days or as per necessity during the working season (i.e. monsoon season).
b) The autographic charts for the ARG instrument are required to be used as needed.
c) The ARG time mechanism, including pen on the chart requires attention. Some oil to the time mechanism and glycerine for pen is to be applied.
d) Stationary:

i)	200 pages hard cover register	2 nos/station
ii)	Data recording forms – monthly	15 nos/station
iii)	Postage	LS/ station
iv)	Rainfall recording graphs (one set contains 100 graphs papers)	4 sets/station
v)	Recording ink bottles 10 ml capacity	2 nos/station

PART – D

Charges of Staff

Payment to the rain-gauge reader during the whole year is recommended, as he has to record/ verify SRG values and analyse autographic charts.

Conclusion

Considering all the above points, the estimate for the annual maintenance of an Autographic Raingauge Station works out to be approximately Rs.8,200/-.

Maintenance Norm

Autographic Rain Gauge (ARG) Station

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Maintenance of Civil Works				
1.	Tightening of barbed wire fencing	Job/year			
2.	Replacing broken angle posts after every three years	Job/year			
3.	Providing 'U' nails & barbed wire etc.	6 kgs			
4.	Painting to angle posts after every two years Quantity: 8.00 m^2 x Rs.40/m^2 = 320/2 years = 160/year = Rs.160/-	Job/year			
5.	Clearing and levelling yard	Job/year			
	Total for Civil Work maintenance				**1,000**
	Part B: Maintenance of Equipment				
6.	Repairs to ARG instrument (Repairs/Renewals)	Job/year			
	Total for maintenance of Equipment				**500**
	Part C: Cost of Consumable Items (Stationery)				
7.	200 pages hard cover register	2			
8.	Data record forms for SRG monthly	15			
9.	Data record forms for analysed values of ARG charts	15			
10.	Autographic charts (100 nos. book)	4			
11.	Recording ink bottles 10 ml capacity	2			
	Total for Consumable Items				**700**
	Part D: Charges of Staff (One Raingauge Reader)				
15.	During rainy season 1-6 to 31-10 (part time)	5	500	Month	2,500
16.	Off-season (1-11 to 1-5) (part time)	7	500	Month	3,500
	Total Charges of Staff				**6,000**
	Grand Total				**8,200**

N.B.:

a) The HP Monitoring Network covers Peninsular India. Hence, providing uniform costs throughout the country may not be appropriate. Costs are recommended amounts, and may have to be adjusted according to local conditions.

b) The cost on account of deployment of staff is the main component of the running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

4 Maintenance norms for Full Climatic station (FCS) for Meteorological Observations

Maintenance costs are required for civil works, maintenance of equipment, consumable items and payments to staff. The details of costs under these headings are worked out as given below:

PART – A

Maintenance of Civil Works

a) Maintenance for fencing due to wear and tear is necessary once a year.
b) Painting to angle iron posts of fencing is necessary yearly.
c) It is necessary to keep the meteorological yard clean and tidy, during the rainy season. Normally, there is growth of weeds and shrubs in the station yard. It shall be cleaned of all such growths. The provision for cleaning the FCS yard is made in the estimate.

PART – B

Maintenance of Equipment

All the meteorological instruments shall be kept in good working conditions throughout the year.

a) **Temperatures:** Maximum-minimum, dry bulb and wet bulb thermometers should be attended to as detailed under routine maintenance.
b) **Anemometer and Wind vane:** Should be attended to as detailed under routine maintenance.
c) **Rainfall measuring instruments:** ARG and SRG instruments shall be attended to as detailed under routine maintenance.
d) **Pan Evaporimeter:** Pan evaporimeter shall be checked as detailed under routine maintenance. Painting to evaporation pan should be done as and when required to avoid rusting and further damages.
e) **Sunshine Recorder:** It shall be attended to as detailed under routine maintenance.
f) **Pillars:** Pillars of the instruments such as anemometer, wind vane, sunshine recorder shall be cement washed and Stevenson’s screen shall be oil painted once a year or as and when required.

PART - C

Cost of Consumable Items

a) For rainfall measuring instruments (SRG/ARG), the requirements are given in Chapter 2 and 3 and will remain the same.
b) The specific type of chart papers for ARG, Thermograph, Hygrograph and Sunshine recorder, should be used as per requirement.
c) Stationery:

i)	200 pages hard board register	3 nos/station
ii)	Data record forms for SRG –monthly	15 nos/station
iii)	Data record forms for hourly rainfall ARG	40 nos/station
iv)	Autographic Raingauge charts	2 sets/station
v)	Sunshine recorders strip charts	1 set/station
vi)	Weekly or ten-daily forms for data despatch	200 nos/station
vii)	Recording ink bottle for charts, 10 ml. capacity	2 nos/station
viii)	Postage and stationery	LS

PART – D

Payments to Staff

At every meteorological station, one M2 observer is required. He should see and keep the meteorological instruments in good working condition and record meteorological observations.

Conclusion

Considering all above points, the maintenance costs of meteorological stations is estimated at approximately Rs.56,000/- per year as detailed below:

Maintenance Cost

Full Climatic Station

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Maintenance of Civil Works				
1.	Providing and carrying out repairs	Job/year	200	Job/year	200
2.	Removing grass, shrub etc.	500 m^2	1	m^2	500
3.	Providing/applying oil paint to fencing	Job/year	800	Job/year	800
	Total for Civil Works maintenance				**1,500**
	Part B: Maintenance of Equipment				
4.	Painting to pan evaporimeter, Stevenson's Screen, and pillars of instruments	Job/year	1,000	Job/year	1,000
5.	Repairs to SRG/ARG, Thermograph, and Hygrograph	Job/year	2,000	Job/year	2,000
6.	Repairs to wind instruments	Job/year	500	Job/year	500
	Total for maintenance of Equipment				**3,500**
	Part C: Cost of Consumable Items (Stationery)				
8.	Register for data entry	12	25	No.	300
9.	White paper and ruled paper	(500p's)	100	1 Ream	100
10.	Autographic Rain Gauge charts	4	100	Sets	400
11.	Sunshine recorder strip charts	350	2	No.	700
12.	Hygrograph charts	350	2	No.	700
13.	Thermograph charts	350	1	No.	350
14.	Recording ink bottle, 10 ml. capacity	6	25	No.	150
15.	Muslin cloth and wick for wet bulb LS	1 m	50	No.	50
16	Cells for quartz clock run instruments	25	10	No.	250
	Total for Consumable Items				**3,000**
	Part D: Payments to Staff (One Raingauge Reader)				
17.	M2 Met Observer's Salary	1 x 12	4,000	Month	48,000
	Total for Pay and Allowances				**48,000**
	Grand Total				**56,000**

N.B.:

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b) The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

5 Maintenance norms for GD Stations

Maintenance costs for GD stations are required for civil works, maintenance of equipment, consumable items, payments to staff and miscellaneous expenditure.

5.1 GD Stations (Wading type)

The annual maintenance costs for a GD station (Wading Type) are estimated at approximately Rs. 17,500/- and are detailed below.

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Maintenance of Civil Works				
1	Jungle clearance	200 m^2	1	M^2	200
2	Repairing/replacing broken and/or fallen gauge plates	Job/ Year	1,000	Job/ Year	1,000
3	Painting	Job/ Year	300	Job/ Year	300
4	Surveys to check BMs, taking cross-sections, longitudinal sections etc.	Job/ Year	3,500	Job/ Year	1,500
				Total for Civil Works maintenance	**3,000**
	Part B: Maintenance of Equipment				
5.	Re-rating of current meters	Job/ Year	3,500	Job/ Year	3,500
				Total for maintenance of Equipment	**3,500**
	Part C: Cost of Consumable Items				
6	Register for data entry	2	50	No	100
7	Stationery (paper, graph sheets, pencil, etc.)	Job/ Year	300	Job/ Year	300
				Total for cost of Consumable Items	**400**
	Part D: Payments to Staff				
8	Khalashi/ Gauge Reader 3 nos. working per day @ 2 days per week over 5 months (4 weeks/ month)	3	80	-	9,600
				Total charges of Staff	**9,600**
	Part E : Miscellaneous Expenditure				
9	Rain suit, umbrella, torch, gum boot	Job/ Year	1,000	Job/ Year	1,000
				Total of Miscellaneous Expenditure	**1,000**
				Grand Total (Part A+B+C+D+E)	**17,500**

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b) The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

5.2 Maintenance norms for GD Station (Bridge or Cableway site + DWLR/ AWLR)

PART – A

Maintenance of Civil Works

Staff gauges and AWLRs housed in steel pipes do the water level measurement. The structural steel pipes attached to the bridge structure need maintenance and periodic painting.

The measurement of discharge is done by wading when there are low flows, and for heavier flows, the measurement of discharge is carried out from a bridge by a bridge outfit arrangement (velocity measurement).

a) Painting to steel structure

   i) The painting of the bridge outfit and the steel pipe housing AWLRs should be done with synthetic enamel paint once in two years.
   ii) The pipe housing AWLRs and cabin should be maintained and painted with synthetic enamel paint above H.F.L. Below H.F.L., it should be painted by bituminous paint once in two years.

b) Overhauling and oiling & greasing of winch and suspension cable in bridge outfit or double drum winches

   In case the bridge outfit is used, it needs to be pulled to the bridge every day. Its winch, suspending cable, locking arrangement to set the current meter have all to be greased and maintained.

c) Maintenance of cableways where these are used in place of bridge

   The cable towers, the track cable, the endless horizontal and the suspending vertical cable are the main components. There are winches, electrical cables and housing cabins. All these have to be maintained. Moving parts have to be greased. Weather exposed parts are to be painted to avoid rusting and jamming. The grease and oil quantity is required as mentioned below:

   - Grease: 4 times x 15 kg each time = 60 kg/year
   - Oil: 4 times x 4 lit each time = 16 lit/year

d) Tensioning/stretching of main rope and 8 mm endless cable

   - The main rope of the winch and cradle arrangement should be tensioned once in two years alongwith 8 mm endless cables. Check all pulleys and turn buckles. These movements should be free, 'U' bulldog bolts should be greased at the time of tensioning.

e) Building Maintenance

   i) The painting of store /residential building housing the bridge outfit, current meters, fish weights, should be done once in three years.
   ii) The repairing of window, doors, water supply, sanitation and electrification should be done once in three years.

PART – B

Maintenance of equipment

a) Current meter with counter

The current meter rating should be done every year. It should be cleaned after every observation. The spin test should be taken every day. The counter should be checked before going to work.

b) Repairs to current meter & counter

The current meter should be repaired and calibrated every year. The electric cable should not disturb the movement of the current meter. The counter settings should work properly.

c) Repairs to stop watch

The stopwatch should be checked with a calibrated stopwatch at least twice in a month. A stand by stopwatch is essential on every site.

d) Repairs to DWLR/AWLR equipment

Working of DWLR/AWLR should be routinely checked by comparing the staff gauge levels with concurrent values from DWLR/AWLR. For AWLR, the ball bearing, pointer of pen, ink, clock wire and batteries for electric clock should be checked and in the case of DWLR, life of batteries, continuous recording of data should be checked.

PART – C

Cost of consumable items

a) Battery or dry battery cell (1.5 volts) for current meter should be used for 15 days or as necessary at the time of working season.
b) Connecting cable from current meter to counter should be changed twice a year. The connecting cable should be of I.S. Standard.
c) The strip charts of AWLR should be used as per requirement of instrument/site.
d) AWLR instrument-recording pointer should be kept in proper working condition, if necessary should be replaced immediately.
e) Printer - specific ink should be used.
f) Good quality clean plastic cans should be used for collection of water samples from river-gauging sites. Generally 16 nos. plastic cans are required for every WQ site. Out of then, 20% i.e., 4 nos. becomes unserviceable every year requiring replacement by new good quality plastic cans.
g) The winch and the cableway arrangement, cradle or bridge outfit should be sheltered properly. The GI sheets or tarpaulin should be replaced once in two years.
h) Stationery
    i) 200 page hard bound register – 10 nos./station
    ii) 200 pages note books – 2 nos./station
    iii) Drawing sheets – 6 sheets/station
    iv) L-section/Cross-section – 3 sheets/station
    v) Plain paper, rubber and pencils should be required for every station

PART – D

Payments to staff

a) At every river gauging site, one observer is required for checking the operations of all instruments for level and discharge measurements. Currentmeter rating chart is checked. Battery and battery box should be kept in ready condition. He should see and keep all the structures, equipment in good working condition for discharge measurements. He should keep daily discharge data posted in books.

b) At every river gauging site two gauge Khalasies (SI) are required for operating of the current meter suspension into the river and in velocity measurements at various sections. They should help the observer in discharge measuring work.
c) Every river-gauging site requires 2 labourers for operating, helping and for carrying out observations. (They should collect and transport the WQ samples by plastic cans from site.) In every gauging station, two labourers are required at each river-gauging site for a period of 5 months.

PART – E

Miscellaneous Expenditure

Every river gauging station requires following items for maintaining and operating the site.

a) The raincoat per person once in two years
b) The gum-boot per person once in two years
c) One torch per person once in two years

Maintenance Norm

GD Station (Bridge or cableway + DWLR/AWLR)

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (in Rs.)
	Part A: Maintenance of Civil Works				
1.	Providing and carrying out repairs	Job/year	500	Job/year	500
2.	Painting to steel structures a) Painting of winches and cable spools by synthetic enamel paint after every two years 200 x 28/2	100 m^2	28	m^2	2,800
	b) Painting AWLR/DWLR housing after 2 years 140 x 25/2	70 m^2	30	m^2	2,100
3.	Overhauling, oiling and greasing of bridge outfit/ winches	Job/year	500	Job/year	
4.	Building maintenance	Job/year	2,500	Job/year	2,500
	Total for Civil Work maintenance				**8,400**
	Part B: Maintenance of Equipment				
5.	Rating of current meter and counter	1	3,500	No.	3,500
6.	Repairs to current meter and counter	Job/year	1,000	Job/year	1,000
7.	Repairs to stop watch	Job/year	500	Job/year	500
8.	Maintenance cost of DWLR/AWLR	Job/year	2,000	Job/year	2,000
	Total for Equipment maintenance				**7,000**
	Part C: Cost of Consumable items (Stationery)				
9.	Battery or dry cells	10	40	No.	400
10.	Connecting cable	20 m	10	M	200
11.	AWLR graphs/ink or DWLR/battery cells	Job/year	1,000	Job/year	1,000
12.	Plastic Sample cans	16	50	No.	800
13.	GI sheets or Tarpaulin	1	500	No.	500
14.	Stationery (paper/charts/ sheets/pencil etc.)	Job/year	1,000	Job/year	1,000
	Total for Consumable Items				**3,900**
	Part D: Charges of Staff				
15.	Observer/ Gauge reader	1 x 12 months	5,500	Month	66,000
16.	Gauge Khalashi / helper	2 x 12	2,000	Month	48,000
17.	TA provision	Job/year	5,000	Job/year	5,000

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (in Rs.)
18.	Seasonal labour (2 x 150 days)	300 days	60	Days	18,000
	Total Charges of Staff				**1,37,000**
	Part E: Miscellaneous Charges				
19.	Rain Suit/Umbrella	2 No.	300	No.	600
20.	Gum Boot	2 No.	250	No.	500
21.	Torch	2 No.	100	No.	200
22.	Kerosene	1 can	100	Can	100
23.	Nylon rope	100 m	5	m	500
24.	Battery cells	30	10	No.	300
	Total for Miscellaneous Charges				**2,200**
	Grand Total				**1,58,500**

N.B:

a) The HP Monitoring Network covers Peninsular India. Thus to provide uniform costs may not be appropriate. Costs are recommended amounts, and may be adjusted.

b) The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

5.3 Maintenance norms for GD Station (Boat Outfit + DWLR/ AWLR)

PART – A

Maintenance of Civil Works

Staff gauges and AWLR/ DWLR should be appropriately housed to do the level measurement. The structural arrangements for stilling and the lead pipes to the structure need maintenance and periodic painting.

The measurement of discharge is done by wading when there are low flows; and for heavier flows, the measurement of discharge is carried out by a boat outfit arrangement (velocity measurement). Markers on the banks and the compass on the boat do the positioning of the boat for velocity measurements.

a) Maintenance to stilling arrangements

- i) The repair and painting of the structure on the bank of the river shall be done once in two years.
- ii) AWLR/DWLR shall be painted by synthetic enamel paint above HFL and by bituminous paint below HFL, once in two years.
- iii) The FRP boats need no painting, but may require occasional repair.

b) Building maintenance

- i) The site store shall be painted once in three years.
- ii) Repair to windows, doors, water supply/sanitation/electrical installations shall be done once in three years.

PART – B

Maintenance of equipment

a) Current meter with counter - The current meter rating shall be checked every year. It shall be cleaned after every observation. The spin test shall be taken every day. The counter-setting shall be checked before going to work.
b) Repairs to current meter & counter - The electric cable shall not disturb the movement of the current meter. The counter shall work properly.
c) Repairs to stop watch - The stopwatch shall be checked with a calibrated stop watch at least twice in a month. Stand by stopwatch is essential at every site.
d) Repairs to DWLR/AWLR instrument - The AWLR shall be overhauled every year. Ball bearing, pointer of pen, ink, clocks, wire and batteries for every clock shall be checked. The DWLR setting shall be cleaned after each setting.
e) The OB engine shall be cleaned and maintained every year before and after the monsoon period. The electrical connections, oil seal and oil tanker shall be cleaned and maintained properly.

PART – C

Cost of consumable items

a) Battery or dry cell (1.5 volts) for current meter shall be used for 15 days or as per necessity.
b) Connecting cable from current meter to counter shall be changed twice in a year. The connecting cable used shall be of I.S. Standard.
c) The specific chart of AWLR shall be used as per requirement of instrument / site condition.
d) AWLR chart pointer shall be kept in proper working condition. If spoilt, shall be replaced immediately.
e) The ink used shall be printer-specific per manufacturers list.
f) Good quality plastic cans shall be used for collection of WQ samples from every river gauging site. Generally 16 nos. plastic can be required for every rivergauging site out of then 20%, i.e., 4 nos., is become unserviceable after every year. These shall be replaced by new good quality plastic cans.
g) The boat and OB engine shall be sheltered by good GI shed /quality tarpaulin cover. These shall be replaced once in every two years. The OB engine shall be kept inside the site store building.
h) Stationery

    i) 200 pages hard bound register – 10 nos./station
    ii) 200 pages note books – 2 nos./station
    iii) Drawing sheets – 6 sheets/station
    iv) L-section/Cross-section – 3 sheets/station
    v) Plain paper sheets, rubber and pencils shall be required for every station

PART – D

Payments to staff

a) At every river gauging site with boat, one observer/gauge reader is required for checking the operations of boat/engine, AWLR/ DWLR. He shall prepare a report and submit it to the sectional engineer, and check that rating chart is received in time. Battery and battery box shall be kept in ready condition. He shall keep all the structures, equipment in good working condition for discharge measurements. He also shall keep daily discharge data in the discharge measurement register.
b) At every river-gauging site with boat three helpers for operation of boat and current meter measurements are needed bends one engine driver. They shall help the observer in discharge measuring work.

c) At every river-gauging site with boat, two labourers are required for operating, helping and for carrying out observations. They shall collect and transport the water samples by plastic cans from site. These labourers shall be employed during monsoon period only (5 months: July - Nov.).

PART – E

Miscellaneous expenditure

At every river gauging station, the following items are required for proper measurement of discharges operating the site.

a) The raincoat to each person once in two years
b) The gum-boot to each person once in two years
c) One torch to each person once in two years

Maintenance Norms

GD Station (Boat and OB Engine + DWLR/AWLR)

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Maintenance of Civil Works				
1.	Providing and carrying out repairs	Job/year	500	Job/year	500
2.	Repair to stilling structures				
	a) Repair cleaning lead pipes and restting after every two years	100 m^2	28	m^2	2,800
	b) Painting AWLR/DWLR housing after 2 year 140 x 25/2	70 m^2	30	m^2	2,100
3.	Overhauling, oiling and greasing to boat outfit/ winches	Job/year	500	Job/year	500
4.	Building maintenance	Job/year	2,500	Job/year	2,500
	Total for Civil Work maintenance				**8,400**
	Part B: Maintenance of Equipment				
5.	Rating of current meter and counter	1	3,500	No.	3,500
6.	Repairs to current meter and counter	Job/year	1,000	Job/year	1,000
7.	Repairs to stop watch	Job/year	500	Job/year	500
8.	Maintenance cost of DWLR/AWLR	Job/year	2,000	Job/year	2,000
9.	Running cost of OB Engine, P O L's	Job/year	L S		200
	Total for Equipment maintenance				**27,000**
	Part C: Cost of Consumable Items (Stationery)				
9.	Battery or dry cells	10	40	No.	400
10.	Connecting cable	20 m	10	m	200
11.	AWLR charts/ink or DWLR/battery cells	Job/year	1,000	Job/year	1,000
12.	Plastic Sample cans	16	50	No.	800
13.	GI sheets or Tarpaulin	1	500	No.	500
14.	Stationery (Paper/charts/ sheets/pencil etc.)	Job/year	1,000	Job/year	1,000
	Total for Consumable Items				**3,900**

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part D: Charges of Staff				
15.	Observer/ Gauge reader	1 x 12 months	5,500	Month	66,000
16.	Gauge Khalashi / helper (includes one OBE driver)	3 x 12	2,000	Month	72,000
17.	TA provision	Job/year	5,000	Job/year	5000
18.	Seasonal labour (2 x 150 days)	300 days	60	Days	18,000
	Total Charges of Staff				**1,61,000**
	Part E: Miscellaneous Charges				
19.	Rain coat/Umbrella	2 No.	300	No.	600
20.	Gum Boot	2 No.	250	No.	500
21.	Torch	2 No.	100	No.	200
22.	Kerosene	1 can	100	Can	100
23.	Nylon rope	100 m	5	m	500
24.	Battery cells	30	10	No.	300
	Total for Miscellaneous Charges				**2,200**
	Grand Total				**1,80,500**

N.B:

a) The HP Monitoring Network covers Peninsular India. Thus to provide uniform costs may not be appropriate. Costs are recommended amounts, and may be adjusted.

b) The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

6 Maintenance norm for Sediment Sampling and Analysis

The annual maintenance costs of a sediment laboratory at a GD site is estimated at Rs. 1,04,000/-. The details are provided in following table.

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Cost of Sediment Sampling and Analysis				
1	Cost of Establishment @ Rs 6000/- for 12 months				72,000
2.	Cost of repairs to sampler's, glassware etc. @ 15% of capital cost (Rs 70,000 plus Rs 80,000 – provided separately, see Annexures I & II)				22,500
3	Cost of other lab consumables	Job/year	1,000	Job/year	1,000
4	Cost of registers, stationery	5	100	No.	500
	Total for Sampling and Analysis				**96,000**
	Part B: Maintenance of building				
6..	Provision for cleaning powder, brushes, brooms, napkins, etc.	Job/year	1,000	Job/year	1,000
7.	Repairs to sanitary/electrical fittings	Job/year	1,000	Job/year	1,000
8.	General maintenance of building	Job/year	1,000	Job/year	1,000
9.	Electrical charges @ Rs. 1000.00/month				5,000
	Total for Lab maintenance				**8,000**
	GRAND TOTAL				**1,04,000**

N.B:

a) The HP Monitoring Network covers Peninsular India. Thus to provide uniform costs may not be appropriate. Costs are recommended amounts, and may be adjusted.

b) The cost on account of deployment of staff is the main component of running cost. It is necessary that some of the staff performing multiple activities have to be considered only once.

7 Maintenance norms for Water Quality Analysis Laboratories

7.1 Introduction

The Hydrology Project provides for establishment of a network of water quality analysis laboratories in the participating agencies to improve the water quality monitoring programmes. Lists of parameters to be tested under the project have also been enlarged to detect toxic substances and heavy metals. The water quality testing facilities envisaged under the project are indicated below:

Water Quality Analysis Laboratories (SW)

S. No.	Participating agencies	Level I	Level II	Level II+
1	Andhra Pradesh	15	2	-
2	Gujarat	24	1	1
3	Karnataka	10	2	-
4	Kerala	10	1	-
5	Madhya Pradesh	15	-	-
6	Maharashtra	21	4	-
7	Orissa	11	-	-
8	Tamil Nadu	15	-	-
9	CWC	96	10	2
	Whole Project	217	20	3

Water Quality Analysis Laboratories: (GW)

S. No.	Participating agencies	Level II	Level II+
1	Andhra Pradesh	5	1
2	Gujarat	3	1
3	Karnataka	4	1
4	Kerala	2	1
5	Madhya Pradesh	7	2
6	Maharashtra	5	1
7	Orissa	4	1
8	Tamil Nadu	3	1
9	CGWB	-	9
	Whole Project	33	18

The details of operation and maintenance cost for each type of laboratory are elaborated separately. Staffing costs are not included.

The operation and maintenance costs of level I and level II/II+ laboratories are divided into the following categories:

1. Cost of chemicals and glassware
2. Maintenance of laboratory building; as the laboratory buildings need some additional maintenance, as compared to normal buildings, these are included under O & M cost.

7.2 Details of Operation and Maintenance Costs of Laboratories under HP

Annual O&M costs are based on:

- Costs as listed in Annex III, IV and V, are based on listed prices of main national suppliers of laboratory equipment **and valid for 1999** (10% annual increase may be added).
- Requirement of laboratory chemicals are based on one year's consumption.
- Laboratories initially have a complete set of glasswares. Annual replacement costs are estimated at 25% of the complete set.

- Equipment repairs are for analysis equipment, such as flame photometer, spectrophotometer, pH and other meters (not including AAS/GC). Annual repair cost is estimated at 10% of total equipment cost, assumed to be Rs.10,000 for Level I and Rs. 500,000 for level II and II+ laboratories.
- Laboratory consumables include items like gases, laboratory wipes, sampling accessories, and other contingent expenditures, not covered under glasswares, chemicals and repairs.
- Annual Maintenance Contract is recommended for AAS and GC equipment, and estimated at 10% of the original cost, assumed to be Rs. 10,00,000 each.
- Costs of transport for collecting samples is NOT included. Separate budget provision must be made for this important item. Rapid and proper transport of sample in icebox is crucial.

7.3 Electrical charges

The electrical charges have been computed @ Rs. 4/- per Kwh for an average consumption as detailed below:

Continuously running equipment

1	Oven for 15 days/month * 2 Kwh * 24h	=	720 kwh
2	BOD Incubator for 15 days/month * 0.5 kwh * 24h	=	180 kwh
3	Bacteriological Incubator for 15 days/month 0.5 kwh * 24 h	=	180 kwh
4	Refrigerator for 30 days/month * 0.5 kwh * 24 h	=	360 kwh
	Total	=	1440 kwh

Intermittently running equipment

1	Autoclave for 2 hours/day for 5 days/month @ 3 kwh	=	30 kwh
2	Air conditioners 2 * 8 hour/day for 25 days/month @ 1 kwh	=	400 kwh
3	Other Instruments 6 hours/day for 25 days/month @ 3 kwh	=	450 kwh
	Total	=	880 kwh
	Grand total	=	2320 kwh

- Total electrical charges per month = Rs. 4 * 2320 = 9280/-
- Total charges for 12 months = Rs. 1,11,360/-

7.4 Maintenance norms for Level I Laboratory

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Cost of Chemicals and Glassware				
1.	Cost of chemicals				2,800*
2	Cost of glassware				2,200*
3	Cost of other lab consumables	Job/year	1,000	Job/year	1,000
4	Cost of registers	5	100	No.	500
	Total for Chemicals and Glassware				**6,500**
	Part B: Maintenance of Equipment				
5.	Equipment repairs	Job/year	1,000	Job/year	1,000
	Total for Equipment maintenance				**1,000**
	Part C: Maintenance of building				
6..	Provision for cleaning powder, brushes, brooms,	Job/year	1,000	Job/year	1,000
7.	Sampling accessories, ice, etc.	Job/year	1,000	Job/year	1,000
8.	Repairs to sanitary/electrical fittings	Job/year	1,000	Job/year	1,000
9.	General maintenance of building	Job/year	1,000	Job/year	1,000
10.	Electrical charges @ Rs. 1000.00/month				12,000
	Total for Lab maintenance				**16,000**
	GRAND TOTAL				**23,500**

*Please refer to details enclosed in Annex III (**1999 prices;** 10% annual increase may be added).

7.5 Maintenance norms for Level II Laboratory

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (Rs.)
	Part A: Cost of Chemicals and Glassware				
1.	Cost of chemicals				35,000*
2	Cost of glassware				25,000*
3	Cost of other lab consumables	Job/year	5,000	Job/year	5,000
4	Cost of registers	5	100	No.	500
	Total for Chemicals and Glassware				**65,500**
	Part B: Maintenance of Equipment				
5.	Equipment repairs	Job/year	50,000	Job/year	50,000
	Total for Equipment maintenance				**50,000**
	Part C: Maintenance of building				
6..	Provision for cleaning powder, brushes, brooms,	Job/year	10,000	Job/year	10,000
7.	Repairs to sanitary/electrical fittings	Job/year	20,000	Job/year	20,000
8.	General maintenance of building	Job/year	10,000	Job/year	10,000
9.	Electrical charges	Job/year	1,40,000	Job/year	1,40,000
10.	**Total for Lab maintenance**				**1,80,000**
	GRAND TOTAL				**2,95,000**

*Please refer to details enclosed in Annex IV (**1999 prices;** 10% annual increase may be added).

7.6 Maintenance norms for Level II+ Laboratory

Item No.	Item	Qtty	Rate (Rs.)	Unit	Amount (in Rs.)
	Part A: Cost of Chemicals and Glassware				
1.	Cost of chemicals				47,000*
2	Cost of glassware				85,000*
3	Cost of other lab consumables	Job/year	10,000	Job/year	10,000
4	Cost of registers	5	100	No.	500
	Total for Chemicals and Glassware				**1,42,500**
	Part B: Maintenance of Equipment				
5.	Equipment repairs	Job/year	50,000	Job/year	50,000
	Total for Equipment maintenance				**50,000**
	Part C: Maintenance of building				
6..	Provision for cleaning powder, brushes, brooms, napkins, etc.	Job/year	10,000	Job/year	10,000
7.	Repairs to sanitary/electrical fittings	Job/year	20,000	Job/year	20,000
8.	General maintenance of building	Job/year	15,000	Job/year	15,000
9.	Electrical charges	Job/year	1,40,000	Job/year	1,40,000
10.	**Total for Lab maintenance**				**1,85,000**
	Part D: Annual maintenance contract for AAS & GC				
11.	AMC for AAS/GC	Job/year	2,00,000	Job/year	2,00,000
	Total for AMC for AAS/GC				**2,00,000**
	GRAND TOTAL				**5,77,000**

*Please refer to details enclosed in Annex IV and V (**1999 prices;** 10% annual increase may be added).

ANNEX I
EQUIPMENT FOR SEDIMENT SAMPLING AND LABORATORY

S. No	Item	Quantity	Rate	Amount
1	Bottle type Samplers	2		
2	Metallic 1 Litre bottle	2		
3	Metallic Conical Flask	2		
4	Metallic Beaker 500 ml.	12		
5	Double Jacketted cylinder	1		
6	Filtering apparatus	1		
7	Hydrometer	1		
8	Set of 3 sieves (4" dia)	1		
9	Bed Material Scoop	1		
10	Oven	1		
12	Other Sundry items			
	Total Cost			**Rs.70,000/-**

ANNEX II
ORDINARY EQUIPMENT REQUIRED IN SEDIMENT LABORATORIES

S. No	Item	Quantity	Rate	Amount
1	Brass Tongs	3		
2	Stop watches	1		
3	Analytical Balance	1		
4	Enamel or Stainless steel (SS) trough 28cmx7cms	1		
5	Buckets S S or Enamel	6		
6	Plates	6		
7	Jug 2 litres	1		
8	Bowls 500 ml	2		
9	Funnel 8 cm dia	2		
10	Funnel 16 cm dia	2		
12	Funnel stand single	2		
13	Funnel stand double	1		
14	Bucket stand with hooks	1		
15	Tripod stand	1		
16	GI Bucket 30 cms	1		
17	Tape metallic 50 mtrs	1		
18	Pipe wrench 35 cms	1		
19	Pliers 20 cm long	1		
20	Pipette stand	1		
21	Triangular file 15 cms	1		
22	Physical Balance in a case	1		
23	Beakers glass 500 ml	6		
	Measuring cylinders 1 lit.	2		
	Measuring cylinders 500 ml	2		
	Desiccator 20 cms dia	1		
24	Rubber cork Flat Bottom flask	6		
25	Funnel glass 100 cms	6		
26	Pipette glass 100 ml	1		
27	Porcelain basin 9 cms	3		
28	Porcelain basin 10 cms	3		
29	Thermometer 110 deg C	2		
30	Thermometer 50 deg C	2		
31	Rubber pad 15 cm dia x 6mm thick	2		
32	Bottle glass 500 ml	12		
33	Rubber Corks assorted	12		
34	Filter Paper assorted	2		
35	Glass tubing assorted	1 kg		
36	Pressure rubber tubing	10 mtrs		
37	Glass marking pencil	6		
38	Glass rod assorted	1 kg		
39	Watch glass 10 cm dia	6		
40	Pinch corks	2		
41	Meter rod	1		
42	Wash bottle polythene	2 sets		
43	Steel Scales	1		
44	Jets and delivery tubes	6 sets		
45	Cleaning brushes	1		
46	Wire gauge with asbestos	6		
47	Cork borer set	1 set		
48	Hammer 1 kg	1		
49	Rechargeable lamps	1		
50	Graph pads 30x20 cms	3		
51	Calcium chloride	500 gms		
52	Alum	500 gms		
	Sundries			
	Total cost			**Rs 80,000/-**

ANNEX III
CHEMICALS AND GLASSWARE FOR LEVEL I LABORATORIES

Table A Chemicals needed on annual basis

Chemical	Quantity Required	Unit Price (Rs)	Amount (Rs)
Buffer Tablet Bottle, pH 4	1 pkt (10 tablets)	55/ pkt	55
Buffer Tablet Bottle, pH 7	1 pkt (10 tablets)	55/ pkt	55
Buffer Tablet Bottle, pH 9.2	1 pkt (10 tablets)	55/ pkt	55
Manganous Sulphate	1 kg	95/500 g	190
Potassium Chloride (GR)*	500 g	130/500 g	130
Potassium iodate (GR)*	100 g	350/ 100 g	350
Potassium iodide	250 g	670/250 g	670
Salicylic Acid	500 g	185/500 g	185
Sodium Azide	100 g	320/100 g	320
Sodium Hydroxide, flakes	1 kg	55/500 g	110
Sodium Thiosulphate (GR)*	500 g	200/500 g	200
Starch indicator	500 g	330/500 g	330
Sulphuric Acid (GR)*	500 ml	100/500 ml	100
Total (excluding taxes)			**2,750**

Table B Glassware (initial requirement)

Glassware	Number Required	Unit Price (Rs.)	Amount (Rs.)
Beaker, 500 ml	2	68	136
Beaker, 100 ml	6	35	210
Conical Flask, 250 ml	10	66	660
Conical Flask, 100 ml	4	42	168
Pipette, graduated,10 ml	5	62	310
Pipette, graduated, 5 ml	2	58	116
Burette,50 ml	2	272	544
Burette Stand, clamps and tile	2	148	296
Measuring cylinders,1000 ml	1	646	646
Measuring cylinders, 500 ml	2	439	878
Measuring cylinders, 250 ml	2	332	664
Measuring cylinders, 100 ml	2	182	364
Reagent bottles, 1000 ml	4	304	1,216
Reagent bottles, 500 ml	4	215	860
Reagent bottles, 250 ml	8	187	1,496
Total (excluding taxes)			**8,564**
Annual costs (25% of total, rounded)			**2,200**

*Note: GR (also AR) = Guaranteed Reagent or Analytical grade reagent
Note: Based on **1999 prices;** 10% annual increase may be added

ANNEX IV
CHEMICALS AND GLASSWARE FOR LEVEL II LABORATORIES

Table A Chemicals needed on annual basis

Name of Chemicals	Quantity Required	Unit Price (Rs.)	Amount (Rs.)
1,2 Cyclohexylenediamine Tetra Acetic Acid	25 g	1,800	1,800
Acetic Acid	500 ml	83	83
Acetone	500 ml	80	80
Aluminium Potassium Sulphate	500 g	65	65
Aluminium Sulphate ($Al_2(SO_4).18\ H_2O$)	500 g	75	75
Ammonia Purpurate (murexide)	5 g	130	130
Ammonium Acetate	500 g	115	115
Ammonium Chloride (GR)*e	500 g	130	130
Ammonium Molybdate (GR)*	100 g	280	280
Ammonium Solution 0.91 Sp. Gr.	500 ml	55	55
Bile salt	100 g	450	450
Boric Acid (GR)*	500 g	320	320
Brilliant Green indicator	25 g	80	80
Bromocresol Green	125 ml	44	44
Buffer Tablets, pH 4.0	10 Tabs x 2	55	110
Buffer Tablets, pH 7.0	10 Tabs x 2	55	110
Buffer Tablets, pH 9.2	10 Tabs x 2	55	110
Cadmium granules	500 g	850	850
Calcium Carbonate	500 g	60	60
Calcium Chloride	500 g	95	95
Chloroform	500 ml	120	120
Copper powder	500 g	510	510
Cupric (Copper) Sulphate	500 g	125	125
Curcumine, crystalline	5 g	500	500
Dipotassium Hydrogen O.Phosphate	500 g	185	185
Eriochrome Black – T (GR)*	25 g	150	150
Ethyl alcohol (95%)	500 m x 3	290	870
Ethylene Diamine Tetra Acetic Acid (EDTA) (GR)*	100 g	140	140
Ferric Chloride (GR)*	500 g	390	390
Ferroin indicator (GR)*	100 ml	550	550
Ferrous ammonium Sulphate	500 g	75	75
Glucose	500 g	75	75
Hydrochloric Acid	2500 ml	240	240
Hydroxyl Amine hydrochloride (GR)*	100 g	290	290
Isopropyl Alcohol (GR)*	500 ml	110	110
Lactose	500 g	140	140
L-Glutamic Acid	100 g	120	120
Magnesium Sulphate (GR)*	500 g	110	110
Manganous Sulphate	500 g x 4	95	380
Mercuric Sulphate	250 g	410	410
Methyl Orange powder	25 g	60	60
Methyl Red	25 g	80	80
Methylene Blue (GR)*	25 g	200	200
N-(1-naphthyl)-Ethylene Diamine Dihydrochloride	5 g	325	325
Oxgall, powder	100 g	900	900
Peptone	500 g	360	360

Name of Chemicals	**Quantity Required**	**Unit Price (Rs.)**	**Amount (Rs.)**
Phenanthroline (GR)*	5 g	225	225
Phenol (GR)*	500 g	200	200
Phenolphthalein Indicator	50 g	75	75
Phosphoric Acid	500 ml	175	175
Potassium Antimony Tartrate (GR)*	100 g	160	160
Potassium Bi-iodate	100 g	320	320
Potassium chloride (GR)*	500 g	130	130
Potassium Chloroplatinate	1 g	1,200	1,200
Potassium Chromate	500 g	240	240
Potassium Dichromate (GR)*	500 g	225	225
Potassium Di-Hydrogen O.Phosphate (GR)*	500 g	230	230
Potassium Hydrogen Phthalate (GR)*	500 g	325	325
Potassium Iodide	250 ml x 4	670	2,680
Potassium Iodide (GR)*	100 g	300	300
Potassium Nitrate	500 g	85	85
Potassium Permanganate (GR)*	500 g	310	310
Silver Nitrate (GR)*	25 g	500	500
Silver Sulphate	25 g	600	600
Sodium Acetate (GR)*	250 g	170	170
Sodium Arsenite (GR)*	250 g	6,000	6,000
Sodium Azide	100 g	320	320
Sodium Carbonate (GR)*	500 g	90	90
Sodium Chloride (GR)*	500 g	48	48
Sodium Fluoride (GR)*	500 g	425	425
Sodium Hydroxide Pellets (GR)*	500 g x 4	105	420
Sodium Hypochloride solution	500 ml	45	45
Sodium Lauryl Sulphate, powder	500 g	270	270
Sodium Nitrate (GR)*	500 g	90	90
Sodium Nitropruside	100 g	190	190
Sodium Oxalate	500 g	120	120
Sodium Tetraborate ($Na_2B_4O_7.10\ H_2O$) (borax) (GR)*	500 g	160	160
Sodium Thiosulphate (GR)*	500 g	200	200
SPADNS (GR)*	1 g	340	340
Starch indicator, soluble	500 g	330	330
Sulphamic Acid	500 g	65	65
Sulphanilamide (GR)*	100 g	300	300
Sulphuric Acid 98%	2500 ml	240	240
Trisodium Citrate	500 g	150	150
Tryptose	500 g	1,500	1,500
Zirconyl Chloride	100 g	3,000	3,000
Total (excluding taxes)			**34,910**

*Note: GR (also AR) = Guaranteed Reagent or Analytical grade Reagent
Note: Based on **1999 prices;** 10% annual increase may be added

Table B Glasswares (initial requirement)

Glassware and Apparatus	Number Required	Unit Price (Rs)	Amount (Rs)
Volumetric flasks, 1000 ml	5	323	1,615
- do - 500 ml	5	215	1,075
- do - 100 ml	10	139	1,390
- do - 50 ml	10	120	1,200
- do - 25 ml	10	107	1,070
Conical flasks NM, 100 ml	10	42	420
- do - 250 ml	25	66	1,650
Burettes single bore with pipe PTFE screwcock, 50 ml	5	791	3,955
Volumetric pipettes, 10 ml	5	58	290
Volumetric pipettes, 5 ml	5	47	235
Volumetric pipettes, 2 ml	5	43	215
Volumetric pipettes, 1 ml	5	43	215
Measuring cylinders with spout, 500 ml	5	439	2,195
- do - 100 ml	10	182	1,820
- do - 50 ml	6	156	936
Graduated pipettes, 10 ml	60	62	3,720
- do - 5 ml	10	58	580
- do - 1 ml	5	45	225
Glass beakers with spout, 1000 ml	5	162	810
- do - 500 ml	5	68	340
- do - 250 ml	10	40	400
- do - 100 ml	25	35	875
Reagent bottles, narrow mouth, Amber coloured, 500 ml	10	310	3,100
Reagent bottles Narrow flat level stopper, 1 lit	10	304	3,040
- do - 500 ml	10	215	2,150
- do - 250 ml	25	187	4,675
- do - 125 ml	10	175	1,750
COD flask, 250 ml , joint 24/29	10	99	990
Reflux condenser, joint 24/29	10	437	4,370
Nessler tubes	10	32	320
Centrifuge tubes, 50 ml	5	110	550
Reagent bottles wide mouth with flat lead dust proof stopper, 250 ml	5	150	750
Burette stand (iron) with fisher type clamps – single	6	175	1,050
Pipette stand, polythene for 12 pipettes	6	105	630
Porcelain tiles glazed, 150x150mm	6	12	72
Porcelain dish, 200 ml	6	120	720
Glass Rod, Assorted	6	8	48
Dessicator, small, with cover knob top, 160 mm	2	1500	3,000
Morter and pestles, porcelain, 15 cm	2	95	190
Watch glasses 125 mm	2	105	210
- do - 100 mm	2	83	166
- do - 75 mm	2	75	150
Weighing bottles 50mm x 35mm	10	299	2,990
Polythene dropping bottles, 100/120 ml	10	28	280
Polythene wash bottles, 1000 ml	10	59	590
Spatulas, S.S. with one side spoon, 150mm	6	10	60
Dishes, evaporating, 150 mm x 80 mm	10	150	1,500
Culture tubes, 25mm x 100 mm	100	10	1,000
Culture tubes, 12 mm x 100 mm	50	5	250

Glassware and Apparatus	Number Required	Unit Price (Rs)	Amount (Rs)
Dilution bottle, 160 ml	20	176	3,520
B.O.D. bottles with interchangeable stopper spout, 300 ml	30	304	9,120
Distillation Assembly with round bottom flask 1000 ml , still head double surface condenser, 2000mm, Thermometer 0-250°C, with PTFE cone and receiver adopter.	1	1,920	1,920
Separating funnels with PTFE plug, conical shape 500 ml	5	658	3,290
Acid and alcohol-proof rubber gloves 300, 350 or 400 mm (any)	4	70	280
Petri dishes glass 100 mm x17 mm	10	99	990
Polythene reagent bottles 125 ml	10	28	280
- do - 500 ml	10	35	350
Wire gauge with asbestos centre 150x150mm	6	8	48
Polythene bottles N.M 2 lit	50	85	4,250
- do - 1 lit	50	48	2,400
Crucible Tongs, S.S. 200mm	2	68	136
Silica crucible 25 ml	1	145	145
Rubber suckers for pipettes of different sizes	12	12	144
Eye and face wash, shower operated	1	5,950	5,950
First aid box	2	295	590
Filter paper, Whatman No.41, 146 x 57mm	1 ream	4,500	4,500
Total, (excluding taxes)			**97,745**
Annual glassware costs (= 25% of total cost, rounded)			**25,000**

Note: Based on **1999 prices;** 10% annual increase may be added

ANNEX V
ADDITIONAL CHEMICALS AND GLASSWARE FOR LEVEL II+ LAB.

All Level II+ laboratories need the complete set of chemicals and glassware as listed in Annex IV. In addition, Level II+ laboratories need certain items for operation of the AAS and GC instruments

Table A Chemicals required annually for AAS and GC

Chemical	Quantity required	Unit price (Rs)	Amount (Rs)
N-Hexane (GR)*	1 L x 3	1,375	4,125
Nitric Acid (GR)*	2.5 L x 1	330	330
Perchloric Acid (GR)*	500 ml x 2	485	970
Standard solutions for organic pollutants (imported)	5	1,250	6,250
Total (excluding taxes)			**11,675**

Table B Glassware and apparatus required for AAS and GC

Glasswares	Quantity required	Unit price (Rs)	Amount (Rs)
Soxhlet extractor plus thimble	1	2,000	2,000
AAS lamps	11	20,000	2,20,000
Volumetric flask, 100 ml	10	326	3,260
Volumetric flask, 50 ml	10	303	3,030
Volumetric flask, 25 ml	10	303	3,030
Volumetric flask, 10 ml	5	324	1,620
Separating funnels, pear shaped, 1 lit	5	818	4,090
Separating funnels, pear shaped, 500 ml	5	658	3,290
Total (excluding taxes)			**2,40,320**
Annual glassware and apparatus costs (= 25% of total cost, rounded)			**60,000**

*Note: GR (also AR) = Guaranteed Reagent or Analytical grade Reagent
Note: Based on **1999 prices;** 10% annual increase may be added

Government of India & Government of The Netherlands

Technical Assistance
HYDROLOGY PROJECT

DHV CONSULTANTS & DELFT HYDRAULICS with HALCROW, TAHAL, CES, ORG & JPS

SURFACE WATER MONITORING

PROCEDURES FOR OPERATION

FEBRUARY 2001

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Preface

The Hydrology Project has made considerable investment in the procurement of equipment and creation of infrastructure and facilities. These facilities need to be maintained so that these are available and perform satisfactorily for their full-expected life-keeping period. The Hydrological Information System supported by the HP investment is a dynamic operating system. It needs checks on system health and spotting impediments, embedded in Operation & Maintenance (O&M) practices. There is a need for focussing and improving the O & M practices and keeping provisions in the annual budget, so that HIS is sustained. A regular updateable, database of station/ office health, equipment health and staff training adequacy, is envisaged for inclusion in the system. The Management Information System (MIS), containing facets indicated above, needs to be used by HIS managers at various levels.

To sustain the operation of HIS, World Bank Missions urge earmarking sufficient budgetary provisions for yearly sustenance of all components established under the Hydrology Project.

The practices recommended in the Manuals and presented here, give in detail what needs to be done for various equipment categories by way of routine maintenance and calibration. What needs to be under watch during inspections for accurate/quality data to emerge, is also presented here. Recommended spares to be stocked are given.

It is incumbent for each agency participating in the Hydrology Project to:

1. prepare list of the network stations, sampling locations and labs with its Sub-divisions, Divisions and higher formations, upto data storage centres.
2. prepare pre-monsoon, during monsoon and post-monsoon inspections by all Assistant Engineers (SDOs), Executive Engineers (DOs) and SEs. Review of inspections by CE need also to be spelt out. A practice of monitoring the officers' effectiveness to observe and remove constraints noticed during these inspections has to be introduced to sustain the HIS.
3. work out annual budget requirement customised to Sub-divisions, Divisions, Circles and to the agencies in the HP, using recommendations given by Consultants.
4. formulate a detailed programme for execution of maintenance works in a planned manner.
5. ensure that the maintenance estimates are sanctioned at the beginning of the financial year so that round-the-year maintenance does not suffer any hindrance.

In this context, this O & M manual brings out the detailed guidelines for visualising the O & M costs of equipment. Establishment recommended has been spelt out separately; but actual deployment may vary and it is left to the agencies to work out their requirement, especially as the establishment cost is substantial.

1 Inspection of Meteorological Stations (SRG/ARG/ HP-FCS)

1.1 Periodicity of Inspections

1.1.1 Rain Gauge Stations (SRG/ARG), Climate Stations (HP - FCS)

Hydrology Project has provided a number of raingauge stations that are stand-alone stations. Some of them are on river gauging (RG) stations. There is a set of HP-FCS stations, which are either stand-alone or on RG locations requiring full-time attention, by a dedicated observer. In the ensuing the procedures by and large consider the requirements for good quality data on all meteorological monitoring, be it from stand alone meteorological locations or RG stations.

It is necessary that the raingauge/ climate monitoring installations are inspected periodically to observe the deficiencies, plan their rectification and implement necessary measures for rectification in appropriate time, when rainfall is not significant. Before the onset of the monsoon, inspections are, therefore, necessary to satisfy the HIS managers that monitoring will proceed and quality information will result during the ensuing monsoon season.

During the monsoon season also, after each unduly heavy downpour or hail storm, it is to make sure that the raingauge and its surroundings are not damaged or disturbed. The Supervisor/AEs in-charge shall undertake site inspections.

Inspection record should reach the Executive Engineers/ Superintending Engineers promptly, to take stock of the system status and provide direction towards system upkeep. A practice to review officer's efficiency based on performance emanating from the outcome of inspections is recommended to ensure efficient HIS network management.

It is advisable that all raingauge stations (SRG & ARG) are inspected, before the onset of the monsoon season every year, by IMD inspectors. Considering the busy schedule of IMD Inspectors, it is practicable/desirable that every raingauge station should be inspected once in 3 years. At the completion of routine inspections, the Inspector is supposed to submit an Inspection Report. A copy of this Report is given to the IMD controlling centre and the CE - HP, with the purpose of implementation of the recommendations made by the Inspector as early as possible.

It is the standard practice to install an instrument at the field station only after its certification/ calibration by IMD. In case the instrument undergoes some replacement, it is advisable to check its calibration simultaneously.

1.1.2 HP FCS

In addition to SRG and ARG, a HP-FCS station is equipped with wind, temperature, evaporation and radiation monitoring instruments both manual and autographic. While carrying out the routine inspection of the station, the Inspector should ensure that the station is well-maintained and that the observer is fully-trained. For this purpose, the Inspectors should follow the following procedure: IMD Inspectors are provided with an Inspection Kit. It contains all necessary items required for the inspection work of all meteorological instruments, their testing, adjustment, cleaning, oiling, painting and minor repairs. The observer also carries out his observational work in the presence of the inspector.

1.2 Proforma for Inspection

It is of great importance that Meteorological (HP – FCS, ARG & SRG) stations should be inspected periodically in order to ensure that instrument condition and exposure always conform to the standards laid down by WMO and adopted by the India Meteorological Department (IMD).

Standard Proformas for field inspection and audit for rainfall stations, climate stations, wind instruments, thermometers and evaporimeters are shown in Annex I.

1.3 Spare Materials to be kept for SRG/ARG/HP – FCS Sites

It is very important to keep spares at each Divisional office. The number or quantity of spares depends upon the number and type of the field stations, like SRG, ARG and FCS, functioning under its control. The following Table may serve is included as a guide:

Item	**Number of spares**	**Remarks**
Rain measuring cylinder (Appropriate dimension)	1 Rain measuring cylinder for every 3 SRG sites	
Autographic charts	A set of 30 charts appropriate to the autographic instrument for every 2 ARG or 1 FCS site	
Nibs for Autographic Instruments	1 Nib for every 4 ARG site or 1 FCS site	To be replaced by trained person
ARG washer	1 washer for every 3 ARG site	To be replaced by trained person
Clock Drum	1 Clock Drum for every 6 ARG or 4 FCS site	To be replaced by trained person
Chart Clip	1 Chart Clip for every 4 ARG or 1 FCS site	
Winding Key or battery cells for clock drum	1 Winding Key or 1 set of battery cells for every 4 ARG or 2 FCS site	
Thermometer	1 Thermometer for every 4 FCS site	
Forms and Registers	15 days' stock for every site	

1.4 Recommended Maintenance Cost

For smooth and uninterrupted functioning of hydrometeorological station (SRG, ARG or FCS), adequate budget is required to be allocated for its maintenance on yearly basis. Considering the accepted norm, which lists depreciation in a year @ 15% of the total cost of investment in establishing a meteorological station. Another 10% of the investment cost is the yearly running cost of the station, which includes the stationery including forms, autographic charts etc. Taking into account both these costs, the annual budget is to be provided.

Considering the investment costs of civil works, instruments and consumable materials prevailing during the year 2000, the cost of setting up a SRG station comes to Rs. 10,000/-, an ARG station to Rs. 30,000/- and a FCS station to Rs. 1,50,000/-.

Keeping investment costs in view and the working requirements, the yearly cost of maintaining a SRG station is Rs, 5,750/-, an ARG station: Rs, 8,000/- and FCS station: Rs 56,000/-.

1.5 Check List for Routine Maintenance

SRG

1. The collector (funnel) of SRG should be cleared of any blockage, like dirt or dry leaves.
2. The collector, receiving bottle and the base of SRG should be checked for leakage. If leakage is detected, immediate repair/replacement is to be undertaken.
3. While replacing the collector on the base, it should be ensured that the two locking rings are engaged properly.
4. The observatory enclosure should be kept clean and locked.

ARG

1. ARG funnel should be regularly checked for dirt/debris
2. Wire gauge filter of ARG should be cleaned once a week or immediately after thunder/dust storm.
3. Inside of the glass disc should be cleaned once a week.
4. Clean the float chamber before the commencement of rainy season.
5. Keep the tip of the nib clean with methylated spirit every week.
6. Special ink is used in the pen to obtain fine trace on the chart. During summer, a minute drop of glycerine to be added to reduce evaporation of ink from the nib.
7. Check alignment of the drum if trace on the chart is not along the zero line when no rain has fallen.
8. Check float for leakage if syphoning occurs after more than 10 mm of rain occurs.
9. Keep observatory enclosure locked, clean and fencing intact.

Wind Instrument

1. Instrument should be kept clean and lubricated at intervals of 15 days.

Maximum and Minimum Thermometers

1. Both the maximum and minimum thermometers are to be set after the routine morning observation at 0830 hrs.
2. The minimum thermometer is again set after the routine observation at 1730 hrs.
3. Ensure that mercury or alcohol thread in the thermometer is not broken anywhere.
4. The thermometers are kept inside the Stevenson screen to protect from direct sunlight and to provide good air ventilation.

Wet bulb Thermometer

1. The wick should be clean and changed every fortnight and also immediately after a dust storm.

Thermograph

1. The instrument should be kept clean. The bearings of the spindle and gate suspension should be cleaned with methylated spirit every fortnight.
2. The pressure of the pen on the chart should be adjusted carefully after setting the chart.
3. The sensor should be kept free from dust by wiping it with soft cloth once a week.

Hygrograph

1. The instrument should be kept clean, the strand of hair should be cleaned by washing with distilled water every week.
2. The strand of hair should not be touched with fingers.
3. The spindle pivots are cleaned once a month with methylated spirit.

Pan Evaporimeter

1. Clean the pan once a fortnight alongwith the three side holes in the stilling well.
2. A small amount of copper sulphate to be added to fresh water when refilled to avoid the growth of algae.
3. Clean the stilling well and centre point rod with a soft cloth every week.

Sunshine Recorder

1. Keep the instrument clean by wiping with a soft cloth.
2. Insert proper chart appropriate to the day / the season.

Observatory Enclosure.

1. Ground to be levelled and clean.
2. Fencing to be strong and tight.
3. Exposure condition to be excellent.
4. Observatory to be kept always locked.

Time of Observation

1. Observer has to synchronise his watch daily with time signal.

1.6 Calibration requirements of Meteorological Instruments

1.6.1 General

All surface meteorological instruments are manufactured in accordance with the Indian Standards (IS). For details, the users may refer to Equipment Specification, Surface Water Manual. It is obligatory on the part of the manufacturers to send these instruments to India Meteorological Department (Instrument Division, Pune) for "certification" before the instruments are supplied to the users. IMD, on their part, mould carry out the testing and calibration of surface meteorological instruments and each instrument with its serial number provided in a certificate.

It is essential to procure meteorological instruments with certification for the sake of uniformity in the field operations, which is the first step to arrive at comparable hydrometeorological data of high quality.

1.6.2 Standard Rain Gauge (SRG)

The Standard Rain Gauge and rain measuring glass are tested for their general appearance, dimensions, locking ring and leakage. Rain measures are calibrated for every 0.5-mm using a standard burette. A polythene bottle of capacity of 2 litres, 4 litres or 10 litres is kept within the base. (10-litre bottle is used in very heavy rainfall areas). The mouth of the bottle shall be not less than 45 mm in diameter. It is ensured that these conform to the Indian Standard (IS: 5225 and IS: 4849) and authenticated by IMD Certification.

1.6.3 Autographic Rain Gauge (ARG)

The Autographic Rain Gauge is tested for its general appearance, dimensions, calibration, clock rating and siphon time conforming to the Indian Standard (IS: 5235) and authenticated by IMD Certification.

The ARG is calibrated under controlled laboratory conditions by slowly running water of fixed quantity equivalent to 16.2 mm from the measure of a SRG (Catch area 200 cm^2), to a 203 mm internal diameter ARG to get one siphoning of 10 mm rainfall and siphoning time is adjusted to 15 seconds. The clock work mechanism of ARG is also calibrated and tested with a standard clock and compensated for all temperatures between 0 and 40^0C. The charts used in ARG should conform to Indian Standard (1S: 5947) for good result.

All the autographic rain gauges shall be tested before the onset of monsoon rains. The instrument needs recalibration if the clockwork mechanism is replaced.

1.6.4 Tipping Bucket Rain Gauge (TBRG)

The Tipping Bucket Raingauge is tested for its general appearance, dimension, and calibration and data logger system. The TBR assembly is calibrated by measuring the volume of water required to cause one tip of the bucket. A controlled burette is filled with clean water until it reads ‘0’ (zero). Water is poured slowly from the burette into the collector to produce 3 tips of the bucket, the rate of flow being reduced to discrete drops before each tip, the burette reading is noted after each tip. The process is repeated to give a total of 12 tips and the average volume per tip calculated. For a 750 cm^2 collector (MK 3 IMD), each tip will be V/75 mm of rainfall, where V is the average volume of water per tip. The calibration value of V/75 mm must lie within the range 0.196 to 0.204 mm per tip.

All TBRGs shall be tested before the onset of the monsoon.

1.6.5 Wind Instruments

Windvane: Mechanical windvanes are tested for general appearance, dimensions, assembly, sensitivity (Friction test) and balancing, conforming to the Indian Standard (IS: 5799) and authenticated by IMD Certification.

For calibration purposes, the 4 direction arms are fixed with the help of a magnetic compass and for the sensitivity of the instrument, the complete instrument on final assembly is held firm at its bottom and the balance weight is imparted an impact by a hammer weighing 0.72 kg and having a handle length of 240 mm, it shall make not less than 5 and not more than 10 complete revolutions before coming to rest.

Anemometer: Cup counter Anemometers are tested for general appearance, dimensions, counter changing, bearing test (sensitivity test) and cup balancing, conforming to the Indian Standard (IS: 5912) and authenticated by IMD Certification.

For calibration purposes, a wind tunnel generating wind upto 125 km per hour conforming to Indian Standard (IS: 5912) is used. After calibration, the instrument is tested within the tolerance limit of +/-1 km/h speed below 10 km per hour and +/- 10% for speed above 10 km per hr. For the sake of sensitivity, the ball bearings and other moving parts should be kept clean and suitably lubricated every week.

1.6.6 Thermometers

All liquid in glass thermometers (Dry bulb, Wet bulb, Maximum, Minimum) are tested for general appearance, uniform graduation, no break(s) in liquid column and corrections, conforming to the Indian Standard (IS : 5681) and authenticated by IMD Certification.

For calibration purposes, the instrument is kept in a constant temperature water bath between 0 to 50^0C after removing possible breaks in the liquid column. The true temperatures of the water bath are obtained from ‘Reference Thermometers’. Relevant correction factor is also determined and the value put on a card and attached to the instrument to determine the correct temperature. The Instrument needs daily checking for possible break(s) in the liquid column.

1.6.7 Thermograph

All thermographs are tested for general appearance, friction, clockwork mechanism and calibration, conforming to the Indian Standard (IS 5901) and authenticated by IMD Certification.

For calibration purposes, the instrument is kept in a thermostatic chamber working within the temperature range of -20^0C to $+60^0$C. Temperature is controlled with a laboratory ‘Reference thermometer’.

The scale error of the instrument is determined by immersing the sensing element (bimetallic element) successively in comparison baths kept well stirred and maintained at 3 or 4 different temperatures, the difference between lowest and highest temperature being about 40^0C. The range of temperature indicated by the reference thermometer and instrument shall be correct to within +/- 1^0C.

The clockwork mechanism is also calibrated and tested as in the case of ARG.

1.6.8 Hydrograph

All hair hygrographs are tested for general appearance, friction, clearing, clock work mechanism and humidity comparison, conforming to Indian Standard (IS 5900) and authenticated by IMD Certification.

For calibration purposes, the instrument is kept in a properly designed and operated humidity cabinet, giving sufficient time for the instrument to reach equilibrium. Humidity is checked against a psychrometer and adjusted to read the ambient relative humidity of 95% after attaining equilibrium when the hair is wetted with distilled water. The error should not exceed +/- 5%, at any point above 20%.

The clockwork mechanism is also calibrated and tested as in the case of ARG.

1.6.9 Pan Evaporimeter

Open Pan Evaporimeter is tested for general appearance, dimensions, leak, chlorinated rubber paint inside and stilling well reference rod, conforming to Indian Standard (IS: 5973) and authenticated by IMD.

The calibration is mainly of the graduated measuring cylinder from which water is poured into the pan and is graduated with a scale 0 to 20 cm. It has a diameter exactly one tenth that of the pan viz 122 mm as the diameter of the pan is 122 cm, so that the cross sectional area of the cylinder is 1/100 of the pan. It means 200 mm water from the cylinder added to the pan, raise the level in the pan by 2 mm. Measurement can be made correct to 0.1 mm.

A thermometer to measure the temperature of water in the pan fixed to the side of the pan and wind instruments to measure the wind speed and direction are installed at a height of 2m above the ground near the pan. Their calibration procedures already discussed in foregoing paras.

1.6.10 Sunshine Recorder

Sunshine recorder is tested for general appearance, dimensions, movement of the standard gauge, quality of burning and centre of the sphere and the bowl must be coincident, and conforming to the Indian Standard (IS: 7243) and authenticated by IMD.

For calibration purposes, the instrument must confirm to the following conditions:

- The centre of the sphere and the bowl must be coincident
- The bowl must be levelled in the east-west direction
- When a card is in position, the hour lines printed across must be in meridian planes of the celestial sphere corresponding to the hour angle 15, 30, 45 degree etc. measured from the geographical meridian.

Above three conditions are to be ensured during manufacture.

Finally the installation of the instrument is to be carried out by an expert who should refer to the proper diagram giving variations of the sun's altitude and azimuth at different times of the year and in different latitudes 0-34 degree North, with the hours of the day in local apparent time marked on the curves. The 3 types of cards used are: the long curved during summer, the short curved during winter and straight one during equinoxes.

2 Inspection of River Gauging Stations

2.1 Introduction

In order to ensure the continuing good quality of data it is essential that regular inspections and audits of gauging stations are undertaken by suitably senior and experienced personnel. It is necessary that the findings of these inspections are recorded and retained in order to assist with any future data validation and quality control queries.

All stations are permanently manned, or at least during the critical monsoon months. Stations having stable stage-discharge relationships might only be visited by field staff periodically, to change charts or offload loggers and/or undertake current meter gauging. However, irrespective of whether a station is manned or unmanned it is of fundamental importance that station logs are maintained for all stations. These not only record data but also any important actions or observations, which are made at a station on each day someone is on site.

No matter how well a gauging station might appear to be run and irrespective of the quality of the staff it is essential that stations, particularly primary network stations are inspected on a regular basis. These inspections shall be undertaken by S5, S6 and S9 staff category. These inspections fulfil a variety of functions, including, but not limited to:

- Check on the performance and the discipline of the field staff;
- Staff motivation and encouragement - one of the keys to good quality data is to ensure that the staff recognise the importance of what they are doing;
- Identify existing or potential instrumentation and/or equipment problems;
- Identify any observation procedure errors;
- Identify structural problems e.g. collapse of gauge posts, wear of cableways;
- Undertake independent level, flow, rainfall and other measurement checks.
- Observer' watch and his time keeping.

The checks to be undertaken will depend on the type of station, the field staff involved and the physical characteristics of the site. However, the following general guidelines have been prepared to assist with the formulation of audit and inspection procedures.

2.2 Frequency of Inspections

State border and other key stations:

S9, S6 and S5 staff category:	Once every three months.
S5 staff category:	Once every month.

Other primary network and special investigation stations:

S9, S6 and S5:	Once every twelve months.
S5:	Once every two months, preferably more frequently during the critical monsoon months

N.B: S9 means 'Executive Engineer" in charge of DDPC, S6 means 'Assistant Executive Engineer / Assistant Engineer' in charge of SDDPC, and S5 means 'AE/AEE' working in the SDDP Centre'.

2.3 Station Log Sheet or Logbook

Every station should have station log sheets or a logbook. Even for permanently manned sites where it might be necessary to fill in several other forms on a daily basis e.g. stage record form, current meter gauging sheet, rainfall amount etc. it is good practice to maintain a daily log sheet/book.

The function of the station log sheet or book is to maintain an on-site record of key data, checks and any maintenance undertaken during any day when the station is manned or visited. This should include routine inspections by S5 staff category and other supervising officers. The maintenance of the log sheet is particularly important for unmanned sites since a record of actions undertaken during previous visits can be maintained on site. Also, it is an extremely important and essential link in the data quality audit chain (trail).

The log sheets are to serve the purpose of quality of but not to find fault with the observer. Observers are to be encouraged to provide honest/correct information about performance problems, than nice but useless / not objective information.

The design of the log sheet or book will depend on the type of station and the parameters monitored. A typical page from a Station Field Record Book for a stage station has already been referred to in this Manual. This form is intended for completion by an inspecting officer as a check on the performance of the stage observer. A typical station log sheet or page from a log book for a stage-discharge station might be of the form indicated in Figure 1.

Part 1 of the form contains spaces to enter the name of the operating authority, the basin, river, and station name and station number.

Part 2 of the form is for entering the gauge zeros relative to GTS (or in exceptional circumstances site arbitrary datum) of the gauge posts installed at the site. At many stations only a set of primary gauges will be installed. However, at other sites one or two secondary gauges might be installed for slope area method estimations. Alternatively two or even three pairs of gauges might be installed i.e. two or three opposite each other on each bank.

Part 3 of the form contains space to enter details about the instruments and equipment, other than gauge posts, installed at the site as follows:

a) **Column 1**: This contains types of equipment AWLR/DWLR, Cableway/bridge outfit, Standard raingauge (SRG), tipping bucket (TBR) or autographic raingauge (ARG), full climate station (FCS) and other to be specified.

b) **Column 2**: ‘Yes’ or ‘No’ is entered in this column. e.g. ‘Yes’, if an AWLR or DWLR is installed, ‘No’, if it is gauge posts only.

c) **Column 3**: Type of instrument e.g. chart recorder drum type

d) **Column 4**: Make of instrument or equipment i.e. manufacturer’s name

e) **Column 5**: Serial number of instrument or equipment

f) **Column 6**: Date installed or taken to site.

Parts 1 - 3 of the form contain standard information, which unless there are changes in datum or equipment will remain at the top of every page. Part 4 contains the variable information, which is logged on the days when the site is manned or inspected.

Figure 1: Example of a Gauging Station Log Sheet/Book

.... STATE SURFACE WATER
STATION LOG BOOK

1. Basin:.......................... River:.......................... Station Name:............................ Station No.:....................

2. Gauges:

	Primary (PG)	Secondary (1) (SG1)	Secondary (2) (SG2)	Secondary (3) (SG3)
Gauge zero:				

3. Equipment:

Equipment	Yes/No	Type	Make(s)	Serial Nos.	Date installed
AWLR/DWLR					
Current meters					
Cableway/bridge outfit etc.					
SRG					
TBR/ARG					
FCS					
Other................................					

4. Station Log:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Date	Time	PG level	AWLR/ DWLR level	Stilling well level	Level Diff. (3) - (4)	Level Diff. (3) - (5)	AWLR/ DWLR time	Time Diff. (2) - (8)	Desi cator (Awlr)	Batt ery volta ge	SG1 Level	SG2 Level	SG3 Level	Measured flow (fm)	Time start fm	Time finish fm	Conditions (river & weather)	Actions taken	Remarks	Signature

For manned sites it is recommended that the form is completed at a fixed time every day e.g. first thing in the morning after the first gauge reading or after the first flow measurement.

For unmanned sites the form should be completed as the information is collected or observed throughout the duration of the visit.

The recommended columns in the log sheet are described as follows:

Column No.	Purpose
1.	Date of entry into log book
2.	Time - take time of primary gauge reading, according to reliable independent watch or clock
3.	Primary (main) stage gauge reading
4.	AWLR or DWLR reading, if one of these is installed
5.	Stilling well level if one is installed i.e. the water level inside the stilling well relative to datum of primary gauge zero, this could be obtained using an internal staff gauge or diptone
6.	Water level difference between primary gauge and DWLR or AWLR, if greater than 5 - 10 mm difference has to be explained
7.	Water level difference between primary gauge and inside stilling well, if greater than 5 - 10 mm difference has to be explained, stilling well might need de-silting
8.	Time according to AWLR or DWLR
9.	Difference between watch time and AWLR/DWLR time. Significant differences have to be explained.
10.	Status of AWLR/DWLR desiccator.
11.	AWLR/DWLR battery voltage if available.
12.	Secondary gauge 1 reading
13.	Secondary gauge 2 reading
14.	Secondary gauge 3 reading
15.	Measured flow if current meter or float gauging undertaken
16.	Time of start of flow measurement
17.	Time of finish of flow measurement
18.	Conditions - river and weather e.g. river in flood, intense rainfall
19.	Actions taken - e.g. changed chart, downloaded logger, re-set AWLR to agree with staff gauge, cleaned gauge posts
20.	Remarks - this column can be used to make general observations about problems encountered if necessary a supplementary sheet clearly referenced and dated can be filled in which should be attached to the relevant page of the log book. Remarks might include information on absence of observers, gauge post damage, stilling well blockage clearance
21.	Signature of officer responsible or most senior officer on site on day of entry

2.4 Field Inspections and Audits - Check list / Standard form

The nature of site inspections and audits will be dependent on the type of station, its importance and the policies of the authority concerned. This Manual contains examples of Field Inspection and Audit form. This has been prepared to provide a checklist of the items to be inspected and the actions to be taken during a gauging station audit. It is recommended that all organisations responsible for streamflow measurement and data collection design and adopts such a form (Annex. II).

The top of the form contains spaces for entry of details of the site and watercourse. The remainder of the form is divided into nine main sections that are summarised as follows:

Section No.	Details required
1.	Details of inspection – date, inspecting officer etc.
2.	Site conditions – physical conditions encountered
3.	Staffing - mainly appropriate for manned sites to provide a record of those present
4.	Stage measurement: 4.1 – Measuring equipment: staff gauges, bench marks, key level checks, A/DWLR instrument installed; 4.2 – Instrument performance and quality checks; 4.3 - checks on observer; 4.4 - Quality checks on data record sheets; 4.5 - general observations
5.	Flow measurement: 5.1 Equipment: current meter, revs counter, assoc. equipment - wading, bridge, bank operated cableway, manned cableway, boat; 5.2 - Quality checks on data record sheets; Flow measurement structures; 5.4 – general observations.
6.	Other equipment - e.g. SRG, ARG, TBR, FCS, Sediment sampling equipment
7.	Buildings and instrument housing - weather tight, security, other
8.	Action items - actions required, target date for completion, action officer, completion date.
9.	Final observations – overall comments, urgent actions, signature of inspecting officer, data

The inspecting officer should complete all sections of the form.

Note that additional information not specifically covered by the form can be entered in the spaces left for general comments. Conversely, for some sites some of the sections will not be appropriate, in such circumstances it is recommended that not applicable or N/A is entered in the sections which are not relevant. Otherwise each section should be completed.

2.5 Follow-up actions

The Inspecting Officers need review at SE/ CE levels. These reviews should identify all remedial works or actions which are required in order to ensure that faults are rectified and good quality data is collected. However, there is a tendency in many hydrometric organisations to identify problems at gauging stations then forget about them. There is no point undertaking quality audits if no follow-up actions are taken. Therefore, the form allows for the identification of actions, target dates for completion and the officer allocated responsibility for these actions. It is imperative that the SE/CE level officers monitors and supervises the progress of all the necessary follow-up actions. If the follow up actions is not undertaken by the target date or in a reasonable time, consideration should be given to taking disciplinary action against the officer concerned.

3 Field Checking of River Gauging Stations and Primary Validations

3.1 Introduction

Whilst sophisticated statistical techniques of validation may be implemented on the computer, the process of checking and validation must commence at a much earlier stage - in the field itself - to establish the reliability and accuracy of the observations and the circumstances under which they were made. Answers to simple questions, such as: "Can the gauge observer read the staff gauge accurately?", "Does the gauge observer consistently attend to observations or does he fabricate readings", can only be obtained by careful checking and observation in the field.

3.2 Observer's ability

The observer is the basic functionary for recording observations. However, observers often have limited education and it is not uncommon to find faults in the level record caused by limitations in the observer's skills. Initial training is therefore essential and must be given and checks by visiting engineers should be made at frequent intervals or on suspicion of inaccurate readings.

A common problem to note is the misplacement of decimal point for readings in the range .01 to .10. For example, a sequence in chronological order of level readings on the falling limb of a hydrograph:

4.12, 4.10, 4.9, 4.6, 4.3, 4.1, 3.99,

should clearly be interpreted as:

4.12, 4.10, 4.09, 4.06, 4.03, 4.01, 3.99.

3.3 Observer's reliability

Experience with streamflow networks in many parts of the world suggests that where observers are left unsupervised for extended periods of time, they will fabricate readings without visiting the station to a greater or lesser extent. The frequency of fabrication can be expected to increase if checks are absent or infrequent or if faulty readings are never challenged.

Suspicions concerning the reliability of observations are usually aroused by the occurrence of observations, which are hydrologically inconsistent. In natural rivers, levels often rise quickly and irregularly to a peak in response to rainfall but fall more slowly and smoothly (exponentially) in response to declining channel and catchment storages. Inconsistency can more easily be identified during periods of recession. Typical indicators of fabrication are:

- Abrupt falls or a sudden change in slope of a recession curve.
- Long periods of uniform level followed by a distinct fall.
- Uniform mathematical sequences of observations, for example, where the level falls regularly by 0.05 or 0.10 between readings for extended periods. Natural hydrographs have slightly irregular differences between successive readings and the differences decline as the recession progresses.
- Where daytime observations only are taken, similarity between the last reading of one day and the first reading of the next, during a period of recession (resulting in a stepped hydrograph) may indicate that only a single daily reading has been taken and the remainder interpolated.

Fabrication is more difficult to identify on heavily regulated rivers where rapid rise and fall in level may result from operation of gates, valves and pumps.

As an additional means of checking on observer's ability and reliability, it is recommended that the gauging team or engineer making periodic visits to the site should note the following information in a Station Field Record Book in a standard column format (Figure 2). Some of these visits can be without advance intimation to the observer.

1. Date/time of visit
2. Was the Observer present on arrival?
3. Current Staff gauge level
4. Last staff gauge reading in the observer's book (mention date)
5. Time of the last observer's reading

Persistent absence of the Observer at the arrival of the team, or discrepancies between current level and the last observation by the Observer, strongly suggests fabrication of readings, and the Engineer should take what corrective or disciplinary steps that are appropriate.

Preferably a separate Station Field Record Book be held for each station as a pocket-sized hard-back notebook which is carried by the engineer on every visit to the station. Persistent good or poor performance by the Observer will be readily identified by reference to this book.

Following field checking by the Hydrometric Supervisor, additional manual validation should be carried out in the Sub-divisional office prior to entry of data to the computer. This would for example identify missing data, confirm that the correct number of data per day or per month has been entered and that there is no discontinuity between batches. Anomalies should be referred back to the Hydrometric Supervisor.

Periodically a DWLR may be installed on site to check the temporary fluctuations in water level, to cross check on observer performance.

3.4 Checking AWLR (Chart recorders)

Chart recorders are long-established and popular instruments for the measurement of water level. They eliminate data uncertainty arising from the ability and reliability of the observer, but they too are subject to errors resulting from malfunction of the instrument or the stilling well in which it is located. Many of these errors can be identified by reference to the chart trace and this should be examined carefully in the field.

The primary measurement remains the staff gauge placed directly in the river against which the chart level is set and checked. Recording instruments deliver the interpolation between successive manual observations. On each visit to the station the Hydrometric Supervisor must check the current level on the chart with the reference staff gauge(s) and enter the readings in the Station Field Record Book (Figure 2). Where discrepancies are noted between staff gauge and chart, these must be investigated immediately on site and corrected if possible. The following are typical malfunctions noted on charts and possible sources of the problems.

1. Chart trace goes up when the river goes down
    - Float and counterweight reversed on float pulley
2. Stepped or flat trace rather than smooth hydrograph
    - Tangling of float and counterweight wires
    - Backlash or friction in the gearing
    - Blockage of the intake pipe by silt or float/ counter weight resting on silt

Figure 2: Format of Station Field Record Book

.... STATE SURFACE WATER SECTOR

STATION FIELD RECORD BOOK

Basin .... River .... Station.................................... Code No ....

Date	Time	Gauge observer present on arrival (Tick)	Staff gauge level	AWLR Level	Last Observer Level	Time of last Observer Level	Remarks (including damage, adjustment, replacement of staff gauges or equipment,stilling well malfunction, erosion and scouring, construction of bunds, sand extraction, debris blockage etc)

Signature .... Designation......................................

3. Flood hydrograph truncated

- Well top of insufficient height for flood flows and float sticks on floorboards of gauging hut or recorder box.
- Insufficient damping of waves causing float tape to jump or slip on pulley.

4. Hydrograph appears OK but the staff gauge and chart level disagree. There are many possible sources including operator setting problems, float system, recorder mechanism or the operation of the stilling well, in addition to those noted above. The following may be considered.

Operator Problems

- Chart originally set at the wrong level

Float system problems

- Submergence of the float and counterweight line (in floods)
- Inadequate float diameter and badly matched float and counterweight
- Kinks in float suspension cables
- Build up of silt on the float pulley affecting the fit of the float tape perforations in the sprockets

Recorder problems

- Improper setting of gear not matching the chart scale
- Distortion and/or movement of the chart paper (humidity)
- Distortion or misalignment of the chart drum
- Faulty operation of the pen or pen carriage

Stilling well problems

- Blockage of intake pipe by silt/ debris.
- Lag of water level in the stilling well behind that in the river due to insufficient diameter of the intake pipe in relation to well diameter.

5. Chart time and clock time disagree

- Chart clock in error and should be adjusted
- Wrong paper time scale
- Wrong gearing

Particular attention must be paid to the intake pipe and stilling well to ensure that they are not obstructed and to the float, to check that it is not stuck, damaged or have debris lodged in it.

Following the return of the chart to the office further checks are performed. The water level by staff gauge, and chart recorder, is again compared by annotating the chart with observer's readings. Comparisons are made routinely for one reading per day and more frequently in the peaks and troughs of flood events which tend to show up more readily the effects of stilling well lag or blockage. However, discrepancies may be from either source and, where the irregularities are not systematic the gauge observer's readings may be suspected and the observer is to be educated, trained, reminded or reprimanded. Missing or faulty records from the recorder may be substituted by the observer's readings.

Before chart data can be entered to the computer and archived, they must be digitised. This may be done by manual extraction of levels from the chart or by using a digitising table which converts the chart trace to a digitised record at the selected interval. Another recent technique is based on scanning of the chart line and tracing/vectoring it on a computer display, assisted by appropriate software. However, in both cases any time or level errors at take off have got to be considered and adjustments made. In the case of manual extraction, if it is assumed that the drift is linear, this consists of distributing a stage adjustment on a daily basis through the chart period and then adding this value to each level extracted from the chart.

Where the chart is digitised manually, the records are entered to a paper file and it may be convenient to use the same hourly form as is used for manual staff gauge observations. Where the chart is digitised using a digitising table the result is a computer file, which can be entered directly to a database or hydrological archive package.

3.5 Checking DWLR

Digital water level recorders provide a more versatile means of measuring water level at a gauging station. Like the chart recorder many DWLRs are still based on a float operated sensor operating in a stilling well. The mechanically operated pulley system is replaced by a shaft encoder which eliminates the errors created by mechanical linkages and the imprecision of a pen trace. However, measurement is still subject to the errors caused by the float system and by the operation of the stilling well. Therefore for float operated DWLRs many of the same or equivalent checks are necessary to ensure the continuity and accuracy of records. In this regard the pressure sensor type DWLRs have an advantage since they have no moving mechanical parts.

However, irrespective of what DWLR is installed similar checks are required to those undertaken for chart recorders. In particular the comparison and noting of staff gauge and logger water levels (and clock time and logger time) at take off and resetting, in the Station Field Record Book are essential for the interpretation of the record in the office.

Procedures in the office for checking the reliability of the record since the previous data download will depend on the associated logger software but should include a graphical inspection of the hydrograph for indications of malfunction (e.g. flat, stepped or truncated trace). Comparisons as for the chart recorder should be made with the observer's readings and bad or missing data replaced by manual observations

3.6 Spare Parts and Equipment

It is very important to maintain an adequate stock of back-up equipment and spare parts at each divisional office. The number of spare instruments and parts to keep in stock will be a function of the number and type of site, the type of equipment and the proximity of the supplier's stocks. The following Table is included as a guide:

Table: Suggested spare requirements

Item	Number of spare instruments	Spares	Remarks
Gauge plates	Min. of 10 no. x 1 m gauge plates for every 5 sites	Supply of spare fixing bolts	
AWLR's	One spare AWLR for every 7 sites	Adequate stock of charts (min. 6 months supply), pens, ink, cable, floats, counterweights, clocks, batteries	The number of spares to be kept in stock should depend on operating experience and the ability of the supplier to react to orders at short notice
DWLR's*	One spare for every 20 sites With the same measuring range And cable requirements	Nil apart from appropriate batteries. It would be possible to keep a few spare loggers for surface logging systems but it is probably better to place responsibility with supplier	If a large number of installations are intended (>10) it is suggested that an annual maintenance contract is agreed with the supplier
Current meters	One spare standard current Meter for every 5 sites	Connecting cables	
Revolution Counters	Preferably one spare unit for Every site, but no less than	Batteries	
ADCP	Nil	Nil	Specialist equipment - should be maintained and repaired by supplier

* - Note: There are several types of DWLR design. In some models the logger is installed in the sensor casing i.e. it is submerged. Conversely, in other systems the logger is installed separately at the surface. Also, there are several different ways of downloading data. Based on operating experience with good equipment it is very rare for more than 1 in 20 instruments to malfunction within their design-life. It is generally recommended that whenever possible, particularly, when a large number of units are purchased that an annual maintenance contract is entered into with the supplier. The responsibility for supplying and installing spare parts and replacements thus rests with the supplier. The ability of a supplier to offer a competitive, efficient support service is a very important consideration when evaluating tenders for the supply of DWLRs.

4 Sediment sampling at River Gauging Sites

4.1 Bottle-type Sampler

4.1.1 General description

The bottle sampler is a point-integrating device. The current practice in most states of the Indian Peninsula is to use the “Punjab” bottle sampler for measuring suspended load. The sampler is appropriate for rivers with suspended load almost exclusively composed of wash load, with no or little coarse and medium particle size fractions. The measurement procedure with this instrument is described in several documents.

Principal advantages, limitations of bottle samplers; alternatives or corrections.

- Bottle samplers are very simple and easy to use; they can be appropriate for operation in rivers containing only wash load in suspension, the coarse and medium particle size fractions being very limited in concentration.
- The Punjab bottle sampler was designed in India in 1935 for slow flowing, shallow rivers and canals, and does not work efficiently at large depths.
- The Punjab-type bottle sampler does not work efficiently at high velocities, mainly due to the difficulty to keep it vertical, also when suspended or hung from a line with a fish-weight.

The water does not enter the bottle with the velocity and direction of the surrounding stream velocity (not iso-kinetic sampling).

- When operated from a survey vessel, a special device can be used to keep the rod-mounted bottle vertical.
- A redesigned Punjab-type bottle sampler (1951-1952) was placed in a fish-weight for use in 8m depths with velocities of 3 m/s, however with poor results; it is not in use anymore.
- Over- or under-filling may be avoided by equipping the bottle with an electrical bell design.

Air exhaust and pressure equalising device may reduce the disturbance of sampling caused by sudden inrush of water when opening the bottle for sampling.

4.1.2 Essential Instructions and precautions while Sampling - for all the Bottle samplers

- The sampler must be kept vertical while sampling.
- The mouth of the bottle must be opened only when the instrument has reached the required depth, not earlier.
- The bottle may not leak; leakage would result in a catch before the actual sampling starts.
- The mouth must be kept open with a sufficient water passage and for a minimum time span so as to fill enough, though overfilling should be avoided.
- The exact volume of the collected sediment sample must be measured and recorded.

4.1.3 Instructions for Punjab Sampler O&M (Check list, Instructions and Precautions)

Before sampling, check

Sampling bottle

- A metallic bottle, if deformed (out of shape) or damaged (especially its mouth) has to be replaced by a spare one.
- A glass bottle, if breached, has to be replaced by a spare one.

Bottle cork

- Must close tightly to avoid leaking.
- May never be painted.
- Damaged corks must be replaced.
- Cork must be suitably tapered to enter 0.5 to 1 cm in bottle mouth.
- Eventually, rub smoothly lower end of cork with emery paper if cork does not enter far enough into the bottle mouth.

Bottle holder (frame)

- Clamps at neck and mid-portion may not be damaged and should hold tightly the bottle with the cork seating perfectly axial in the mouth.
- Fly nuts for locking must operate easily; they should be replaced if they don't lock gently
- Socket thread may not be damaged.

Pipe, rod, spring and lever

- Brass rod and pipe may not be bending.
- Spring must be checked and dead springs replaced.

Sampler leakage

- The sampler must be tested for possible leakage by holding it tightly closed under water for 5 minutes and collected sample needs to be less than 5 cc.
- In case of leakage, do not try to repair on the spot and use spare sampler.

During sampling, instructions and precautions

In general

- The sampler must be oriented with the vertical frame perpendicular to the flow so that it does not disturb the flow at the mouth.
- The time required to fill the sampling bottle must be checked by trial and error, so that sampled volume would total between 80 and 90 % of the bottle volume (i.e. 0.4 l to 0.45 l for a 0.5 l bottle).
- Samples from partially or fully filled bottles must be rejected and a new sample taken.
- Sampler may never touch the stream bed.
- The distance between sampler bottom and the streambed must always be more than 20 cm.

When sampling from a survey vessel

- If flow permits, the survey vessel should be kept stationary to hold the sampler vertical.
- In high flows, use a fitting to the hull and a line for keeping the sampler vertical whenever possible.
- In flows too strong for keeping the sampler vertical, drifting from the vessel may be allowed exceptionally to reduce the drag on the sampler as to keep it vertical, this only if sampling can be

performed in the selected vertical (this procedure should be first tested in presence of the assistant research officer and/or junior officer).

When sampling while wading

- During sampling, keep the bottle upstream and well in front of you.
- Avoid sampling when the product of flow velocity (in m/sec) with depth (in m) exceeds 1.

When sampling from a bridge

- The bottle sampler should not be used if it cannot be kept vertical in the flow.
- When flow is too strong for measuring at 60 % of the depth (0.6 d), a water surface sample may be taken, but with the bottle mouth at least 0.5 m under water.
- Operation of the bottle sampler with a fish weight should be avoided if this is not specifically designed to contain the bottle.
- When operated with a suitable fish, the drift angle measured at the protractor should not exceed 15 degrees.

After sampling, instructions and precautions

- Reject the sample if there is any floating debris hanging to the sampler or trapped between bottle mouth and cork.
- The sample must be collected carefully, without spilling any water.
- The volume of the collected sample must be measured precisely before rinsing, even if sediment remains in the bottle, to be rinsed later with clean water.
- If water or sediment is spilled during collection of sample, this must be rejected and a new sample taken.
- The rinsing water with its sediment must be added to the collected sample.

4.2 Sediment Analysis

4.2.1 Introduction

The sediment analysis methods, techniques and instruments in use in India are described in the technical literature:

- Analysis using sieves and a hydrometer for C, M and F fractions.
- Dry sieving for the medium and coarse fractions.
- Bottom-withdrawal tube.

They will not be discussed in this manual.

For bed material, the complete sediment size distribution is determined, while for suspended load, only the percentage of coarse, medium and fine grades are measured.

The sediment size information is quite limited for the transported material as the volume of the catch is usually very small. It would therefore be advised to introduce new methods for particle size determination.

The choice of the method and equipment needed for determining sediment particle size distributions would depend on:

- The kind in information requested (what do we want to know?, for what purpose?
- The skills of the personnel in the laboratory.

- The need for particle size analysis of the complete sample, or only of part of it (e.g. do we need the size distribution of the sand/silt/clay fractions?).
- The number of samples to be analysed per day.
- The sample volumes.
- The kind of “size” needed.

When dealing with suspended- and bed-load, data may be required for various purposes, among which sediment transport computations. In this case, more detailed information is needed, such as:

- Complete size distribution.
- Particles’ densities.
- Particles’ shapes or angularities.
- Particles’ fall velocities.

The sediment size methods are based on the determination of one or several characteristic dimensions or properties of a given sediment particle:

- The sieve measures a particle length.
- The settling tubes or sedimentation balances measure a particle settling velocity.
- The Coulter-Counter (originally a blood cell counter) measures a particle volume.
- Some light extinction methods measure particle surfaces etc.

When the sample catch is small and when the particle sizes range between 0.O62mm and 2mm, the visual-accumulation-tube size analyser, such as the US VATSA-58 is a recommendable instrument. It has even been used for sediment fractions down to 0.025mm.

4.3 Routine analysis for Coarse, Medium and Fine fractions

4.3.1 Analysis for estimation of Coarse and Medium grade fractions

From the samples of water and sediment mixture collected in the enamelled buckets normally about 5 litres, the same is allowed to settle for about a minute. The supernatant water is carefully decanted off. The residue is passed into a numbered beaker for further analysis of coarse and medium fractions of sediment

Each sample in the beaker is then passed through a IS – 212 micron sieve placed over a beaker marked upto 10 cm height. The sediment retained by the sieve is washed thoroughly with a jet of clean water till all the coarse grade particles are separated and particles of medium and fine-grained size have passed through, into the beaker. The particles retained by the sieve after washing and removing organic matter is transferred to silt measuring tubes. Its volume in cubic centimetres (cc) is noted after tapping on a rubber pad. This can later be expressed as cubic centimetres per litre.

The sediment and water passing 212-micron sieve collected in the beaker is made up upto 10-cm height. The mixture is stirred in clockwise direction for a few seconds and allowed to stand for the required interval of time given in table below, according to the temperature of water in the beaker.

Time taken for particles above 0.075 mm to fall through 10 cm column of water at different temperature is shown in the table below:

Water temperature, in °Celsius	Time of fall for particles of 0.075 mm to fall 10 cm in seconds
5	31
6 - 10	28.5
11 - 15	25
16 - 20	22
21 - 25	20
26 – 30	18
31 - 35	16.5

The supernatant water is poured off. This process of separation of medium grade sediment by decantation of supernatant liquid, followed by filling the beaker upto the marked height is repeated, till the supernatant water is rendered clear. The medium grade sediment settled in beaker after the final washing and decantation process is transferred to a measuring tube and the volume is measured in cc as in the earlier case. The material is also washed down on to a pre-weighed filter paper, initially drained of all water, and then subjected to drying in a oven. It is allowed to cool in a dessicator and then weighed along with the collected dried sediment for obtaining its weight. This gives the concentration of medium fraction in gms per litre.

4.3.2 Estimation of Fine-grained fraction of Sediment by Hydrometer method

The fine grained sediment fraction can be estimated with the help of a sensitive calibrated hydrometer. A hydrometer calibrated initially in distilled water is to be used. The hydrometer is to be placed for about five minutes in a separate sample of sediment and water to allow it to attain the water temperature. This helps also to eliminate effect of temperature change due to sudden placing of the hydrometer. The hydrometer is then taken out of the sample water. The water is stirred vigorously to put the sediment entirely into suspension and later poured into a double jacket metallic cylinder. The hydrometer is then immersed into the water in the cylinder and stopwatch started simultaneously. The level of immersion of the hydrometer in the cylinder is read after lapse of time intervals given in table below, depending on water temperature in the cylinder.

The time interval after which hydrometer is to be read for estimating fine sediment, corresponding to water temperatures, is also indicated in the following table:

Water temperature, in °Celsius	Time interval in seconds after which hydrometer to be read
5	105
6 – 10	100
11 – 15	87
16 – 20	77
21 – 25	70
26 – 30	63
31 – 35	58

The point upto which the hydrometer is immersed can be used to derive the concentration of fine grained material and dissolved material in gms per litre as given below:

$$F + D = (R' - R) K$$

where: F = Concentration of fine sediment in gms per litre
D = Concentration of dissolved material in gms per litre
R' = Hydrometer reading taken in the cylinder water as described
R = Hydrometer reading in distilled water at the same temperature
K = Factor for the hydrometer for converting to value in gms per litre

Next filter the water containing the sediment through filter paper and take readings of hydrometer in filtered river water for obtaining the concentration of dissolved material as below:

Thus: $D = (r' - r) K$

Where: r' = Hydrometer reading for the filtered water
r = Hydrometer reading in distilled water

For arriving at value of F = (F+D) – D is to be evaluated in gms per litre

4.3.3 Precautions

1. The water sample should be at room temperature
2. The Hydrometer should be kept immersed in the water sample for about 5 minutes so that it attains the water temperature.
3. The water sample should be thoroughly stirred before pouring into the jacket cylinder
4. No air bubbles should be sticking to the hydrometer stem and hydrometer should not touch the cylinder sides

4.4 The Visual-Accumulation-Tube Size Analyser (VAT-SA)

4.4.1 Introduction

The visual-accumulation-tube sediment-size-analyser is widely used in the USA, but not well known in Europe in particular or in other countries all over the world. It is a very reliable instrument, well suited for particle size determination of fluvial sediment. It is sometimes confused with a simpler sedimentation tube device.

The VAT-SA consists of a vertical transparent tube - usually glass, may be perspex - through which the sediment sample is settling. The tubes are of several lengths (1.2 m and 1.8 m) and diameters. At the lower end, the diameter reduces through a conical funnel down to a cylinder with various sizes (inside diameter of 2.1, 3.4, 5.0 or 7.0 mm).

The measurement principle is based on two hypotheses:

- Having little interaction with the surrounding particles, the individual particles settle with a terminal fall velocity, that can be related to an equivalent particle diameter through a simple formula
- The volume of particles settled in the lower and narrow end of the tube is considered to be linearly related to the weight of accumulated solids

This makes it best suited for uniform, sphere-shaped particles with uniform density.

The device is mainly used for determination of the particle sizes or fall velocity's distribution of sand composed of mainly quartz with a shape close to a sphere, what is quite acceptable in most sand-bed rivers.

The analysis is made by introducing the sample - which volume is usually very small, only a few cc's - in a glass funnel on top of the tube and recording the height of the accumulated sediment on the bottom of the tube. The top glass funnel is connected to the settling tube by a closure rubber funnel/tube with same diameter, equipped with a valve mechanism. The accumulation of the settled sediment is recorded versus time on a chart recorder.

In the hypothesis that the particles are all spherical, the measure of the bed height is linearly proportional to the accumulated sediment volume. This is based on the mathematical law of the sphere, that says that the total volume of spheres with a given diameter contained in a recipient is independent of the diameter of the spheres.

For small size particles, compaction of the settled layer will vary with time. Therefore, a special tapping device is used to have the sediment particles well compacted as soon as they have settled.

The VATSA-58 can be purchased in the USA, but it can easily be manufactured locally, making it possibly more appropriate for use in India.

4.4.2 Operation, Principal advantages and limitations; alternatives or corrections

The sample is first wet-sieved to remove the sizes coarser than 2 mm and finer than 0.062 mm. An experienced operator may use the VAT-SA for a wider range of sediment particles, between 3 mm and 0.025 mm. The fraction coarser than 2 mm may be further sieved if sufficient sample volume is available. For small volumes, optical particle counting under a microscope may be feasible. If needed, the size distribution of the fraction finer than 0.62 mm may be determined with other methods such as sedimentation balance or Adreassen pipettes. This is however not necessary if the finer fraction is less than 20 % of the total.

Volumes as little as 1 cc can be analysed in the VAT-SA. This may be suited for the very small suspended sediment catches. For analysing bed load or bed material samples, cone and quartering technique should be applied to reduce the amount of sample to the optimum volume required for the sediment size analysis. Too much is not good as the fall velocities will not be the terminal ones (particles influencing each other), while too small a volume may not be representative.

A major advantage is the speed by which a size analysis can be performed with the VATSA: about 6 minutes only are required for a skilled VAT-SA operator.

A limitation of the VAT-SA is due to possible heterogeneous composition of the sample. When rounded quartz particles and mica flakes happen to occur in the same range of settling velocities, then the ratio height/volume of the accumulated deposit is not anymore linearly related. Best is to take a large and representative sample in a given gauging site and to split it into size fractions by sieving. Each fraction may be sieved and measured separately in the VATSA to establish the experimental height/volume relationship, instead of using the theoretical one delivered with the instrument or by formulas.

The settling velocities are function of temperature. Therefore, the temperature must be measured at each size analysis. The temperature of the water in the VATSA should be kept as constant as possible. The tube must not necessarily be emptied entirely after each analysis, if finer fraction is removed prior to it. Water from a container kept in the same room may be used to refill the tube as this water would have almost the same temperature.

4.4.3 Essential Instructions and Precautions for Operation of the VAT-SA

Before operation of the analyser

- Prepare the sample by removing the size fractions >2 mm and <0.062 mm
- Place the sample in a clean bucket with clean water
- Chose the suited tube length and diameter on the basis of the sample volume and apparent particle size
- Check if the tube is perfectly clean and fix it in the tube holder
- Check the functioning of the tapping device
- Verify the functioning of the valve mechanism and the status of the rubber tube, especially to check whether there are no particles left from a previous analysis
- Place a new paper on the recorder after having filled all data related to the analysis
- Stir the sample in the bucket and pour it as a suspension in the funnel
- Keep stirring in the funnel till opening the valve

During operation of the analyser

- Start the analysis by opening the valve, initiating the registration of the settling height
- Watch carefully the first particles reaching the bed and start the registration by following precisely the elevation of the deposit
- While operating, check the functioning of the tapping device
- The analysis is ended after a time corresponding to the settling of the slowest particle (about 0.062 mm), taking into account the possibility of lower settling velocity due to flat-shaped particles; this time depends on the length of the tube and should preferably be determined experimentally

After the analysis

- Remove the recording paper and note all necessary and useful information
- Close the valve
- Place a clean bucket under the tube and remove the tap so that the sediment sample is recovered from the tube, but without emptying it entirely (most of the water would be retained in the tube due to suction, if upper valve is well closed)
- Replace the tap and open the valve
- Store the sample if required, possibly for repeated size determination
- Enter a long, clean stick in the tube and stir to detach particles that might remain attached to tube, funnel and upper sample container
- Let the detached sediment settle and repeat the operation
- Refill the tube with clean water, preferably from a tank stored in the same room in the laboratory, having the same temperatureHaving closed the valve, the instrument is ready for a new analysis

5 Water Quality Sampling and Analysis at sites

5.1 Laboratory preparations for Sampling

Many preparations for a sampling campaign need to be made at the laboratory where the bulk of the analyses are being carried out, i.e. Level II/II+ laboratory. In some cases, these preparations can be done at a Level I laboratory, if samples are only being collected for analysis of the 'field parameters'.

Laboratory preparations must be made for:

- Sampler(s)
- Sample containers
- Reagent solutions
- Instruments
- Ice box

5.1.1 Sampler

At least two types of samplers will be needed in the field: general purpose sampler and Dissolved Oxygen sampler. The samplers should be cleaned and rinsed. Samplers should also be briefly checked for functioning, closing caps if applicable, and condition of the rope.

5.1.2 Sample Containers

The sample containers for the water quality sampling need to be prepared in the laboratory and given to the person conducting sampling.

The number of containers and the type of containers needed for the water quality sampling needs to be determined based on the number of sites to sample and the parameters selected for monitoring. In the design-phase of the monitoring programme, the sampling locations, and the type of sampling location (baseline, trend, surveillance, etc.) is determined, which gives the frequency of sampling and the parameters.

In order to cover the range of parameters which need to be sampled and analysed, a variety of sample containers are used. Table 1 gives the required type of container and the suggested volume of sample for most common parameters.

Bottles which are to be used for the samples must be thoroughly washed and then rinsed with distilled water before use. Bottles which are to be used for microbiological samples must be thoroughly washed and sterilised before use. Sterilising can be carried out by placing the bottles in an autoclave at 121^{o}C for fifteen minutes or, if the caps of the bottles do not contain plastic or rubber materials, in an oven at 170^{o}C for at least two hours. Bottles to be used for pesticides samples are to be rinsed with organic solvent (e.g. hexane) prior to use. This should be done in the laboratory.

All bottles should be checked to see if the (screw)caps and seals close properly. Labels for the sample bottles should be prepared or special pens for labelling the bottles should be used. Making a list of sample containers per site will ensure that the right number and type of containers are brought to the field. Always bring a few extra in case of unforeseen events.

Parameter Group	Parameter	Sample Container (See note below)	Sample Pre-treatment (See note below)
General	Temperature	On-site analysis	On-site analysis
	Suspended Solids	1	None*
	Conductivity	On-site analysis	On-site analysis
	pH	On-site analysis	On-site analysis
	Dissolved Oxygen	2	7
	Dissolved Solids	1	None*
Nutrients	Ammoniacal Nitrogen	3	8
	Total Oxidised Nitrogen	3	8
	Total Phosphorus	4	None*
Organic Matter	Chemical Oxygen Demand	3	8
	Biochemical Oxygen Demand	2	4^oC, Dark
Major Ions	Sodium	3	None*
	Potassium	3	None*
	Calcium	3	None*
	Magnesium	3	None*
	Carbonates and Bicarbonates	1	None*
	Chloride	1	None*
	Sulphate	1	None*
Other Inorganics	Silica	1	None*
	Fluoride	1	None*
	Boron	1	None*
Metals	Cadmium	3	9
	Mercury	4	9
	Zinc	3	9
Organics	Pesticide (Indicator)	5	4^oC, Dark
	Synthetic Detergents	1	None*
	Organic Solvents	1	4^oC, Dark
	Phenols	5	8
Microbiological	Total coliforms	6	4^oC, Dark
Biological	Chlorophyll ‘a’	1	4^oC, Dark

NOTES:
Containers:
1. 1000 millilitre polyethylene bottle
2. Special BOD bottle (normally 300 millilitre)
3. 500 millilitre polyethylene bottle
4. 100 millilitre glass bottle
5. 1000 millilitre glass (or Teflon) bottle with Teflon lined caps
6. Strong thick-walled, screw-capped glass bottle (300 millilitre capacity). Only good quality will maintain a good seal after multiple sterilisations in an autoclave

Preservation:
7. Samples for dissolved oxygen analysis are fixed by adding 1 ml of manganous sulphate solution, 1 ml of alkaline iodide-azide solution and mixing. Care should be taken to ensure that no air is added to the sample during this process.
8. Samples should be acidified with 2 ml of concentrated sulphuric acid
9. Samples should be acidified with 2 ml of concentrated nitric acid.

*None: Ideally, *all* samples should be kept cool and in the dark after collection. If this is not possible, then at least samples for BOD, coliforms, chlorophyll, pesticides and other organics that are likely to volatilize MUST be kept at 4^oC, and dark. Remaining samples can have no preservation.

Table 1: Water Quality Parameters - Sampling Containers and Pre-treatments Required

5.1.3 Reagent Solutions

For some of the field analyses, reagent solutions are necessary for the analysis. All necessary reagent solutions should be prepared in the laboratory and brought to the field by the sample collector. Alternatively, reagent solutions can be kept at a Level I laboratory near the sampling site, if the 'field analyses' are going to be made there. In all cases, sample preservatives and DO fixing solutions *must* be brought to the field and added to the samples immediately after collection.

Refer to the *'Guidelines on Standard Analytical Procedures for Water Analyses'* for detailed procedures on preparation of reagents. For analysis of pH, buffer solutions are necessary to standardise the pH meter: Buffer solutions should be prepared in the laboratory, or purchased, for pH = 4, pH = 7, and pH = 9.

For analysis of Electrical Conductivity, standard potassium chloride solution, KCl (0.01*M*) is needed to standardise the conductivity meter.

For analysis of dissolved oxygen, DO fixing chemicals are necessary:

- manganous sulphate solution
- alkaline iodide-azide solution
- concentrated sulphuric acid

DO fixing chemicals should be kept in glass or PE bottles. If a glass bottle is used, a rubber stopper must be used for the alkaline reagent. A glass pipette or dropper of 2 ml capacity is needed to add the fixing chemicals to the samples.

Chemicals for DO titration must also be brought to the field, or must be available at the Level I laboratory where the titration will be done:

- Starch indicator
- Standard sodium thiosulphate titrant, 0.025M (0.025N). This needs to be standardised with potassium bi-iodate solution 0.0021M (0.0126N).

For preservation of certain samples, concentrated nitric acid and concentrated sulfuric acid are needed.

A supply of distilled water is needed for rinsing equipment.

5.1.4 Instruments

Some instruments and equipment are necessary to make the field analyses. Instruments and equipment must be brought to the field, or must be available at the Level I laboratory where the 'field analyses' will be done. *Temperature should always be measured in the field*:

- For measurement of Temperature, a (mercury) thermometer or thermistor is needed.
- For analysis of Electrical Conductivity, a conductivity meter is needed.
- For analysis of pH, a pH meter is needed.
- For analysis of DO, equipment for a DO titration is necessary: Erlenmeyer flask and burette

Note: it is possible that instead of separate meters for temperature, pH and conductivity, there is a single instrument with different probes which will measure all three parameters.

A supply of batteries and standard spare parts should also be carried along with the field instruments.

5.2 Check list for field visit

Table 2.1 contains a list of items which should be checked before starting on a sampling mission. At least one day before sampling, make sure that all the arrangements are made as per the check list.

Make sure that you know how to reach sampling site(s). Take help of location map for each site which shows the sample collection point with respect to prominent landmarks in the area. In case there is any deviation in the collection point, record it on the sample identification form giving reason.

Note that depending on the local conditions, water body, analysis requirements, etc., not all items on the check list may be necessary. Other items, not listed, may be required. The field operation may make his or her own personal checklist based on Table 2.

Decide on the number of each item that would be required depending on the number of samples to be collected. It is always safer to carry a few numbers in excess.

If for any reason the laboratory conducting analyses is different from the laboratory preparing sample bottles, ensure that the concerned laboratory is informed of the programme and ready to receive samples, particularly those which would need immediate attention.

• Itinerary for the trip (route, stations to be covered, start and return time)	• Personnel and sample transport arrangement
• Area map	• Sampling site location map
• Icebox filled with ice or icepacks	• Weighted bottle sampler
• DO sampler	• Rope
• BOD bottles	• Sample containers
• Special sample containers: bacteriological, heavy metals, etc.	• DO fixing and titration chemicals and glassware
• Sample preservatives (e.g. acid solutions)	• Thermometer
• Tissue paper	• Other field measurement kit, as required
• Sample identification forms	• Labels for sample containers
• Field notebook	• Pen / pencil / marker
• Soap and towel	• Match box
• Spirit lamp	• Torch
• Drinking water	• Knife
• First Aid box	• Gloves and eye protection

Table 2: Checklist for field visit

5.3 Collecting the sample

5.3.1 Sample containers

The sample containers needed for a sampling campaign are prepared by the laboratory and given to the person collecting samples. An overview of the types of containers and preservation is given in Table 3. More detailed information on the specific containers needed for each parameter is given in Table 1.

	Analysis	Container	Volume (mL)	Preservation
0	on site analysis	PE bowl or container	±200	-
1	General (SS, TDS, major ions, chlorophyll-a)	Glass, PE	1000	-
2	COD, NH3, NO2-+NO3-	Glass, PE	500	H_2SO_4, pH <2
3	P	Glass	100	-
4	DO	special BOD bottle	300	DO fixing
5	BOD	Glass, PE	1000	4^oC, Dark
6	Coliforms	Glass, PE, Sterilised	300	4^oC, Dark
7	Heavy metals (Cd, Zn)	Glass, PE	500	HNO_3, pH <2
8	Mercury	Glass	1000	HNO_3, pH <2
9	Pesticides	Glass, Teflon	1000	4^oC, Dark

Table 3: Container types and volumes needed for sampling

5.3.2 Collecting the sample

Samples will be collected from the selected site at the intended date and time of sampling. At that time the collector should collect the required volumes of water in the allocated container(s). Usually, unless specified otherwise, the samples to be collected are grab-samples taken from the well-mixed section of the main current.

In the event that the monitoring is meant to check the water quality for a specific water use function (i.e. surveillance monitoring), then the sample should be collected at the point of use. For example, if water quality monitoring is meant to check bathing water quality, a sample should be collected at the bathing location. For water quality monitoring to check drinking water quality, a sample should be collected at the point of water abstraction.

The simplest form of a water sampling device is a bottle or bucket attached to a string. However, this will not sink easily below the water surface. To lower a plastic or glass bottle in a body of water it is necessary to use a bracket or holder of sufficient weight to overcome the buoyancy of the bottle and allow it to sink rapidly to the required depth, usually 20-30 cm below the water surface. Such a holder designed to contain a one or two-litre bottle is shown in Figure 3.

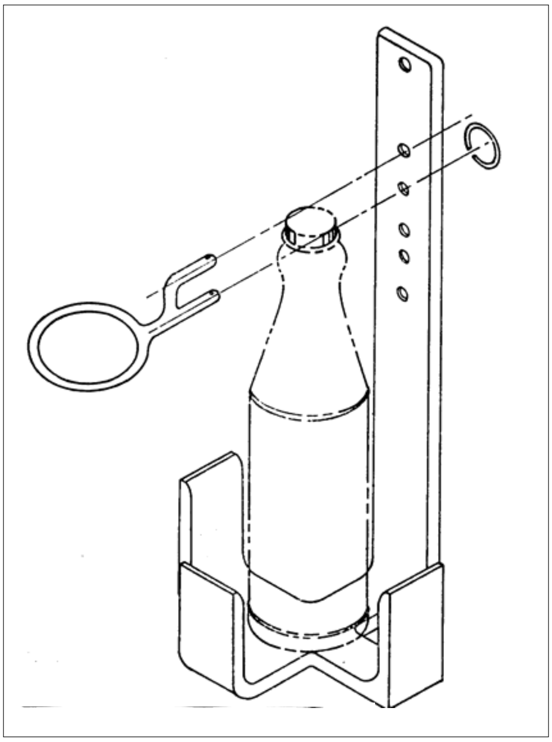

Figure 3:
Sample bottle holder for sampling

Where feasible a sample may be collected by holding the sample bottle in hand and submerging it. Collect the sample from the well-mixed section of the river, approximately 20-30 cm below the water surface (see Figure 4). Care must be taken not to catch any floating material or bed material into the container. If the water is less than 40cm, the sample should be collected at half the actual water depth. If possible, sampling from shallow waters (less than 40cm) should be prevented by moving, within the site, to a deeper part of the river or stream.

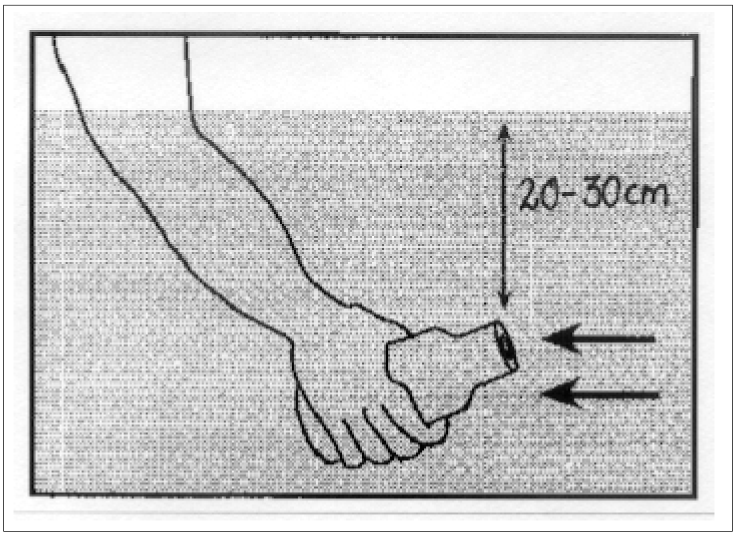

Figure 4:
Collecting a sample from surfce water

Samples from reservoir sites will be collected from the outgoing canal, power channel or water intake structure, in case water is pumped. When there is no discharge in the canal, sample will be collected from the upstream side of the regulator structure, directly from the reservoir.

Rinse the sample container three times with the sample before it is filled.

Leave a small air space in the bottle to allow mixing of sample at the time of analysis.

5.3.3 Special samples

Dissolved Oxygen

Collecting a sample for Dissolved Oxygen analysis requires special sampling equipment: a purpose-built dissolved oxygen sampler, for collection of undisturbed samples from surface waters (Figure 5). This sampler prevents air bubbles from entering into the sample and changing the dissolved oxygen concentration of the sample.

To collect the sample, insert the special ground glass-stoppered bottle (a 'BOD bottle') into the DO sampler. Submerge the sampler, such that water enters the BOD bottle directly by means of a dip-pipe thus displacing all air from the bottle. Retrieve the sampler after it is full, and then immediately seal the full bottle with a ground glass stopper.

The Dissolved Oxygen sample needs to be 'fixed' immediately after collection as described in Section 5.3.6.

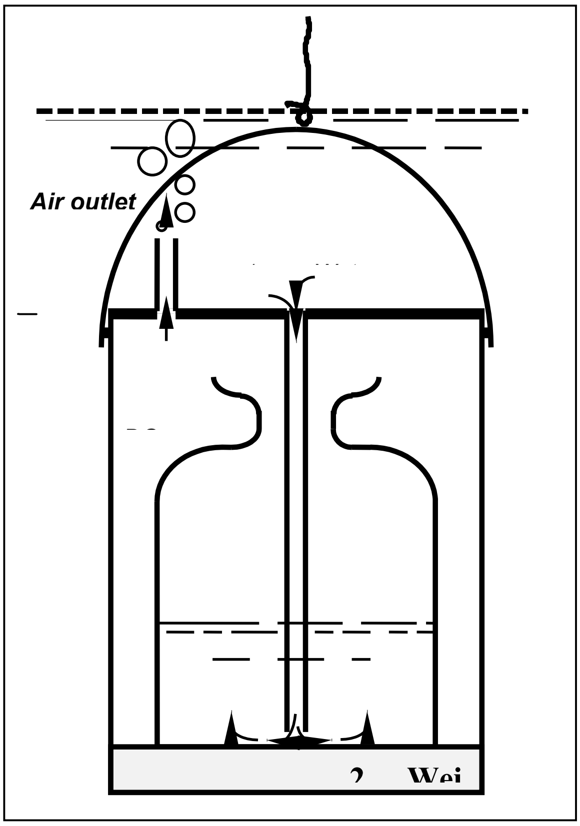

Figure 5:
Dissolved oxygen sampler (with one BOD-bottle).

Composite Samples

In most cases, a composite sample is a combination of equal volumes of a number of grab samples collected at the same location at different times. The volumes of the individual grab samples making the composite sample may also be varied in proportion to the flow in the river at the time of sampling. In such a case it is called a flow weighted composite sample.

Composite samples may be required only in special cases for calculation of mass flux in rivers when the quality of water is suspected to change over short periods of time. It is, however, a routine practice when wastewater streams are to be characterised.

Integrated Sample

An integrated sample is a mixture of grab samples collected simultaneously at different locations across the width of the river and/or at different depths. The need for an integrated sample may occur for very wide and deep rivers where the quality of water may vary across its width and depth.

5.3.4 Sample identification forms

The sample identification form provides a record of all important information concerning the sample collected. Complete the sample identification form at each monitoring site, detailing the samples that are collected at that site. Note that if more than one bottle is filled at a site, for different types of analyses, this is to be registered on the same form.

Local conditions, such as weather, human activity on the banks, state of water body, etc., at the sampling site should be recorded on the form, at the time of sampling. Such information may be useful in analysis of data.

The form for identifying the sample and recording the field measurements and site conditions is given in Figure 6.

Sample identification forms should be given to the laboratory analyst together with the samples. The forms should all be kept in a master file at the level II or II+ laboratory where the samples are analysed.

5.3.5 Sample labelling

Label the sample container properly, preferably by attaching an appropriately inscribed tag or label. Alternatively, the bottle can be labelled directly with a water-proof marker. Information on the sample container or the tag should include:

- sample code number (identifying location)
- date and time of sampling
- source and type of sample
- pre-treatment or preservation carried out on the sample
- any special notes for the analyst
- sampler's name

5.3.6 Sample preservation and transport

Preserve the collected samples as specified in Table 1 and Table 3.

Samples for BOD and bacteriological analyses should be stored at a temperature below 4°C and in the dark as soon as possible after sampling. In the field this usually means placing them in an insulated cool box together with ice or cold packs. Once in the laboratory, samples should be transferred as soon as possible to a refrigerator.

Sample code		
Observer	Agency	Project
Date Time	Station code	

Parameter Code	Container				Preservation				Treatment		
	Glass	PVC	PE	Teflon	None	Cool	Acid	Other	None	Decant	Filter
(1) Gen											
(2) Bact											
(3) BOD											
(4) COD, NH_3,NO_3^-											
(5) H. Metals											
(6)Tr. Organics											

Source of sample				
Waterbody	***Point***	***Approach***	***Medium***	***Matrix***
o River o Drain o Canal o Reservoir	o Main current o Right bank o Left bank	O Bridge O Boat O Wading	o Water o Susp matter o Biotap o Sediment	o Fresh o Brackish o Salt o Effluent

Sample type	o Grab o Time-comp o Flow-comp o Depth-integ o Width-integ
Sample device	o Weighted bottle o Pump o Depth sampler

Field determinations			
Temp °C	**PH**	**EC μmho/cm**	**DO mg/L**

Odour Code	(1) Odour free (2) Rotten eggs (3) Burnt sugar (4) Soapy (5) Fishy (6) Septic (7) Aromatic (8) Chlorinous (9) Alcoholic (10) Unpleasant	**Colour code**	(1) Light brown (2) Brown (3) Dark brown (4) Light green (5) Green (6) Dark green (7) Clear (8) Other (specify)

Remarks	
Weather	o Sunny o Cloudy o Rainy o Windy
Water vel. m/s	o High (> 0.5) o Medium (0.1-0.5) o Low (< 0.1) o Standing
Water use	o None o Cultivation o Bathing & washing o Cattle washing o Melon/vegetable farming in river bed

Figure 6: Sample identification form for surface water samples

Samples for DO measurement should be chemically fixed immediately after collection:

a. With the stopper in the bottle, drain any liquid in the flared lip of the BOD bottle containing the sample.
b. Remove stopper and add 1 mL of $MnSO_4$ followed by 1 mL alkali-iodide-azide reagent. Hold the pipette tip just below the liquid surface touching the side of the bottle. Wash the pipette before returning to the reagent bottles.
c. Stopper the bottle carefully to exclude air bubbles. Mix by inverting the bottle a few times.
d. Allow the brown manganese hydroxide floc (white floc indicates absence of DO) to settle approximately to half the bottle volume, then add 1.0 mL conc H_2SO_4 and re-stopper. Mix by inverting several times until dissolution is complete. Such samples can then be kept up to six hours before titration.

If samples collected for chemical oxygen demand (COD) analysis cannot be analysed on the day of collection they should be preserved below pH 2 by addition of concentrated sulphuric acid. This procedure should also be followed for samples for ammoniacal nitrogen, total oxidised nitrogen and phenol analysis.

Samples which are to be analysed for the presence of metals, should be acidified to below pH 2 with concentrated nitric acid. Such samples can then be kept up to six months before they need to be analysed; mercury determinations should be carried out within five weeks, however.

After labelling and preservation, the samples should be placed in an insulated cool box for transportation (Figure 7). Samples should be transported to concerned laboratory (level II or II+) as soon as possible, preferably within 48 hours.

Analysis of bacteriological samples should be started and analysed within 24 hours of collection.

If samples are being brought to a Level I laboratory for the 'field determinations', they should be transported in less than 24 hours.

5.4 Standard Analytical Procedures – Field Determinations

5.4.1 General

Measurements of colour, odour, temperature, electrical conductivity, pH and dissolved oxygen are considered to be 'Field Determinations' and should be made as soon as possible after collecting a sample.

Measurement of these parameters can be made in the field if field meters are available. This is the best option, as the analyses will be made immediately. Another option is to bring samples to the nearest Level I laboratory, where equipment for analyses is set up. If samples are brought to the level one laboratory, the travel time should be *very* short, so that parameter values do not change between the time the sample is collected at the time of analysis. Note that the DO sample must be 'fixed' immediately after collection and that the temperature must be measured at the site.

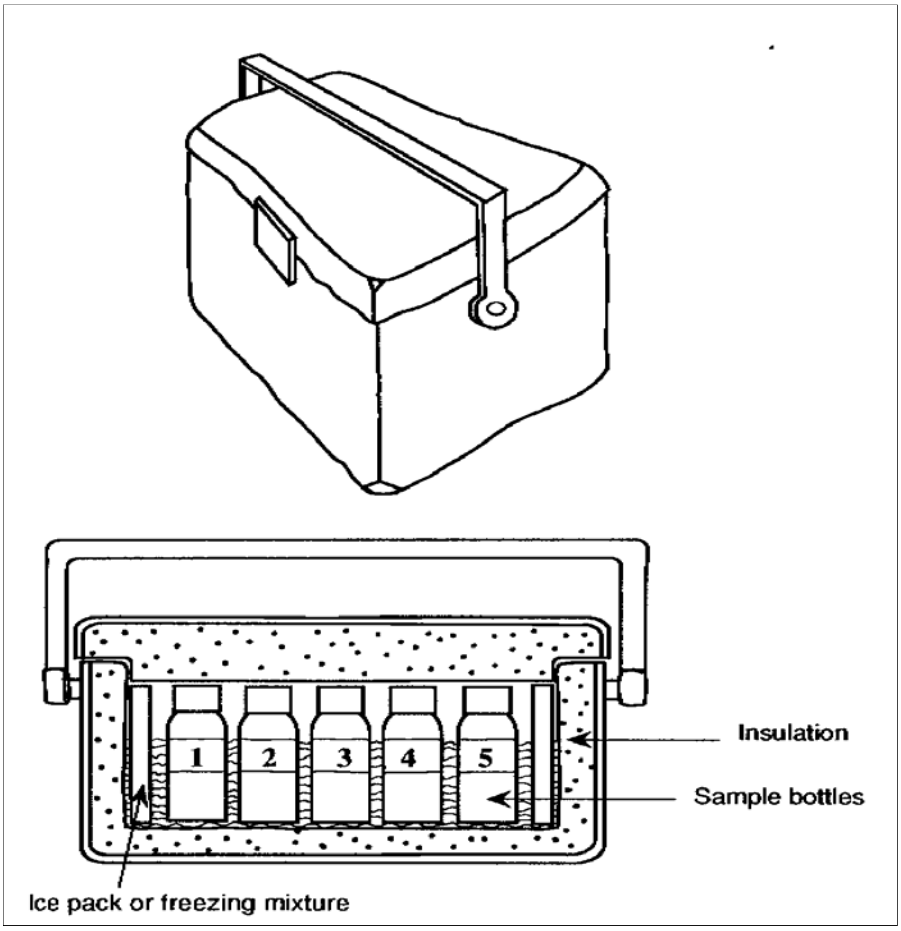

Figure 7: Insulated bottle carrier for water quality samples

5.4.2 Colour

Determining the colour in the field is relatively easy. Pour an aliquot of approximately 10mL of sample into a glass test tube and judge the colour observed. Assign **one** of the colour codes from Table 4 to the sample. In case the colour of water does not fall under code 1 to 7, select code 8 and note down the details of the colour observed. Report the colour code on the sample identification form.

Colour Code	(1)	Light brown
	(2)	Brown
	(3)	Dark brown
	(4)	Light green
	(5)	Green
	(6)	Dark green
	(7)	Clear
	(8)	Other specify

Table 4: Colour codes for field determination of colour

5.4.3 Odour

Determining the odour should always be done in the field, as soon as possible after collecting a sample. After collection, fill a cleaned odourless bottle half-full of sample, insert stopper, shake vigorously for 2-3 seconds and then quickly smell the odour. Alternatively, pour an aliquot of approximately 5mL of sample into a glass test tube and judge the odour.

Assign **one** of the odour codes from Table 5 to the sample. In case option 10 'unpleasant' is selected please try to note down the details of the odour observed (e.g. agreeable or disagreeable). Note: Do not select option 10 if the odour observed can be classified as one in the list from 1 to 9. Report the odour code on the sample identification form.

Odour Code	(1)	Odour free
	(2)	Rotten eggs
	(3)	Burnt sugar
	(4)	Soapy
	(5)	Fishy
	(6)	Septic
	(7)	Aromatic
	(8)	Chlorinous
	(9)	Alcoholic
	(10)	Unpleasant

Table 5: Odour codes for field determination of odour

5.4.4 Temperature

Water temperature should be measured in degrees Celsius, using a mercury thermometer or a thermistor. Normally, if temperature is measured electronically using a thermistor this device is built into an instrument which is capable of making other water quality measurements (e.g., pH and EC).

Whenever possible, the temperature should be measured by directly dipping the thermometer in the natural body of water being studied. In case it is not possible, collect about 500 mL sample in a plastic or glass container and measure temperature by immersing the thermometer in the sample. Read the temperature after equilibration (no more change in the temperature reading).

Report the Temperature on the sample identification form in degrees Celsius with 1 figure after the decimal point e.g. 13.2 ^{o}C.

5.4.5 Electrical conductivity

Measurement of Electrical Conductivity should be made in the field at the time of sampling, using a purpose-built meter. Refer to the *'Guideline on Standard Analytical Procedures for Water Analyses'* for detailed procedures including preparation of reagents in Chapter 5. The procedure is also given below:

a) Prepare the instrument following manufacturer's instructions. Rinse conductivity cell with at least three portions of 0.01M KCl solution. Measure resistance of a fourth portion and note temperature.

b) In case the instrument indicates conductivity directly, and has internal temperature compensation, after rinsing as above, adjust temperature compensation dial to 0.0191/ ^{o}C and with the probe in standard KCl solution, adjust meter to read 1412 μmho/cm. Continue at step d.

c) Compute the cell constant, K_C according to the formula:

$$K_C = \frac{1412}{C_{KCl}} \times [0.0191(t-25)+1] \quad (1)$$

where:

K_C = the cell constant, 1/cm

C_{KCl} = measured conductance, μmho

t = observed temperature of standard KCl solution, °C

The value of temperature correction [0.0191 x (t-25)+1] can be read from Table 4.3.

d. Rinse cell with one or more portions of sample. The level of sample aliquot must be above the vent holes in the cell and no air bubbles must be allowed inside the cell. Adjust the temperature of sample to about 25°C (outside the temperature range of 20 - 30°C, error increases as the sample temperature increasingly deviates from the reporting temperature of 25°C). Read sample conductivity and note temperature to nearest 0.1°C.

e. Thoroughly rinse the cell in distilled water after measurement; keep it in distilled water when not in use.

Calculation

a. When sample conductivity is measured with instruments having temperature compensation, the readout automatically is corrected to 25°C. If the instrument does not have internal temperature compensation, conductivity at 25°C is:

$$\text{Electrical Conductivity} = \frac{C_M \times K_C}{0.0191(t-25)+1} \; (\mu\text{mhos/cm}) \quad (2)$$

where:

K_C = the cell constant, 1/cm

C_M = measured conductance of the sample, μmho

t = observed temperature of sample, ^{0}C

The value of temperature correction [0.0191 x (t-25)+1] can be read from Table 6.

b. Record the meter reading, the unit of measurement and the temperature of the sample at the time of reading. Report the Electrical Conductivity at 25°C on the sample identification form in μmho/cm with no figures after the decimal point, e.g. 1135 μmho/cm.

T (°C)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
15	0.810	0.812	0.814	0.816	0.818	0.820	0.821	0.823	0.825	0.827
16	0.829	0.831	0.833	0.835	0.837	0.839	0.840	0.842	0.844	0.846
17	0.848	0.850	0.852	0.854	0.856	0.858	0.859	0.861	0.863	0.865
18	0.867	0.869	0.871	0.873	0.875	0.877	0.878	0.880	0.882	0.884
19	0.886	0.888	0.890	0.892	0.894	0.896	0.897	0.899	0.901	0.903
20	0.905	0.907	0.909	0.911	0.913	0.915	0.916	0.918	0.920	0.922
21	0.924	0.926	0.928	0.930	0.932	0.934	0.935	0.937	0.939	0.941
22	0.943	0.945	0.947	0.949	0.951	0.953	0.954	0.956	0.958	0.960
23	0.962	0.964	0.966	0.968	0.970	0.972	0.973	0.975	0.977	0.979
24	0.981	0.983	0.985	0.987	0.989	0.991	0.992	0.994	0.996	0.998
25	1.000	1.002	1.004	1.006	1.008	1.010	1.011	1.013	1.015	1.017
26	1.019	1.021	1.023	1.025	1.027	1.029	1.030	1.032	1.034	1.036
27	1.038	1.040	1.042	1.044	1.046	1.048	1.049	1.051	1.053	1.055
28	1.057	1.059	1.061	1.063	1.065	1.067	1.068	1.070	1.072	1.074
29	1.076	1.078	1.080	1.082	1.084	1.086	1.087	1.089	1.091	1.093
30	1.095	1.097	1.099	1.101	1.103	1.105	1.106	1.108	1.110	1.112
31	1.114	1.116	1.118	1.120	1.122	1.124	1.125	1.127	1.129	1.131
32	1.133	1.135	1.137	1.139	1.141	1.143	1.144	1.146	1.148	1.150
33	1.152	1.154	1.156	1.158	1.160	1.162	1.163	1.165	1.167	1.169

Table 6: Value of [0.0191 x (t-25)+1] for Temperature Correction of EC Measurement

5.4.6 pH

Measurement of pH should be made in the field at the time of sampling, using a purpose-built meter. Follow the procedure below:

a. Prepare instrument as according to manufacturer's instructions. Remove instrument electrodes from storage solution, rinse with distilled water, blot dry with soft tissue.

b. First standardisation: Place electrode in initial buffer solution and standardise pH meter to the known pH according to manufacturer's instructions.

c. Second standardisation: Remove electrodes from the first buffer, rinse thoroughly with distilled water, blot dry and immerse in second buffer preferably of pH within 2 pH units of the pH of the sample. Read pH of the second buffer, which should be within 0.1 unit of the known pH of the buffer.

d. Determine pH of the sample using the same procedure as in (c) after establishing equilibrium between electrodes and sample. For buffered samples this can be done by dipping the electrode into a portion of the sample for 1 min. Blot dry, immerse in a fresh portion of the same sample, and read pH.

e. With dilute poorly buffered solutions, equilibrate electrodes by immersing in three or four successive portions of the sample. Take a fresh sample to measure pH.

f. Stir the sample gently while measuring pH to insure homogeneity.

g. Report the pH on the sample identification form in pH units with 1 digit after the decimal point, e.g. 7.6.

5.4.7 Dissolved oxygen

After the dissolved oxygen sample has been fixed by addition of chemicals (see Chapter 3.6), the sample is analysed by Winkler titration.

Titrate 201 mL sample with standard $Na_2S_2O_3$ (thiosulphate) solution to a pale straw colour. Add a few drops of starch indicator. Continue titration to first disappearance of blue colour. Calculate concentration of dissolved oxygen as:

$$\text{mg DO/L} = \frac{V \times M}{0.025} \qquad (3)$$

where:

V = mL thiosulphate solution used

M = molarity of thiosulphate titrant

Report the Dissolved Oxygen concentration on the sample identification form in mg/l with 1 figure after the decimal point, e.g. 8.2 mg/l.

6 Upkeep of water quality laboratories

Development/strengthening of a water quality laboratory in the government sector is usually project-specific. Hence, upgrading of laboratory instruments and equipment is not only infrequent but also uncertain. Under the circumstances, it is important to keep the instruments, what-so-ever purchased, in good working condition through proper operation and timely maintenance. This increases not only the life of the instruments but also the reliability of the observations.

It is, therefore, important to maintain a logbook for proper record of the laboratory items procured including instruments, equipment, chemicals, glasswares and other consumables to facilitate annual maintenance of the sophisticated instruments, maintain history of the type of attendance they require for keeping healthy through repairs, timely replacement of the exhausted instrument spares, glasswares, chemicals and other consumables, and departmental audit.

6.1 Sophisticated laboratory instruments (level II / II+)

Instruments, like UV-Visible Spectrophotometer, Atomic Absorption Spectrophotometer (AAS), Gas Chromatograph (GC), are quite delicate to operate and maintain. The instrument supplier provides training to the chemists at the time of installation and commissioning of the instrument regarding its operation, general maintenance and operational fault finding. However, special care is needed for preventive maintenance and repairing of fault, which can only be attended to through Annual Maintenance Contract (AMC), preferrably by the instrument supplier or its approved agent. For this purpose, a complete inventory of these instruments along with accessories and spares must be prepared and maintained separately for each instrument. The format for such an inventory/logbook is shown in Annexure III.

6.2 Other requirements of laboratories (level I, II and II+)

Besides the sophisticated instruments, there are many other instruments and equipment in the laboratory which should also be inventorised not only for maintenance of stock but also for regular maintenance and repair, as and when required. The format designed for this purpose is shown in Annexure IV.

The formats for maintenance of stock for chemicals, glasswares and other often-required consumables are also shown in Annexure IV to facilitate replenishment of stock sufficiently in advance before it is exhausted.

ANNEX. I
FIELD INSPECTION AND QUALITY AUDIT REPORT

..............................STATE SURFACE WATER

RAIN FALL STATIONS (SRG/ARG)

Division:...

Station No:............. **Station name:.....................................**

River:............................... **Basin:..**

1. INSPECTION/AUDIT: GENERAL DETAILS

Date of inspection:.............................

Inspected by:..................................... **Designation:...................................**

Assisted by:.. **Designation:....................................**

Time of start:.................................... **Time of completion:............................**

2. SITE CONDITIONS

Weather conditions:...

River conditions:...…..........

3. STAFFING (manned sites only)

(1) **No.**	(2) **Name**	(3) **Position**	(4) **Present (Yes/No)**	(5) **If answer to column (4) is 'No'; give reason**	(6) **Remarks**

4. INSPECTION CHECK LIST (SRG/ARG)

S. No.	**Particulars**	**Remarks of Inspecting Officer**	**Observations of next higher authority**
1	**2**	**3**	**4**
1	Whether the instrument is suitably fixed (installed) and is in good working condition.		
2	Whether the measuring glass is appropriate to the capacity of the rain gauge (SRG) or charts appropriate to the capacity of ARG and clean.		
3	Whether the observer is fully conversant with rainfall measurements and makes correct observation at proper time (0830 hrs IST) and makes correct entries in the records. Whether Observer is synchronising his watch to get proper time setting.		
4	Whether the observer sets or removes charts (ARG) at proper time (0830 hrs IST)		
5	Whether the observer checks the working of clock drum and siphoning mechanism of the instrument before commissioning the rain gauge (ARG)		
6	Whether all rainfall records are properly and neatly maintained and data despatched to controlling SDO office in time.		
7	Whether any part of the rain gauge requires repair or resetting or replacement.		
8	Whether the capacity of the rain gauge is appropriate at places where heavy rainfall is recorded.		
9	Whether the observatory enclosure field, instrument housing/ enclosures are kept clean, and fencing and exposure conditions are good.		

General Remarks	
Date:	(Signature & Designation) (inspecting Officer)

..............................STATE SURFACE WATER

HP-FULL CLIMATE STATIONS (HP-FCS)

Division:..

Station No:............ **Station name:.....................................**

River:.............................. **Basin:...**

1. INSPECTION/AUDIT: GENERAL DETAILS

Date of inspection:..............................

Inspected by:..................................... **Designation:...................................**

Assisted by:.. **Designation:....................................**

Time of start:.................................... **Time of completion:............................**

2. SITE CONDITIONS

Weather conditions:...

River conditions:..

3. STAFFING (manned sites only)

(1) **No.**	(2) **Name**	(3) **Position**	(4) **Present (Yes/No)**	(5) **If answer to column (4) is 'No', give reason**	(6) **Remarks**

4. INSPECTION CHECK LIST (SRG/ARG)

S. No.	**Particulars**	**Remarks of Inspecting Officer**	**Observations of next higher authority**
1	**2**	**3**	**4**
1	Whether the instrument is suitably fixed (installed) and is in good working condition.		
2	Whether the measuring glass is appropriate to the capacity of the rain gauge (SRG) or charts appropriate to the capacity of ARG and clean.		
3	Whether the observer is fully conversant with rainfall measurements and makes correct observation at proper time (0830 hrs IST) and makes correct entries in the records. Whether Observer is synchronising his watch to get proper time setting.		
4	Whether the observer sets or removes charts (ARG) at proper time (0830 hrs IST)		
5	Whether the observer checks the working of clock drum and siphoning mechanism of the instrument before commissioning the rain gauge (ARG)		
6	Whether all rainfall records are properly and neatly maintained and data despatched to controlling SDO office in time.		
7	Whether any part of the rain gauge requires repair or resetting or replacement.		
8	Whether the capacity of the rain gauge is appropriate at places where heavy rainfall is recorded.		
9	Whether the observatory enclosure field, instrument housing/ enclosures are kept clean, and fencing and exposure conditions are good.		

General Remarks	
Date:	(Signature & Designation) (inspecting Officer)

5. INSPECTION CHECKLIST FOR WIND INSTRUMENTS

S. No.	Particulars	Remarks of Inspecting Officer	Observations of next higher authority
1	**2**	**3**	**4**
	The inspector should check the following:		
1	Whether the wind instruments are properly installed at 2m height above ground, balanced lever turns freely, no rusting etc.		
2	Whether the exposure conditions are good and both the anemometer and the windvane are fixed at least 2 m apart.		
3	Whether Ball bearing is received with a few drops of spindle oil every fortnight.		
4	Whether the observer washes all parts of the instrument thoroughly in Kerosene oil, clean and lubricate them every six months.		
5	Whether the observer measures the wind speed by following the correct procedure.		
6	Whether all nuts, especially that of cups, are fully tightened		
General Remarks			
Date:		(Signature & Designation) (inspecting Officer)	

It is advisable that the Inspector carries out the complete cleaning and oiling operation of the wind instrument by following the laid-down maintenance procedure. He should also check the accuracy after reassembling the instruments.

Thermometers

For temperature measurement, the instruments provided at FCS are:

- Dry bulb thermometer
- Wet bulb thermometer
- Maximum thermometer
- Minimum thermometer and
- Thermograph

The Inspector should ensure that all the thermometers are mounted and placed properly i.e. for sunshade and ventilation.

The relative humidity is calculated from the difference of temperature between dry bulb thermometer and wet bulb thermometer. It is also measured directly from Hygrograph.

6. INSPECTION CHECK LIST FOR THERMOMETERS

S. No.	Particulars	Remarks of Inspecting Officer	Observations of next higher authority
1	**2**	**3**	**4**
	The inspector should check the following:		
1	Wick of the wet bulb thermometer is clean and properly tied.		
2	Thermometers setting is done correctly		
3	Ensure that the thermometers are recording correct temperature.		
4	The graduation is clearly readable.		
5	The Stevenson screen door opens towards North and does not obstruct to prevailing wind.		
6	The Stevenson screens are fixed at proper height above the ground, well-painted and free from white ants.		
7	Sensors of both Thermograph and Hygrograph are clean and instruments are working properly.		
8	The temperature and humidity values are comparable with the observation made by mercury thermometers.		
General Remarks			
Date:		(Signature & Designation) (inspecting Officer)	

Evaporimeter

Evaporation is measured by class 'A' Pan Evaporimeter. As the measurement of evaporation is made by adding known quantity of water to the pan from a graduated cylinder, the observer has to be thoroughly conversant with the whole procedure. This has to be checked by the Inspector.

7. INSPECTION CHECK LIST FOR EVAPORIMETER:

S. No.	Particulars	Remarks of Inspecting Officer	Observations of next higher authority
1	2	3	4
	The inspector should also ensure the following:		
1	The instrument is clean, painted, levelled and covered with wire mesh from top.		
2	The Reference Point is sharp.		
3	There is no leak in the pan.		
4	Pan is cleaned and filled with fresh water every fortnight and painted with chlorinated white rubber paint every year.		
5	During the rainy season, ensure that the wooden platform and bottom of the pan are perfectly horizontal.		
General Remarks			
Date:		(Signature & Designation) (inspecting Officer)	

8. SUNSHINE RECORDER

For radiation measurement, the FCS is equipped with a sunshine recorder. This instrument is fixed by IMD expert keeping in view the latitude of the station. The Inspector has to ensure that the observer is fully aware of the daily and seasonal practice of putting the appropriate chart. This instrument should also be provided good exposure condition in the direction of the sunrise and sunset.

9. AUTOGRAPHIC CHARTS

Autographic charts of the autographic instruments, like ARG, thermograph, hygrograph and sunshine recorder, require hourly tabulation. The Inspector should check the actual tabulation by picking up 1 or 2 charts of each instrument.

On the completion of the inspection of the observatory, the Inspector should give proper instructions / guidance to the observer which he considers important for improving the working of the Station. He should also prepare 3 sets of Inspection Reports with his recommendations, one copy to be given to the controlling office for rectification of defects, one copy for the Head and the third copy for IMD. The Inspector must keep an office copy with him and take it with him when he goes again to that station for inspection and check whether his previous recommendations have been implemented or not.

Date:………………….   ………………………………………….

(Signature of Inspecting Officer)

ANNEX. II
FIELD INSPECTION AND QUALITY AUDIT SITE REPORT

..............................STATE SURFACE WATER

RIVER GAUGING STATIONS

Division:..

Station No:............ **Station name:.....................................**

River:............................... **Basin:..**

---

1. INSPECTION/AUDIT GENERAL DETAILS

Date of inspection:.............................

Inspected by:..................................... **Designation:...................................**

Assisted by:.. **Designation:....................................**

Time of start:.................................... **Time of completion:............................**

---

2. SITE CONDITIONS

Weather conditions:...

River conditions:...

---

3. STAFFING (manned sites only)

(1) **No.**	(2) **Name**	(3) **Position**	(4) **Present (Yes/No)**	(5) **If answer to column (4) is 'No' give reason**	(6) **Remarks**

4. STAGE MEASUREMENT

4.1 Measuring Equipment

Staff Gauges:

	Primary (PG)	Secondary (1) (SG1)	Secondary (2) (SG2)	Secondary (3) (SG3)
Gauge zero (most recent values)				
Staff gauge reading				
Condition of gauges (G/F/P)				
Condition of river bank/gauge foundations/fixings				
Actions required				

Bench Marks:

Condition of primary site bench mark (BM1): Good/Fair/Poor

Condition of secondary site bench mark (BM2): Good/Fair/Poor

Key level checks:

Undertake a comparison of bench mark levels and visible gauge posts and compare with previous readings.

Comments on level differences/discrepancies (if any) including actions required:

....

Instruments installed:

Equipment	Yes/No	Type	Make(s)	Serial Nos.	Date installed
AWLR					
DWLR					
Diptone or other device to measure water level in stilling well					

4.2 Instrument performance and quality checks:

Instrument/method	Level	Time	Level Diff.	Time Diff.	State of instrument Good/Fair/Poor	Comments/ Actions required
Primary staff gauge						
AWLR						
DWLR						
Level in stilling well						

If stilling well installed does it need de-silting: Yes/No

4.3 Checks on Observer

Observer(s) to read gauge at same time as inspecting officer:

Gauge	Observer reading	Inspecting Officer reading	Reading difference (if any)	Comments
Primary				
Secondary gauge (1)				
Secondary gauge (2)				
Secondary gauge (3)				
Well gauge/diptone reading				

Additional comments on observer performance:
....
....
....

4.4 Quality Checks on Data Record Sheets

Item	Good/Fair/Poor	Remarks
Neatness		
Completeness		
Accuracy		
Other......................		

4.5 General Observations on Stage Monitoring

....
....
....

5. FLOW MEASUREMENT

5.1 Equipment

Current Meters

Serial/Ref. No.	Meter type	Make	Date of last calibration	Spin test OK? Yes/No	Remarks

Revolution counters

Serial/Ref. No.	**Counter type**	**Make**	**Timer (if fitted) OK? Yes/No**	**Pulse counts OK? Yes/No**	**Remarks**

Associated Equipment

a) <u>Wading equipment</u>? Yes/No

If 'Yes', answer the following:

<u>Wading rods</u> Condition Good/Fair/Poor

Replace? Yes/No

<u>Distance measurement equipment</u> e.g. tapes, tag lines

Condition Good/Fair/Poor

Check distance marks against reliable tape:

....

Replace? Yes/No

b) <u>Bridge outfit</u>? Yes/No

If 'Yes', answer the following:

<u>Suspension derrick/bridge outfit</u> Condition? Good/Fair/Poor

<u>Depth measurement</u>: Winch counter installed? Yes/No

If 'Yes' Check against known reference...

If 'No' check method of determining depth and position in vertical

....

<u>Horizontal distance measurement</u>:

Are bridge markings at frequent enough interval? Yes/No

Are bridge markings clearly visible? Yes/No

<u>Pulse Counting</u>:

Condition of connecting cable Good/Fair/Poor

Check performance of counter/meter in situ, OK? Yes/No

c) <u>Bank operated cableway</u>? Yes/No

If 'Yes' answer the following:

Date of last service/maintenance:..

Condition of cables and winches: Good/Fair/Poor

Condition of support stanchions: Good/Fair/Poor

Comments:...

Check horizontal distance counter: OK? Yes/No

Check depth counter: OK? Yes/No

<u>Pulse Counting</u>:

Condition of connecting cable Good/Fair/Poor

Check performance of counter/meter in situ, OK? Yes/No

d) Manned cableway? Yes/No

If 'Yes' answer the following:

Date of last service/maintenance:...

Condition of cableway and winches: Good/Fair/Poor

Condition of towers: Good/Fair/Poor

Condition of carriage: Good/Fair/Poor

Comments with particular reference to operator safety:

....

e) Boat gauging? Yes/No

Condition of suspension equipment Good/Fair/Poor

Condition of distance measuring equipment

e.g. pivot points, tag lines/cables Good/Fair/Poor

Condition of boat Good/Fair/Poor

Condition of outboard engine Good/Fair/Poor

Number of life jackets: ....

Condition of life jackets Good/Fair/Poor

Pulse Counting:

Condition of connecting cable Good/Fair/Poor

Check performance of counter/meter in situ, OK? Yes/No

5.2 Quality Checks on Maintenance of Current Meter Gauging Forms

Item	Good/Fair/Poor	Remarks
Neatness		
Completeness		
Accuracy		
Other....................		

5.3 Flow Measurement Structures

Note: This section should only be completed if there is a structure is used for flow measurement purposes.

Type of structure (e.g. Crump weir, gated spillway etc.):...……………….

....

Condition

Item	Condition	Remarks
Crest		
Approach		
Exit/downstream channel		
Divide walls		
Gates		
Gate opening measurement device		
HEP off-take		
Other:.................................		

5.4 General Observations on Flow Measurement

....
....

6. OTHER EQUIPMENT

Item	Please ✓ the appropriate box(es)	Type and make	Serial No.	Condition	Remarks/Actions Required
SRG					
ARG					
TBR					
FCS:					
Thermometers					
Sunshine recorder					
Radiometer					
Net Radiometer					
Anemometer					
Wind direction					
Evaporation pan					
Suspended solids					
Bed load					

7. BUILDINGS AND INSTRUMENT HOUSINGS

Item	Please ✓ the appropriate box(es)	Watertight Yes/No	Secure Yes/No	General condition	Action/remarks
AWLR/DWLR housing					
Office					
Stores					
Other e.g. sleeping quarters					

Check furniture and other equipment inventory.

Comments on general state of buildings and surrounds:

....
....
....

8. ACTION ITEMS

No.	Task/Action Required	Additional Comments	Action officer	Target date for completion	Actual completion date	Action approved by

9. FINAL OBSERVATIONS

9.1 Overall comments..………………
………………………………………………..

9.2 Urgent actions..
....……………………………………..............

Date:………………….   ………………………………………….

(Signature of Inspecting Officer)

ANNEX. III
LOGBOOK FOR WATER QUALITY LABORATORIES

Location of Laboratory: …………………….. Year of Establishment:………………

SOPHISTICATED INSTRUMENTS (LEVEL II/ II+)

1. Name of the Instrument:
2. Date of purchase:
3. Cost:
4. Make/brand:
5. Warranty period:
6. Name and address of supplier:

7. Details of Annual Maintenance Contract (AMC)

    a. Name of the agency with whom AMC is signed:
    b. Date of signing AMC and duration:
    c. Address and telephone no:

8. Specifications of the instrument:

LIST OF SPARES

S. No.	Name of the spare and supplier alongwith address and bill no.	Quantity	Amount (Rs.)	Date of purchase	Shelf-life	warranty

RECORD OF MAINTENANCE

S. No.	Date	Problem/fault	Date of complaint	Complaint Receipt No.	Date of attending complaint	Status/ test report	Cost involved 9rs.)
1	2	3	4	5	6	7	8

ANNEX. IV
OTHER REQUIREMENTS OF WQ LABORATORY (LEVEL I, II & II+)

GENERAL LABORATORY EQUIPMENT

Location of Laboratory: …………………….. Year of Establishment:………………

S. No.	Name of Equipment, address of supplier and bill no.	Qty	Amount (Rs.)	Date of purchase	Detail of Maintenance/Repairing			Remark
					Nature of Repair	Date of Repair	Approx Cost (Rs.)	
1	2	3	4	5	6	7	8	9

CHEMICALS

Location of Laboratory: …………………….. Year of Establishment:………………

S. No.	Name of Chemical/ reagent	Qty.	Amount (Rs.)	Date of purchase	Detail of stock			Remark
					Name of the person to whom issued	Number/ amount issued	Balance of the stock left	
1	2	3	4	5	6	7	8	9

GLASSWARES

Location of Laboratory: …………………….. Year of Establishment:………………

S. No.	Name of glassware	Qty.	Amount (Rs)	Date of purchase	Detail of stock			Remark
					Name of the person to whom issued	Number/ amount issued	Balance of the stock left	
1	2	3	4	5	6	7	8	9

OTHER CONSUMABLES (POLYTHENE SAMPLE CONTAINERS, ETC.)

Location of Laboratory: …………………….. Year of Establishment:………………

S. No.	Name of Consumable	Qty	Amount (Rs)	Date of purchase	Detail of stock			Remark
					Name of the person to whom issued	Number/ amount issued	Balance of the stock left	
1	2	3	4	5	6	7	8	9